Free Digital Products and Aggregate Economic Measurement

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Abstract – The widespread use of free digital services such as online search and social media raises the question of how to measure the economic activity and welfare provided by zero price digital products. Among the possible approaches, the so-called stated preference method directly questions consumers about the value they place on these products. Through three large representative UK surveys before and during COVID-19 lockdowns, we ascertain consumers' stated willingness to accept the loss of a range of 'free' online and offline products, and some paid substitutes. The average stated value for free products is generally high, with clear rankings among products, while the natural experiment of the lockdown brought about changes in stated values that were often significant and of plausible sign and scale. The stated preference method therefore provides useful insights. However, there are limitations in using it to estimate aggregate economic welfare, including the absence of a budget constraint.

JEL: D12, D60, I31, C43
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There is no consensus about how best to account for 'free' digital products in aggregate economic measurement, which is crucial to inform public policy. Survey methods are one possible approach to estimating the incremental surplus contributed by these free-to-consumer products, and have been advocated as a means either of expanding GDP measurement (e.g. Brynjolfsson *et al.*, 2020; Hulten & Nakamura, 2022; Bourgeois, 2020) or valuing household production activity (Schreyer, 2022). For this approach to be useful, measures calculated using stated preference surveys would need to be reliable (consistent over time and between samples) and consistent with fundamental economic measurement principles.

Recent approaches to estimating the value that consumers place on a product that they use for free suggest asking them about the minimum financial compensation that would be required for them to accept the loss of use for a given period of time. This value is called the willingness-to-accept compensation for the loss of use of the good or service.[1] In this paper we use large-scale surveys to estimate stated willingness-to-accept (WTA) loss values of a range of zero price digital products, and some positively priced non-digital substitutes, and zero price non-digital products. We also used the natural experiment of lockdowns to explore changes in relative stated values, in three samples across a 12-month period. By comparing them to other free products, such as access to parks, and to paid-for substitutes, such as newspapers, we were able to assess whether the results are plausible in scale.

We found that some users place a high value on free digital products and mean stated values are strongly correlated with the proportion of respondents using them. The 'elasticity' of WTA in response to usage varies widely between different products. Comparing online products and offline substitutes, the online stated values are considerably higher, suggesting that there may be aspects of online use such as convenience, choice or time-saving that may deliver considerable consumer value. There were large changes in both usage and stated values between the pre- and post-lockdown surveys. The changes in ranking of the WTA for different products are plausible. We identified large differences in valuations along different demographic dimensions. We did not test willingness-to-pay (WTP) for specific products, but consistent with the contingent valuation literature we find WTA values for free products that are much larger than actual average revenues per user or comparable prices for marketed products.

In the absence of other methods for estimating the consumer surplus[2] associated with free digital products, the survey-based stated preference approach therefore provides some valuable insights. However, there are a number of open questions requiring further consideration, certainly before such estimates could be used for aggregate measurement of economic welfare, as suggested by some authors. In particular, it is not clear how to define and partition the universe of products to survey. For example, the stated values for 'social media' in general do not equal the sum of stated values for each social media platform named separately. The stated WTA values for 12 months' loss of a good typically are less than 12 times the values for one month, which may be behaviourally explicable and consistent with reasonable forms of discounting, but raises the question of the 'right' time period to use when one wants to estimate the consumer surplus. Finally, it is not obvious how to impose an adding-up constraint in terms of the time spent using free digital products and other products, whereas with paid-for products this constraint is provided by actual monetary expenditures and consumers' budget constraints. Finally, we found mean stated values were large but they exceeded the median values as sub-groups of intensive users state very high values. These differences matter if the aim is to develop an aggregate measure of economic welfare as in that case the large distributional differences in usage and values (for example, between age groups or genders) would need to be taken into account.

We conclude that users derive great economic value from 'free' digital products but without addressing these issues of aggregation, great care is needed in drawing any conclusions about aggregate economic welfare or activity. Nevertheless, surveys offer a practical method of addressing important unanswered questions about the consumer surplus arising from free digital products, absent other techniques.

1. Accounting for 'Free' Digital Products

Although national accounts aggregates may capture some aspects of these zero monetary price products, they create potentially large consumer surplus, and so there may be an increasing digital

1. Symmetrically, the value placed by consumers on a product can be measured by the stated price they are willing to pay for it, otherwise known as willingness-to-pay (WTP).

2. In the economic literature, the difference between the willingness-to-pay and the actual price paid to acquire the product is called the consumer surplus.

wedge between GDP and elements of consumer welfare (Heys *et al.*, 2019). This observation has driven interest in methods of estimating the scale of the wedge. There have been a number of suggested approaches: for example treating the data and monetary transactions involved in the provision of advertising-supported free-to-consumer digital products as a barter arrangement (Nakamura *et al.*, 2017). As an alternative, survey methods can provide a direct estimate of consumer welfare additional to the marketed activity included in GDP (Brynjolfsson *et al.*, 2019a; 2019b; 2020).

The use of contingent valuation or stated preference methods is still novel for digital products, but there is a large literature on their use in environmental economics and cultural economics (see Carson *et al*., 2001; McFadden & Train 2017 for surveys). The approach is contested for several reasons, including the potential for strategic responses, the common finding of wide gaps between willingness-to-pay (WTP) and willingness-to-accept (WTA) results for non-marketed products, and whether or not results are consistent with plausible income and substitution effects or adding up constraints (the sum of the values given to individual products should be close to the value given to the whole). Some economists (e.g. Hausman, 2013) have concluded the method is hopeless whereas others (e.g. Blinder, 1991) strongly defend the need to use interview or survey techniques in contexts where economics is unable to provide any preferred method for empirical estimation – as is the case with many non-monetary public products. While there are alternative approaches worth exploring, such as hedonic methods relying on revealed preference or household production function approaches using available measures such as time spent and travel costs, the Blinder argument has some weight in the context of digital products and services for which users do not have to pay a direct monetary price. Survey methods would also be appropriate for statistical production, as conventional economic statistics are already often survey-based, whereas the alternative approaches would require econometric methods. As noted, a number of authors are now advocating this approach to digital valuations.

In their assessment of the use of stated preference methods (in the context of environmental measurement) Carson *et al.* (2001) note that some of the criticisms of these survey-based methods are based on intuitions about responses to marginal price changes for marketed products whereas the empirical results in the literature are in fact more consistent with the context of (often non-marginal) quantity changes for public products. For example, one common criticism is that implied demand curves for products in stated preference studies have implausibly low elasticities; but the standard income elasticity of demand refers to the change in quantity demanded when income increases, whereas the elasticity of a stated valuation reflects how much the WTP/WTA for a fixed quantity of a good changes as income rises (and similarly for price elasticities). There will be a shadow price of the implicitly rationed good, such that the latter 'income elasticity' is likely to be lower than the conventional one. There have also been methodological advances in terms of ensuring incentive compatibility, as another common criticism is that they are being asked about hypothetical situations rather than an actual choice situation, so have no incentive to answer sincerely. Surveys can be designed to elicit 'true' answers (i.e. to be incentive-compatible). However, some key issues remain, notably 'anchoring' effects from survey questions on the size of respondents' valuations, or in other words they give answers that are influenced by the figures given in the questions; the WTP-WTA gap when the corresponding compensating and equivalent variation should be close (which also sometimes manifests itself with some marketed products, such as large bid-ask spreads in options markets); and the question of whether the sum of valuations when people are surveyed about products individually is within their budget. In our context, the relevant 'currency' for the budget constraint would plausibly be time used (Coyle & Nakamura, 2022).

More recently there have been some examples of either the stated preference approach or experimental methods being applied in the context of digital products and services for which there is no direct market price, or where there are likely to be significant externalities including network effects (Brynjolfsson *et al.*, 2019a; 2019b). This has contributed to a broader debate about whether and how these 'free' products should be accounted for in aggregate economic measurement (e.g. Ahmad & Schreyer, 2016; Nakamura *et al.*, 2017; Bourgeois, 2020).

In their influential contribution to this new literature, almost all of which concerns the US, Brynjolfsson *et al.* (2019a) used large-scale online choice experiments to elicit consumer surplus estimates and concluded that the welfare value (beyond GDP) was large. For instance, in their incentive-compatible discrete choice experiments, the median US Facebook user needed around $37 to give up the service for a month (although just $322 to give up 'all social

media' for one year). Others have reported a range of median values – a lower (annual) figure of $59 willingness-to-accept and a median $1 willingness-to-pay in Sunstein (2019) to over $1,000 a year in Corrigan *et al.* (2018). The method was extended by Brynjolfsson *et al.* (2019b) to calculate an extended GDP, "GDP-B", using estimates of consumer welfare elicited from online discrete choice experiments for a number of products. These authors calculated growth in the wider measure, concluding that it would add 0.05 to 0.11 percentage points a year to US growth compared to conventional GDP. Hulten & Nakamura (2022) also suggest using stated preference methods as a means of estimating their proposed E-GDP (GDP expanded by incorporating shifts in consumer technology), while Schreyer (2022) uses the Brynjolfsson *et al.* method to construct a value for the household use of Facebook.

In another interesting recent study Allcott *et al.* (2020) found median annual values for Facebook of around $100 using similar methods, but queried aspects of the methodology. For example, some studies they consider did not require users to actually deactivate their social media accounts. In particular, though, they find that willingness-to-accept stated values are not firmly anchored, and furthermore changed after users in their experiment had actually gone without Facebook: "*We find that four weeks without Facebook improves subjective well-being and substantially reduces post-experiment demand*." (Allcott *et al.* 2020, p. 672). This result, if confirmed, raises some fundamental questions about the nature of consumer preferences, which both conventional and stated preference methods take to be well-determined and stable. On the other hand, Collis & Eggers (2019) do not find any impact of social media usage on well-being.

However, the literature applying stated preference methods to free digital products remains limited and has not to date been applied to many countries other than the US. Furthermore, there is increasing interest in the insights from survey data for related research questions, such as the impact of the COVID-19 pandemic (e.g. Adams-Prassl *et al.*, 2020; Alsan *et al.*, 2020). In this paper we test the approach in the UK, across the period of lockdowns. In contrast to previous work, we also take advantage of a large and representative sample to investigate differences between groups.

2. The Surveys

We use surveys representative of the UK online population to elicit stated willingness-to-accept (WTA) values, using insights from a series of pilots to test valuation ranges proposed to the respondents and which products to include. As of December 2021, 6% of the UK population did not have internet access at home, the largest number being the over-75s; this was sufficiently small that reweighting to adjust did not significantly affect the main results, but we discuss this further in reporting results by socio-demographic groups.[3] The pilots were conducted in 2019, and full-scale surveys in February 2020, May 2020 and February 2021. This enabled us to incorporate the natural experiment provided by the UK COVID-19 lockdown, which led to a rapid switch to readily available digital tools in people's personal and professional lives, while other personal demographic features remained largely constant over the 10-week period between the first two surveys. We also use the large size and representative character of our sample to explore socio-demographic differences.

We opted for an online survey representative of the UK's population with home internet access, rather than more costly incentive-compatible laboratory experiments designed to ensure respondents do not give hypothetical answers, in order to test a method providing a large sample and scalable for regular estimation or statistical production. One of the concerns in the stated preference literature is whether respondents will be honest, or alternatively have strategic reasons to misstate their 'true' valuations. Although our approach is not incentive compatible in the sense of actually withdrawing the products included in the survey in return for payment, there does not seem to be a strong rationale for strategic misstatement in this context.[4] Moreover, for many products it was neither feasible or ethical to actually remove access and enforce it at scale (e.g. online news, personal email, public parks, TV sets). In order to check the robustness of our approach, we supplemented the survey with some 'best-worst scaling' (BWS) questions as a test for the consistency of preference rankings in a forced choice context. The plausible scale of changes in stated values during the pandemic also offers another check.

Initially, we ran pilots to test the products to include and select appropriate valuation bands for all the products. Fuller discussion of the pilots is in the Online Appendix S1 (link to

3. https://www.ofcom.org.uk/__data/assets/pdf_file/0022/234364/digital-exclusion-review-2022.pdf

4. The survey of 30 questions takes around 15 minutes to complete and participants are not directly paid for their time. YouGov does offer a minimal compensation using a points-based system, but people need to take part in a considerable number of surveys to reach the first payout.

the Online Appendix at the end of the article), along with the final survey. For the large-scale surveys we selected the price bands that resulted in a distribution of stated values, for 1 month and 12 month periods. Where specific products have high usage rates among the population (e.g. Facebook) we opted to ask about them specifically rather than at the category level (e.g. all social media). Asking about categories instead about specific products is more useful where there are many competing providers but it is possible that people might not consider the full ramifications of giving up access (i.e. no substitutes).

We ran three survey waves using YouGov's online panel for Great Britain, in February and May 2020 and February 2021. In waves 1 and 3 we surveyed 10,000 people, while wave 2 included 1,600 respondents. The latter was intended to capture the impact of lockdown conditions specifically.[5] Of the 10,000 individuals that took the survey in February 2020 around 5,000 took it again in February 2021. In addition, we included 5,000 individuals who had not previously completed the survey. In each wave we randomly asked half the sample to consider either a valuation period of 1 month or 12 months. Of the 5,000 individuals that took both large surveys, 2,500 of them were asked about the same period (i.e. 1 month or 12 months) both times.

We selected 30 products for the survey, based on 1) number of users and time spent on them; 2) products used in the previous literature, to allow some comparisons; 3) a wider coverage of categories than prior studies (for example including banking, gaming, news, some non-digital free and some non-digital products that are potential marketed substitutes). The surveyed products were identical for waves 1 and 2. For wave 3 (February 2021), we dropped "Citymapper" (not used widely outside London) and also"Facebook Messenger", as Messenger is now an integrated function of "Facebook". We added TikTok and Zoom in wave 3, as they had emerged as widely used digital tools during 2020, albeit Zoom is more widely used for professional than personal purposes (see the Online Appendix S2 for further details). Survey participants were asked about their willingness-to-accept giving up 30 different products for one or 12 months. The order in which the products were presented to participants was randomised. Participants were asked to select from the pre-determined valuation bands shown in Figure S1-I in the Online Appendix S1. The advantage of using pre-defined bands is that our results are less likely to be influenced by the few extreme values observed when testing open boxes in the pilots.

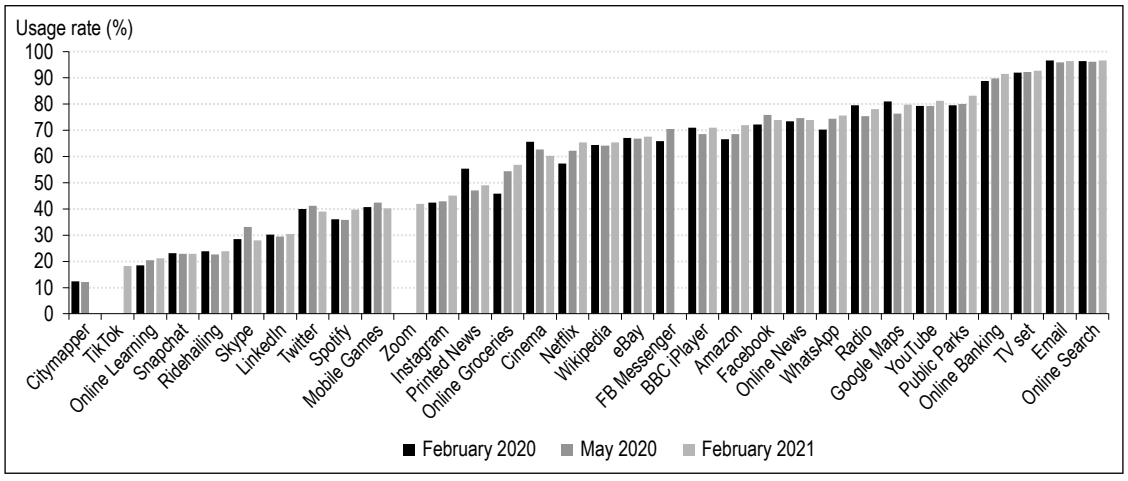
3. Results

3.1. Usage

Not surprisingly, there are significant differences in the extent to which the different products and services are used, ranging from almost universally for personal email and online search (over 95% of respondents) to minority usage of categories such as online learning (of most use to households with children) or Snapchat and TikTok (aimed at a specific demographic) (Figure I). As the first two survey waves were

5. The first COVID-19 death in the UK occurred on 5th March and the country officially went into lockdown on 23rd March. The first steps in easing 1st lockdown restrictions in the UK occurred on 13th May. A second lockdown was in place in February 2021.

Figure I – **Proportion who use specified products**



Source: Authors' YouGov survey results.

only 10 weeks apart and people were asked to consider the next 12 months, one might not usually expect large changes in usage rates; but there were in fact significant changes in some categories during lockdown (Table 1). Again, these were not surprising in the circumstances, but they do provide interesting insights into substitutability between digital and non-digital products. While in February 2020 around 45% reported that they shop online for groceries, this had increased to 54% by mid-May and 57% by February 2021. The share of people using Skype, Facebook Messenger, Netflix and WhatsApp also increased by around 5 percentage points after the UK went into lockdown. Other products that saw an increase in usage were Facebook, online learning, mobile games, Amazon Marketplace and Twitter. On the other hand, the usage of various other products declined. In February 2020 around 55% reported they use (offline) printed newspapers or magazines, and this decreased to 47% in mid-May. Reported use of Google Maps, Radio, BBC iPlayer and cinemas also decreased somewhat.[6]

3.2. Stated Values

Table 2 shows the mean and survey and median stated values for 12 months in each of the three waves (confidence intervals are shown in the Appendix 3, Figure A3; they are small given our sample size).

Stated values are strongly positively correlated with usage, with a February 2020 correlation coefficient of 0.84. We find higher values than would be indicated by a linear relationship

6. Cinemas were closed at that point, but the question asked about 12-month usage.

Table 1 – **Proportion who use, ranked by annual percentage point change between February 2020 and February 2021**

	February-20 (%)	May-20 (%)	February-21 (%)	February-20 to February-21
Online groceries	45.7	54.3	56.9	11.2
Netflix	57.2	62.2	65.3	8.1
WhatsApp	70.3	74.5	75.6	5.4
Amazon	66.6	68.5	71.8	5.3
Public parks	79.7	80.1	83.3	3.6
Spotify	36.1	35.7	39.7	3.6
Online banking	88.8	89.7	91.5	2.7
Instagram	42.3	42.8	45.0	2.7
Online learning	18.6	20.3	21.0	2.5
Facebook	72.1	75.9	74.0	1.9
YouTube	79.3	79.2	81.1	1.9
Wikipedia	64.5	64.1	65.4	0.9
TV set	92.0	92.2	92.8	0.8
Online news	73.3	74.6	74.0	0.7
eBay	67.1	66.8	67.6	0.5
Online search	96.4	96.2	96.8	0.4
LinkedIn	30.2	29.3	30.4	0.2
BBC iPlayer	71.0	68.6	71.0	−0.1
Ridehailing	23.9	22.5	23.7	−0.1
Email	96.6	95.9	96.4	−0.2
Snapchat	23.1	22.8	22.7	−0.4
Mobile games	40.7	42.4	40.2	−0.5
Skype	28.4	33.2	27.9	−0.5
Twitter	39.9	41.2	38.9	−1.0
Google Maps	80.9	76.4	79.8	−1.1
Radio	79.5	75.5	78.1	−1.4
Cinema	65.7	62.7	60.2	−5.5
Printed news	55.2	46.9	48.9	−6.3
Zoom			41.8	
TikTok			18.2	
Citymapper	12.3	12.0		

Sources: Authors' YouGov survey results.

Table 2 – **Average and median 12-month stated values (£) and annual growth (%)**

	Average (£)			Growth (%)		Median (£)	
	February-20	May-20	February-21	2020-21	February-20	May-20	February-21
Amazon	1,782	1,826	1,995	11.9	50	50	150
BBC iPlayer	1,400	1,387	1,352	−3.4	50	50	50
Cinema	1,212	1,040	936	−22.8	50	50	50
Citymapper	286	231	-		10	10	
eBay	1,339	1,424	1,443	7.7	50	50	50
Email	5,912	5,827	5,855	−1.0	3,500	3,500	3,500
Facebook	2,159	2,393	2,214	2.6	150	150	150
FB Messenger	1,826	1,996	-		50	50	
Google Maps	2,246	1,807	2,011	−10.5	150	150	150
Instagram	1,075	1,123	1,128	4.9	10	10	10
LinkedIn	395	367	371	−6.1	10	10	10
Mobile games	973	1,020	954	−2.0	10	10	10
Netflix	2,086	2,306	2,479	18.9	50	50	150
Online banking	4,839	4,878	5,068	4.7	1,500	1,500	1,500
Online groceries	1,203	1,818	1,886	56.7	10	50	50
Online learning	404	515	464	15.0	10	10	10
Online news	2,129	2,167	2,124	−0.2	150	150	150
Online search	5,428	5,505	5,411	−0.3	1,500	1,500	1,500
Print news	954	729	868	−9.0	50	10	10
Public parks	3,359	3,688	4,004	19.2	350	350	750
Radio	2,909	2,673	2,756	−5.3	350	150	150
Ridehailing	395	341	383	−2.9	10	10	10
Skype	548	558	471	−14.1	10	10	10
Snapchat	569	553	518	−8.9	10	10	10
Spotify	1,134	999	1,356	19.6	10	10	10
TikTok			485				10
TV set	5,630	6,095	5,957	5.8	3,500	3,500	3,500
Twitter	912	685	842	−7.7	10	10	10
WhatsApp	2,658	3,064	2,789	5.0	150	350	150
Wikipedia	1,185	1,151	1,137	−4.0	50	50	50
YouTube	2,360	2,455	2,522	6.9	150	150	150
Zoom			611	11.9			10

Sources: Authors' YouGov survey results.

with usage for the four most used products: online banking, physical TVs, online search and personal email. This seems to indicate that consumer surplus grows at an increasing rate with the proportion of people using a good, consistent with the existence of network effects.

The stated WTA values for 12 months loss of access are broadly in line with the values we get when multiplying the monthly values by 12 but for some products these "imputed" annual values are higher than the stated annual values (LinkedIn, Facebook, Instagram, mobile games, printed news), while for others they are lower (public parks, Amazon, cinema, Wikipedia). The first case could imply 'overvaluation' of short periods or 'undervaluation' of longer periods.[7] The latter would be consistent with the frequent finding in behavioural economics that some form of hyperbolic discounting of the future is common (Frederick *et al.*, 2002). Other explanations are of course possible, including people's consideration that there is more potential for substitution to other products over a longer time frame. For a third set of products, the ratio of annual to 12 times monthly stated values is almost exactly one. This includes online search, personal email and physical TV sets, the three most widely used and most highly valued of the 30 products.

We did not ask willingness-to-pay questions, but the WTA results can perhaps be benchmarked against average revenues per user (ARPU) for the free service providers; the two measures are clearly unrelated but ARPU could be a starting

7. As stated above, half of survey respondents were asked to consider giving up access for 12 months and the other half for 1 month. None were asked to consider both.

point for how a service provider might think about pricing the service if it were a subscription offer. Ofcom (2019) estimates per capita revenues for various online services in the UK in 2018.[8] In this Ofcom study, ARPU for online search was estimated to be £101, for social media £45, for free video streaming £27, for online news £11, for online shopping £1,094, for online entertainment £47, and for online gaming £63. In almost all of these examples, the stated values in our surveys exceed these ARPU figures by a large margin.[9] Although this should be interpreted with caution given the pricing structures and loss-tolerant business models of digital platforms, this gap is consistent with consistent findings of a large gap between willingness-to-accept and willingness-to-pay valuations both in this context and more broadly in the contingent valuation literature (Sunstein, 2019). Our mean Facebook WTA valuation of £1,278 for 12 months compares with the range of $48 (for the median user) to $1,000 in the related US literature discussed earlier, whereas the median band selected in our surveys was a more comparable £101-200.

Looking at the ratio between those aged 18-24 to those aged 65 or over, the difference in stated values is most pronounced in the case of Snapchat (valued about 50 times more by the younger people), Instagram and Spotify (15 times), online learning and Twitter (10 times). The differences are less pronounced but still large when comparing the 18-24 group to respondents over the age of 50. As might be expected, however, older people tend to value non-digital services more than the younger people. For instance, stated values for printed newspapers, radio, and a physical TV set were twice as high for those above 65 than for those aged 18-24. In the case of Amazon, personal email, online banking, eBay and BBC iPlayer there appear to be no significant difference in valuations between younger and older age groups.

There are also some striking gender differences in average stated values (Table 3). While some products are heavily skewed towards one gender (e.g. Instagram +60% for women, Twitter +40% for men in 2020), other widely used ones only show minimal differences (TV set, Amazon marketplace, online banking, radio, public parks). Gender differences also changed considerably over the three waves. In some cases, they have become narrower (e.g. online news +28% for men in 2020 down to +21% in 2021). Most strikingly, the stated values for online learning were heavily skewed towards men in 2020 (+72%) but much less so in 2021 (+4%). In other cases, stated values have become even more skewed in one direction (e.g. LinkedIn +42% for men in 2020 and +62% in 2021; mobile gaming +19% for women in 2020 and +31% in 2021). In a few instances, the stated values skewed towards one gender have flipped to the opposite (Spotify +12% for men in 2020 but +8% for women in 2021).

3.3. Changes in Stated Values

We were interested in changes between waves 1 and 2 (February and May 2020), attributable to the lockdown, and over the year between waves 1 and 3 (February 2020 and February 2021).

Between February and May 2020 there were significant increases (at the 5% level) in stated values in the case of six products (online groceries, online learning, WhatsApp, Netflix, Facebook, public parks, and TV sets). There were significant decreases in stated values for nine products, including the online services related to mobility and inaccessible services such as cinemas. Full details are in the Online Appendix S4. The changes in stated values were strongly positively correlated with changes in usage, with a correlation coefficient of 0.74. It is striking how large some of these changes are in just 10 weeks, although generally intuitive. For example, there is a very large positive change in the value stated for online grocery shopping with the biggest increases being among women (from £826 to £1,426) and the oldest age categories (from £476 to £1,083 among over-65s). Similarly, while stated values for Facebook decreased by 2%-4% for those aged 25-65, they increased by 26% for those aged 18-24 and by 38% for those aged above 65.

Looking at the entire period from February 2020 to 2021, Figure II shows the percentage change in mean stated values. As the UK was again in lockdown in February 2021 – and given that some changes in behaviour are likely to persist – the same patterns as over the shorter period are evident. In a small number of cases, though (e.g. Spotify, search) the direction of change switches between the three months and one year comparisons.

8. Based on estimates of UK market share in total global revenues, averaged across UK population rather than actual users. ARPU per user will be somewhat higher.

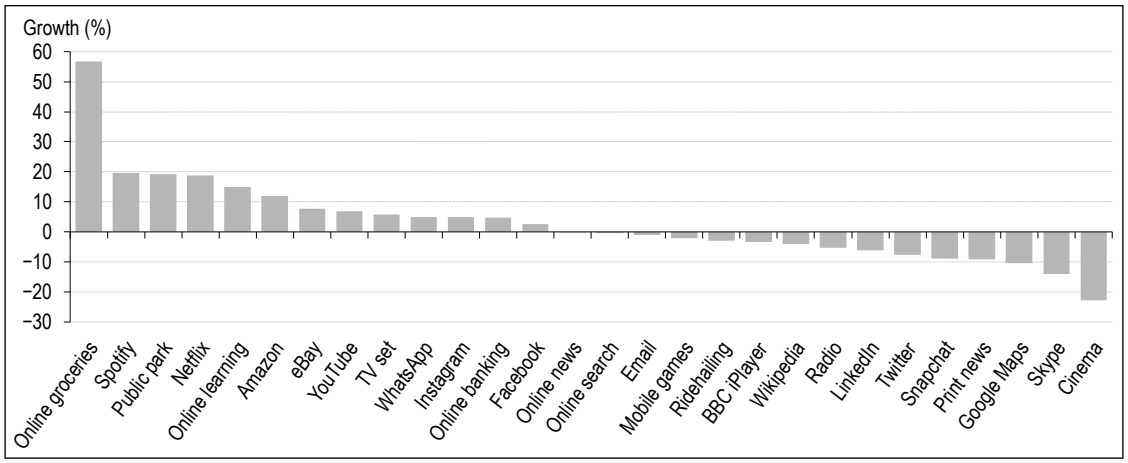
9. The exception being online shopping in February 2020, although we only consider online grocery shopping rather than all online shopping.

Table 3 – **Gender skews: Valuation "premium" by gender, February 2020 and February 2021 (%)**

	February 2020		February 2021	
	Skewed M	Skewed F	Skewed M	Skewed F
Facebook		+42		+35
Instagram		+65		+40
Twitter	+45		+34	
LinkedIn	+41		+66	
Snapchat	+11			+2
Online search		+2		+8
Email	0		+8	
WhatsApp		+39		+46
FB Messenger		+51		
Skype	+13		+27	
Amazon		+3		+5
eBay	+12		+14	
Online groceries		+36		+40
Ridehailing	14		+36	
Google Maps		+6	+11	
Citymapper	+11			
Online news	+26		+23	
Mobile games		+20		+30
Spotify	+11			+7
YouTube	+37		+44	
Netflix		+29		+43
BBC iPlayer		+15		+13
Wikipedia	+47		+69	
Online learning	+71		+5	
Online banking	+1			+3
TV set		+2		+6
Print news	+21		+24	
Cinema	+5		+21	
Radio	+2		+4	
Public parks		+5		+3
TikTok				+24
Zoom				+47

Sources: Authors' YouGov survey results.

Figure II – **Changes in 12-month stated values: February 2020-February 2021**



Source: Authors' YouGov survey results.

3.4. Demand Curves and Consumer Surplus

Stated values could be used to estimate the consumer surplus associated with free digital products, if the aim is to calculate an aggregate measure. By consumer surplus we refer specifically to the area under the demand curve but above the market price (zero here), as is the common practice in this literature. The mean or median of the individual WTA results could be used as the relevant shadow price. Some studies have tried to capture the consumer surplus thus defined of these products by looking at the time spent using them (Goolsbee & Klenow, 2006; Brynjolffson & Oh, 2012). Based on search time savings Varian (2011) estimates that the consumer surplus of Google was around 2-4 times its advertising revenue of $36 billion per year in 2011. Another approach has looked at advertising revenue (Nakamura *et al*., 2017). Both approaches have the drawback that consumer surplus could be very high for some products despite users spending little time on them (e.g. online banking), or their having little associated advertising revenue (e.g. Wikipedia, or niche products with a dedicated user base).

We construct implied or shadow demand curves for the products surveyed. In the case of Facebook, for example, 28% of our respondents reported that they do not use it at all. In other words, even at a zero price their marginal utility from using Facebook is zero, while it is positive for 72% at a £0 WTA.[10] Similarly, we find that 21% of respondents require between £1-100 to give up access to Facebook for 12 months. If we subtract those from the respondents that would rather keep access at that level, we can see that for an expected payment of maximum £100, around 51% of our sample would choose to consume Facebook, and 49% would give up access. This is because those who would give up access for £1 would also do so for £100 (we asked for the "lowest amount" people would be willing to accept to forego access). Compared to this, when offered £100 only 18% of respondents would give up access to personal email. Continuing this calculation for Facebook, we arrive at less than 9% of respondents willing to keep access when offered between £5,001-10,000. Log-linear demand curves for a selected number of products in each wave constructed in this way are shown in Figure III (digital) and Figure IV (non-digital); the rest are shown in the Appendix 1. The minimum quantity and the implied 'elasticities' are highly variable between products.

But note that the intuition differs from standard demand curves showing price and quantity for market products. The demand curves here show the proportion of people who would not access the good (varying 'quantity') at different 'prices' (i.e. WTA levels). As quantity accessed is varying, a steeper curve indicates a bigger change in the WTA amount required and hence a *more* elastic response to the quantity change. For example, based on our findings this implies that cinema and newspaper demand are rather elastic while personal email and search or TV set demand is inelastic with respect to quantity. The thought experiment behind these demand curve differs from that behind the standard price-quantity relationships in the case of marketed products, although in principle the measure of consumer surplus remains the area under the shadow demand curve. It is immediately apparent that these numbers would be large if aggregated up to the population. For example, with about 57 million adults in the UK, and 72% stating a non-zero WTA for zero price Facebook alone, with a (12 months) median of £150, the total across the universe of free digital products would be enormous. However, as we discuss below, aggregation is not straightforward.

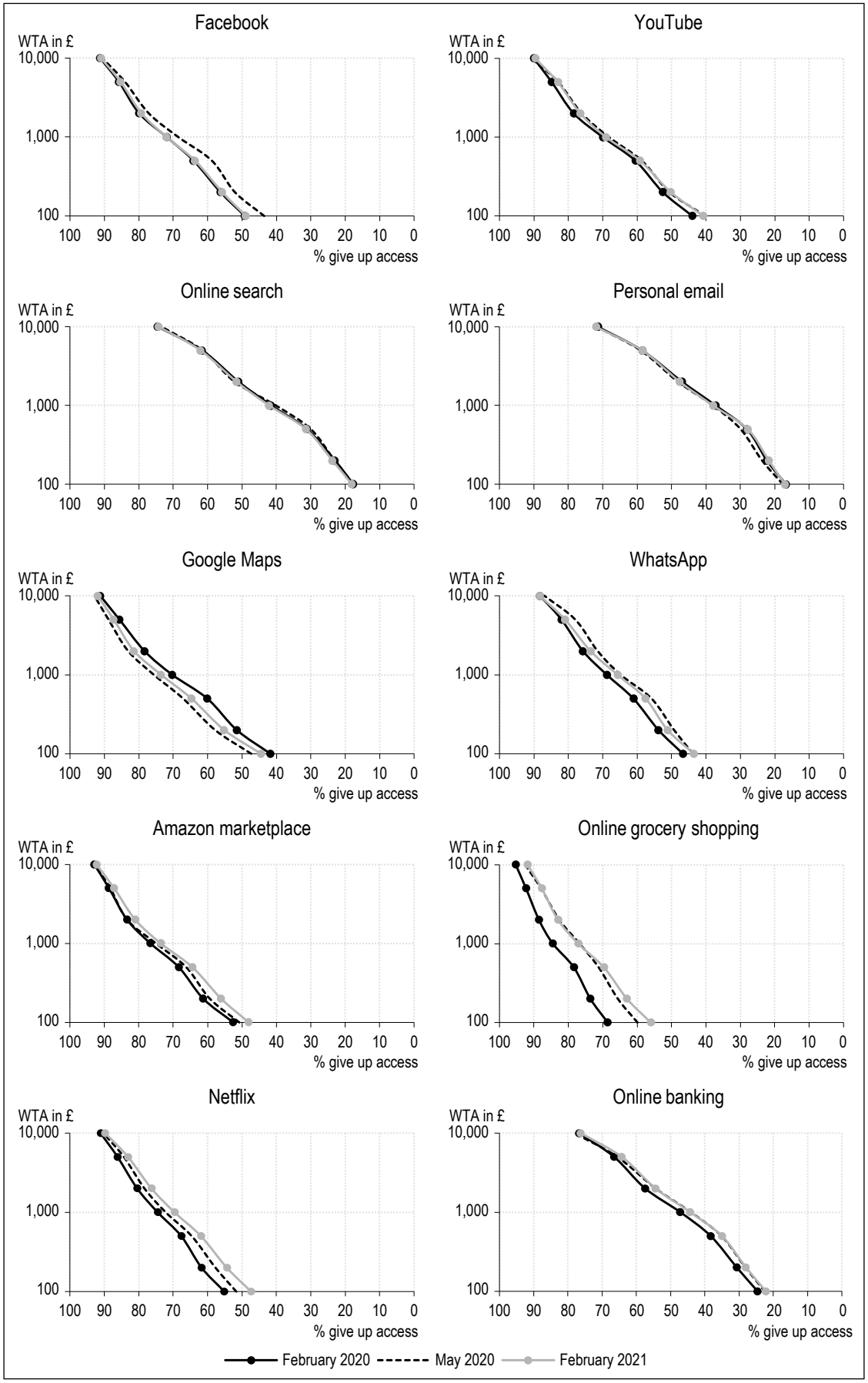
3.5. Socio-Demographic Differences

The stated values themselves display considerable differences across demographic groups. Table 4 shows the percentage change across waves 1 and 2 and waves 1 and 3 for different age groups for all the products. Many have a pronounced age gradient in one direction or the other, although generally the changes are less pronounced over the full year than over the 3 months of 2020. Note that the results for the 65+ age group are thus the most likely to be affected by the under-representation of over-75s in the sample.

Table 5 shows regional divergences in valuations, compared to GB average in February 2021. Regions with the highest differences from the average are highlighted. Regional differences in valuations in some instances are large (minimum 500 observations by region for waves 1 and 3, see the Online Appendix S7 for details). For example, average stated values for LinkedIn are 200% of the national average in London and

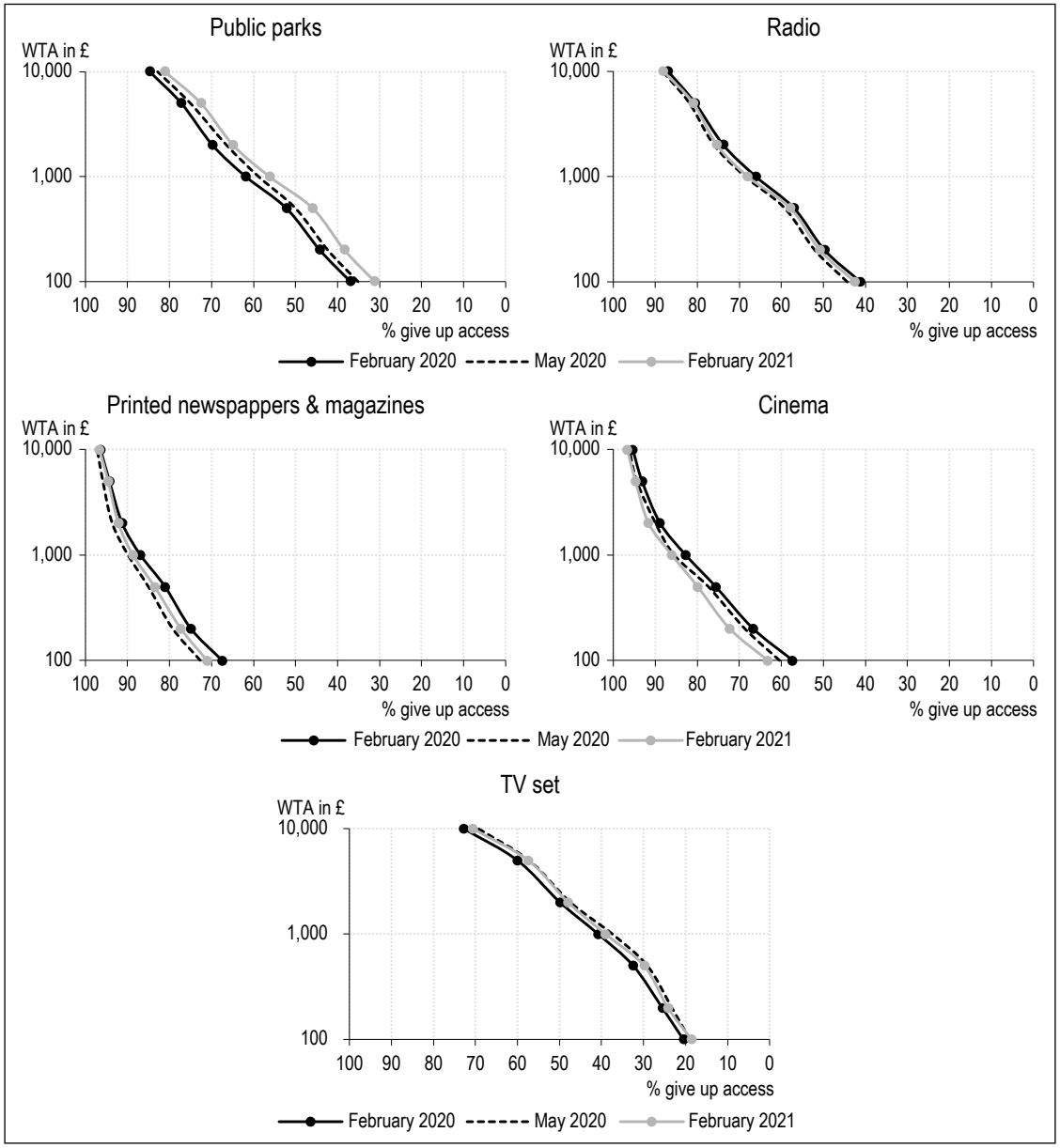
10. While we know whether a consumer uses a certain product (e.g. Facebook, public parks), we do not know anything with regards to quantity or quality of usage (e.g. time spent, condition of local park). In addition, there are entry costs to using free digital products, including mobile devices such as smartphones and tablets, and internet access. However, while these costs can be high, they are likely to be stable or decreasing over time. This is supported by the fact that the average smartphone penetration and monthly usage of mobile broadband has been increasing steadily over time. On average UK households spent £77.50 on all telecoms services in 2019, a 6% decline from the previous year; Ofcom 2020 https://www.ofcom.org.uk/__data/assets/pdf_file/0026/203759/cmr-2020.pdf.

Figure III – **Demand curves for selected digital products, February 2020 to February 2021**



Source: Authors' YouGov survey results.

Figure IV – **Demand curves for selected non-digital products, February 2020 to February 2021**



Source: Authors' YouGov survey results.

only 38% in the South West of England. Other "London-skewed" products include Wikipedia (189%) and ride-hailing services (183%) as well as some social media (Instagram, WhatsApp, TikTok, and Twitter). Interestingly we also find this skew for some "offline" products such as cinema (126%), print news (136%) and public parks (121%). However, valuations of access to personal email, a TV set, online search, and to some degree online banking, online news, YouTube, and radio are much more evenly distributed across geography.

To summarise conveniently the multivariate relationships between stated values and the socio-demographic characteristics of interest, we regressed stated values on gender, education, age and region of residence, choosing as reference categories: male, no degree, 25-49, and London. We used standard Ordinary Least Squares to control for several characteristics simultaneously and illustrate correlations. We do not claim any the relationships to be causal. We generated a variable 'low income' for those with incomes below £20,000 a year and included a dummy variable for respondents using a mobile phone or tablet to complete the survey (as opposed to a laptop/desktop). The coefficients in Table 6 can be interpreted as the stated value in pounds for the period. The table presents the results for the 12-month stated values for Facebook and 5 other products, as examples.

Table 4 – **Changes in mean stated values by age group: February-May 2020 and February 2020-February 2021 (%)**

	February-May 2020				February 2020-February 2021				
	18-24	25-49	50-64	65+	18-24	25-49	50-64	65+	All
Facebook	19.2	1.0	3.0	47.1	3.6	−3.5	9.8	10.9	2.6
Instagram	15.3	−8.4	15.6	20.6	−14.4	9.0	33.4	14.9	4.9
Twitter	−46.3	−8.6	−16.7	−53.4	−42.6	14.1	1.3	−19.2	−7.7
LinkedIn	−12.6	−3.9	−2.1	−29.8	−44.0	10.9	−20.9	11.0	−6.1
Snapchat	2.4	−18.5	41.2	−45.4	−14.5	−8.1	15.5	−1.9	−8.9
Online search	−10.6	4.0	−10.1	20.3	2.0	−0.2	−1.1	−3.2	−0.3
Email	−4.7	−3.3	2.6	0.1	−2.5	−0.1	1.3	−5.9	−1.0
WhatsApp	30.9	2.7	35.6	28.0	−1.3	1.0	9.6	15.6	5.0
Skype	−0.1	−8.4	−6.2	30.0	−41.5	−9.6	−16.5	10.3	−14.1
Amazon	−13.2	5.5	1.9	5.0	10.8	12.5	9.5	14.2	11.9
eBay	−5.7	18.0	−4.8	1.3	1.7	11.5	13.2	−5.7	7.7
Online groceries	−7.6	39.5	40.3	146.4	32.6	47.9	54.7	103.8	56.7
Ridehailing	−46.1	7.0	−15.5	−28.5	−25.5	2.2	32.4	−9.9	−2.9
Google Maps	−7.7	−15.4	−32.3	−35.5	−13.4	−7.1	−16.3	−17.7	−10.5
Online news	−21.6	0.6	7.6	18.6	−15.6	1.3	3.6	3.8	−0.2
Mobile games	−21.3	16.3	7.1	−13.2	−16.7	4.5	−6.3	−7.5	−2.0
Spotify	−21.1	−3.9	−20.0	−15.2	11.5	25.0	0.7	64.7	19.6
YouTube	5.0	3.0	−7.9	15.1	3.0	7.8	4.9	8.2	6.9
Netflix	7.3	7.6	5.0	40.7	3.1	22.3	7.4	44.3	18.9
BBC iPlayer	8.9	−0.8	−5.0	−2.0	−17.8	−3.5	2.5	−2.1	−3.4
Wikipedia	−18.4	−10.6	17.1	18.4	−9.8	−4.3	3.8	−8.5	−4.0
Online learning	33.2	32.6	20.2	−16.4	6.6	22.0	2.7	18.4	15.0
Online banking	−19.1	1.7	7.4	2.4	1.4	6.2	7.6	−1.0	4.7
TV set	7.9	7.1	7.4	13.5	4.2	7.6	2.6	7.2	5.8
Print news	−36.1	−10.0	−38.3	−20.3	−21.7	−4.0	−13.7	−5.8	−9.0
Cinema	−44.2	1.8	−29.5	−4.6	−23.7	−19.1	−29.2	−24.5	−22.8
Radio	10.7	−6.0	−14.3	−7.4	−13.1	−4.2	−0.5	−9.7	−5.3
Public parks	19.4	18.7	1.7	−9.7	47.1	15.3	10.3	26.1	19.2

Sources: Authors' YouGov survey results.

Recall that the mean and median values across the sample for loss of Facebook for 12 months (in February 2020) were £1,278 and £101-200, respectively, with 75% of respondents using it. Women responded that they would require a 40% higher monetary amount than men to give up use of Facebook for 12 months, reflected in the high and highly significant coefficients on the Female variable here. Regional dummies were insignificant. More educated respondents stated lower values.

Public parks are most valued by the age group 25-49, and there are also significantly lower valuations outside London. Online search – which has high mean and median valuation across the whole sample – is most valued by more educated and younger groups. Interestingly, by contrast Brynjolfsson *et al.* (2019a) found that in the US search was valued more by people above 55. Twitter and Instagram skew mobile respondent and young, but Twitter skews male while Instagram skews female. Snapchat skews young and strongly toward those who do not have a degree. For online news there is a strong skew toward male, highly educated people, and some degree of skew towards London users, while the oldest age group is significantly less likely to value online news. Printed news on the contrary skews female and older.

The results serve to underline an important point about using such stated values for constructing aggregate economic welfare measures. They show that the selection of products to include in any aggregate total will have significant distributional implications as between different socio-demographic groups, which ought to be taken into account if the aim is an estimate of total welfare.

3.6. Best Worst Scaling Questions

At the end of the survey, for robustness, we presented respondents with a best-worst-scaling (BWS) question. Among a set of choices, participants had to pick the one they were most and

Table 5 – **Regional variations in average stated values (compared to national average): February 2021 (%)**

	North East	North West	Yorkshire & The Humber	East Midlands	West Midlands	East of England	London	South East	South West	Wales	Scotland
Facebook	88	107	123	108	84	87	104	92	94	108	107
Instagram	84	83	108	105	91	74	142	96	89	111	108
Twitter	113	98	85	115	68	75	138	98	70	94	143
LinkedIn	61	98	46	145	104	88	200	112	38	80	68
Snapchat	103	121	130	75	114	51	94	121	52	150	101
Online search	93	98	109	98	89	91	103	106	94	103	111
Email	81	97	109	102	93	100	106	101	96	91	108
WhatsApp	74	109	91	84	87	108	135	99	78	105	104
Skype	51	99	97	86	86	53	126	117	80	138	146
Amazon	87	104	102	120	109	92	93	101	77	99	115
eBay	69	110	108	118	107	112	71	107	93	78	107
Online groceries	86	90	97	102	83	108	99	121	93	101	104
Ridehailing	112	101	79	57	104	36	183	94	74	87	150
Google Maps	75	117	116	101	87	84	127	92	77	91	112
Online news	107	116	93	107	80	76	116	115	97	92	86
Mobile games	129	99	120	100	106	64	86	109	79	113	124
Spotify	88	122	105	85	68	63	133	121	73	103	112
YouTube	88	115	101	85	84	94	117	99	81	102	118
Netflix	97	95	111	105	82	89	109	109	84	105	110
BBC iPlayer	100	96	101	101	83	84	106	105	115	120	94
Wikipedia	108	90	118	94	72	66	189	96	71	96	73
Online learning	64	108	66	104	139	71	138	100	68	88	121
Online banking	93	104	102	111	85	99	106	94	91	113	107
TV set	115	104	111	94	91	102	83	103	101	105	103
Print news	123	116	82	59	87	95	136	105	93	90	97
Cinema	101	111	109	94	87	46	126	100	91	122	118
Radio	105	91	113	99	96	105	90	96	112	103	101
Public parks	85	109	92	92	83	100	121	97	92	95	113
TikTok	77	139	66	106	101	84	138	94	58	75	125
Zoom	90	69	60	73	72	81	142	148	113	62	132

Note: For each product, the national average is set to 100. In the East Midlands, the average value reported for Facebook is 8% higher than the national average. The grey cells indicate the region where the value is highest.
Sources: Authors' YouGov survey results.

least willing to give up (see the Appendix 2 and Online Appendix for details). The seven choices were Facebook, personal email, WhatsApp, online search, Wikipedia, public parks, and 'earning less' (in order to provide a monetary benchmark – with an amount of annual income reduction drawn randomly from five options).

As expected, the smaller the hypothetical reduction in income, the fewer respondents selected it. For example, while 40% say they would be least willing to accept earning less when facing a decrease in annual income of £10,000, the proportion was 20% in the case of earning £500 less per annum and only 9% when earning £100 less. This indicates that people make intuitive choices between losing access to specific products and monetary values.

Second, the proportion of respondents least willing to give up access to personal email or online search was higher when the amount of income reduction proposed was smaller. This again shows that respondents were making the expected trade-offs between the size of reductions in income and loss of access to products. For example, the proportion stating they would be least willing to give up personal email was very similar when the alternative was an income loss of either £5,000 or £10,000 a year (around 21-22%). However, at an income loss of only £100-500 a considerably higher proportion (29-32%) said they would be least willing to give up email. There was an equally pronounced trade-off in the case of online search. When the alternative was an income loss of £10,000 or £5,000, 8-11% opted for access to online search

Table 6 – **Regressions, using 12-month valuations, February 2020**

	Facebook	Public park	Online search	Twitter	Snapchat	Online news
Female	490.8***	18.61	122.3	−147.6**	−4.383	−236.9**
	(−5.72)	(−0.17)	(−1.00)	(−2.62)	(−0.11)	(−3.02)
Low income	152.8	−83.9	−142.1	106.3	65.98	−35.06
	(−1.44)	(−0.63)	(−0.95)	(1.54)	(−1.34)	(−0.33)
Mobile device	229.5*	288.9*	155.6	74.19	73.22	−124.9
	(−2.52)	(−2.53)	(−1.20)	(1.24)	(−1.72)	(−1.35)
GCSE	−354.3	−76.86	412.8	−82.42	−145.5	17.47
	(−1.70)	(−0.29)	(−1.36)	(−0.61)	(−1.49)	(−0.08)
A Level	−469.9*	−27.31	497	−163	−83.52	−45.78
	(−2.26)	(−0.10)	(−1.66)	(−1.43)	(−0.86)	(−0.22)
Degree	−676.6***	349.1	693.0*	−183.6	−315.9***	139.9
	(−3.43)	(−1.41)	(−2.43)	(−1.43)	(−3.43)	(−0.84)
Other (*)	−401.0*	60.46	374.6	−214	−201.8*	42.27
	(−2.10)	(−0.25)	(−1.36)	(−1.73)	(−2.27)	(−0.22)
18-24	−438.8**	−819.6***	711.8**	839.4***	1,204.0***	135.9
	(−2.77)	(−4.15)	(−3.19)	(−7.98)	(−16.01)	(−0.84)
50-64	−519.8***	−350.3*	−554.7***	−177.8*	−194.3***	−140
	(−4.70)	(−2.51)	(−3.51)	(−2.44)	(−3.75)	(−1.24)
65+	−758.4***	−859.3***	−1,265.8***	−388.7***	−225.0***	578.8***
	(−6.62)	(−5.93)	(−7.72)	(−5.17)	(−4.19)	(−4.94)
Constant	1,633.3***	2,992.6***	3,518.6***	1,105.4***	461.0***	2,018.9***
	(−6.52)	(−9.48)	(−9.72)	(−6.76)	(−3.94)	(−7.92)
Regional dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4,650	4,534	4,456	4,791	4,838	4,585

(*) Mainly vocational qualifications or diplomas.
Note: * P<0.10, ** P<0.05, *** P<0.01 (*t* statistics in parentheses)
Sources: Authors' elaboration based on YouGov survey results. OLS figure.

as the good they were least willing to give up, but this proportion increases to 15-20% when faced with a loss in annual income of £100-500. A broadly similar pattern can be observed for access to public parks (12-14% in case of £5,000-10,000 income loss as compared to 18% in case of £100-500 income loss). Other categories displayed a less pronounced trade-off between access and loss of income. Thus, a proportion of respondents appear to always be least willing to give up access to some products such as Facebook or WhatsApp, at least for the earnings decreases offered in our survey. These results suggest that for this group, implied consumer surplus is large. This tallies with the distribution of stated values noted above, with an important proportion of respondents stating high values. An avenue for future research would be to explore this phemenon across a full choice set.

3.7. The Value of Reading the News

Our selection of products means we can compare in some cases stated values for online products and physical substitutes. One of the pairs is online news and printed newspapers. In recent years there has been progressive substitution from print to online formats: Ofcom figures show daily newspaper circulation in the UK has declined from 21.9 million in 2010 to 9.3 million in 2019.[11]

In our February 2021 sample, 74% of respondents stated that they read news online and on average required £2,124 to give up access to online news for 12 months (median £150).[12] This is similar to the February 2020 usage rate for online news (73%). In comparison, 49% of respondents say they read printed newspapers and magazines (down from 55% a year earlier) and on average stated a WTA value of £868 (median £10) for the same time period. There are interesting differences in terms of usage rates and WTA across age groups (Table 7). Reading printed newspapers appears to be negatively associated with age, while online news is most widely used by people age 50-64. Readership of online news is the lowest (64% in February 2020) among those aged 65+, as are annual valuations (£1,425). At the same time, this age group

11. https://www.ofcom.org.uk/__data/assets/pdf_file/0013/201316/news-consumption-2020-report.pdf
12. Calculated based respondents that did not reply "Don't know/None", which in this case was almost 10%. Questionnaire did not specify whether online news was paid-for or free.

Table 7 – **Mean stated values (12 months WTA in £) and usage of reading news online and offline, February 2020 & 2021**

		All	18-24	25-49	50-64	65+
Online news (February 2020)	WTA £	2,129	2,857	2,395	2,008	1,425
Online news (February 2021)	WTA £	2,124	2,412	2,426	2,081	1,479
Print news (February 2020)	WTA £	954	931	636	984	1,516
Print news (February 2021)	WTA £	868	729	610	849	1,428

Sources: Authors' YouGov survey results.

has the highest share of reading printed newspapers (66%) with the highest average valuation (£1,516). Stated values for online news are the highest for respondents aged 18-24 (£2,857) so twice as high as for people aged 65+.

Over the period of 10 weeks between end of February and mid-May usage of printed newspapers declined from 55% to 47%, while use of online news slightly increased from 73% to 75%. By February 2021, these proportions had changed a little to 49% and 74%. At the same time average stated values for printed news changed from £954 to £729 to £868 across the waves, while the valuation of online news changed little, from £2,129 to £2,167 to £2,124.

Overall our results are consistent with other surveys indicating that all age groups are now more likely to read the news online, but particularly younger people. The additional insight from the comparison between print and online is that WTA values for online news (which is either cheaper than print news or free to access) are on average more than twice as high as those for printed newspapers (for which users have to pay). The average February 2021 WTA for printed newspapers of £868 compares to an annual print subscription of £468 for The Times (whose digital subscriptions are £180-£312 a year), for example, or £144 for a subscription to £820 at newsstands a year for The Guardian in print (and zero-£144 for tiers of its online access). For the other products in our survey for which there are offline comparators, one could compare the mean and median stated values to actual average expenditure – for example, Google Maps compared to average spending on road atlases and maps, and navigation devices. To the extent they diverge, this could suggest aspects of online services that are valued, such as convenience or speed, which would be worth exploring.

For there are additionally products in the survey whose valuation seems to represent a pure welfare gain in terms of time saved, convenience, or increased choice or control. For instance, online banking is highly valued (mean 12 months WTA in February 2021 was £5,068 and median WTA £1,500) yet the outcomes – transactions people need to carry out – are the same whether online or offline. Another example is the BBC iPlayer, which allows users to access all BBC programmes when they like rather than when broadcast; the mean WTA (£1,352 for 12 months) is high, and considerably higher than the BBC licence fee of £157.50 a year. The time saved or convenience/choice gained through online services is still today an under-explored source of consumer welfare (Coyle, 2019; Coyle & Nakamura, 2022).

* *
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The stated values we report are correlated with stated usage in a plausible way, are broadly consistent across time periods with reasonable forms of discounting, can identify clear rankings among products, and whose changes in response to lockdown are plausible. During the lockdown, we observed rapid changes in the contributions different products and services make to consumer welfare, with some significant differences by age group and gender. In this sense the lockdown was a type of natural experiment capable of revealing the extent to which digital products and physical products are substitutes, although not a controlled experiment, and occurring in the context of trend increases in digital use. As many of the products we considered are free to use, these changes in stated values along with stated usage give useful insights into economic welfare and activity that are not captured by changes in market prices. We consider the approach we use is not only a useful way to assess economic welfare absent a monetary price, but also provides important,

policy-relevant insights into distributional questions as between men and women and different age and socio-economic groups.

However, there are significant hurdles before this approach could be used for aggregate measurement of economic welfare, mapping out a path for future research. Notwithstanding some recent work constructing distributional GDP measures (e.g. Aitken & Weale, 2020; Bureau of Economic Analysis, 2020; and importantly adopting a standardised methodology Zwijnenburg *et al.*, 2021), distribution is not taken into account in GDP. Yet it would be odd to think about constructing an explicit aggregate welfare metric without consideration of distribution. Our results show significant differences in the stated values for different products by gender, age and social grade, and a skewed distribution of values as shown by the mean-median gaps, with a proportion of respondents assigning very high values to certain products. Our data set offers rich opportunities for exploring the distributional questions. The definition of the universe of free products to be included in an aggregate welfare measure, and how it is to be partitioned among specific and general categories, would affect the aggregate. There is no reason to expect the stated value for 'all social media' would be equal to the sum of values for each social media platform, for example, as some of the free products can be substitutes for each other. And indeed, there is a 'new products' problem; we did not initially include TikTok, for example, which was very little prominent before the first survey was conducted, but used by 19% in our third survey wave. The selection of some specific platforms would have welfare implications depending on the demographic skews in the stated values. For instance, certain selections might tilt toward platforms valued more highly by men or by young people.

Another significant issue is the absence of a budget constraint. For marketed products, the monetary budget constraint, and consumer expenditure within that limit, ensures that the estimated total does not exceed the money available (including some consumption smoothing over time *via* borrowing). However, in their usage of any products but particularly the free digital ones we are considering here, people are constrained by time; the usage rates established from the survey give the extensive margin only. Time use statistics could supplement these usage figures and the stated values. For example, ONS time use statistics indicate the average time spent on all social media (in Sept./Oct. 2020) was 7 minutes a day, checking email 4.3 minutes, 'finding guidance on the internet' less than 1 minute, and 'streaming TV or videos on the internet for entertainment' 40 minutes.[13] With a defined universe of free products, time use statistics for these products could be used to construct weights, potentially by gender and age. We consider this an important avenue to pursue as survey-based stated preference is increasingly advocated for economic measurement of digital products. However, there are important questions to address, including whether there is diminishing marginal utility from time spent on digital activities, and whether the shadow price of time is encompassed by the shadow prices discovered from stated preference estimates relating to specific activities (Coyle & Nakamura, 2022 discuss these issues).

As the literature on application of stated preference method to free digital products grows, some important insights are emerging. The mean values stated for these products are generally high, as well as medians in some cases. A sub-set of the products emerges as almost indispensable and highly valued. The results are also broadly consistent with intuitions from economic theory. However, further insight is needed into whether, as compared to offline versions, these high values reflect other specific attributes of online activity such as convenience and time saving or greater choice – in other words, are the online and offline versions not perfect substitutes due to valued characteristics common to online activity. Significant questions remain therefore to be addressed before the method is applied to the construction of an aggregate economic welfare measure. □

13. *https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/conditionsanddiseases/datasets/anewnormalhowpeoplespenttheirtimeafterthemarch2020coronaviruslockdown*

Link to the Online Appendix:
www.insee.fr/en/statistiques/fichier/7647309/ES539_Coyle-Nguyen_Online-Appendix.pdf

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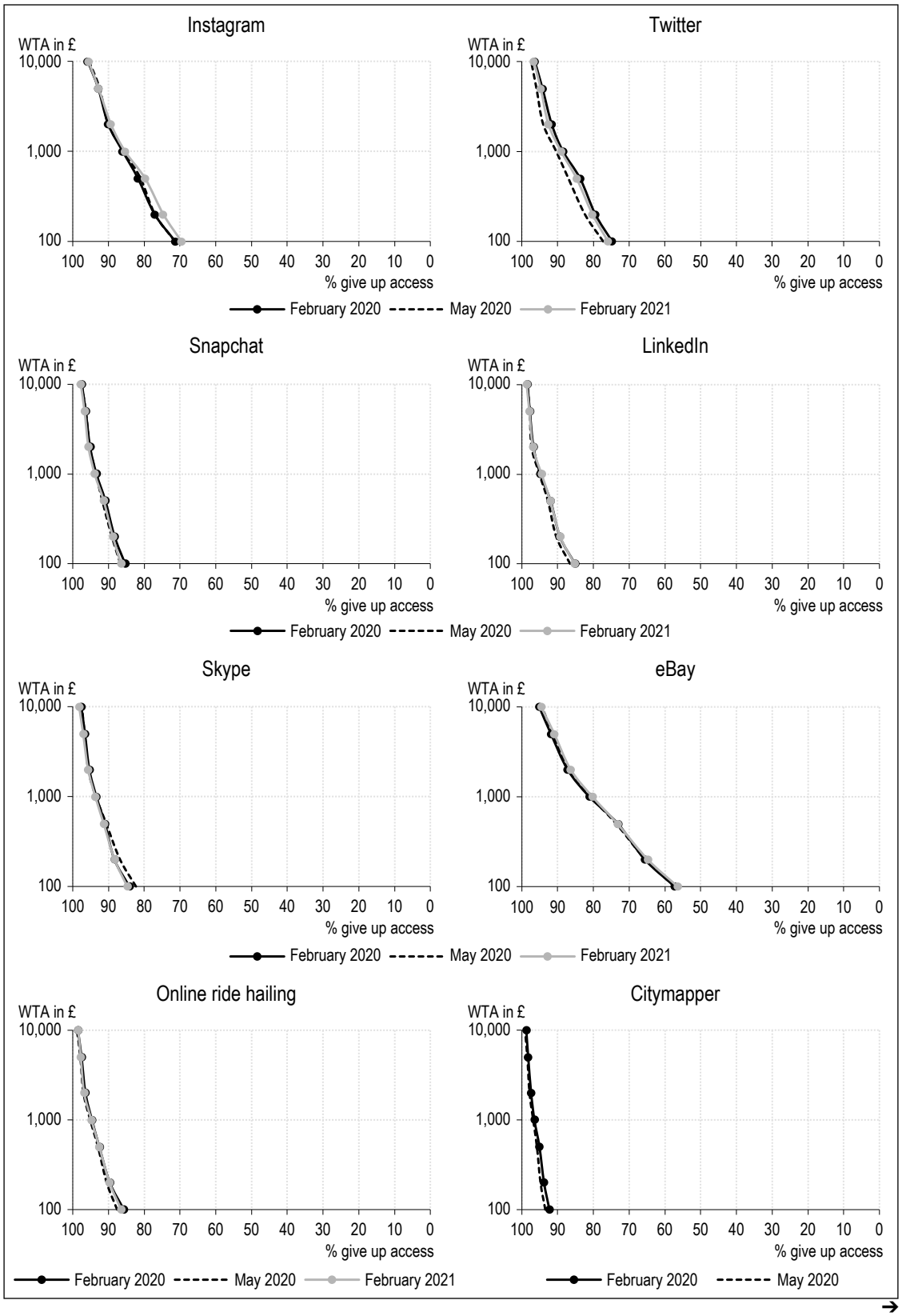
APPENDIX 1

DEMAND CURVES, REMAINING GOODS

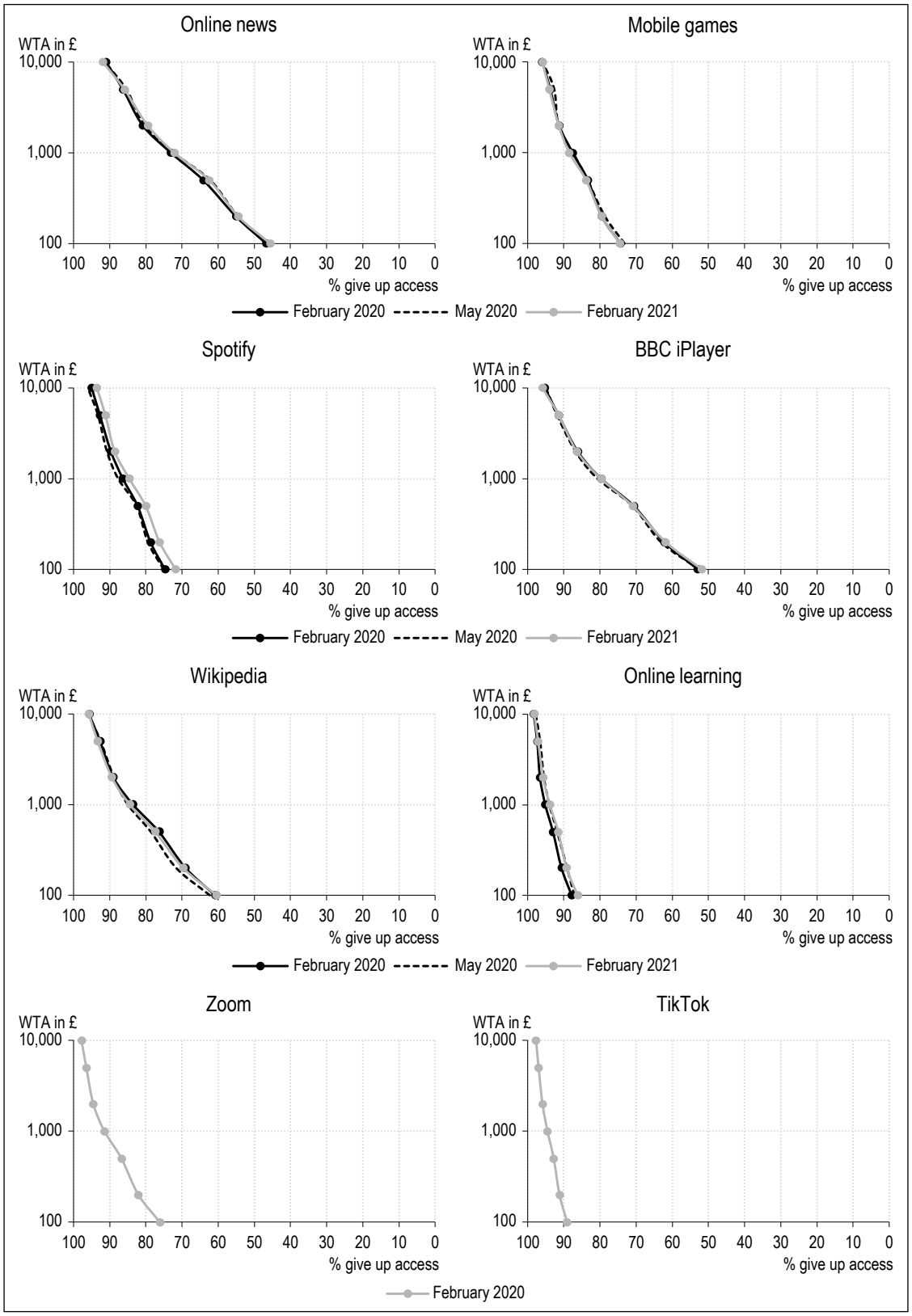
The demand curves for the remaining products than those shown in Figures III and IV are shown in Figure A1.

Figure A1 – **Demand curves, remaining goods**



➔

Figure A1 – *(contd.)*



APPENDIX 2

BEST-WORST-SCALING, FURTHER DETAILS

At the end of the main February 2020 and 2021 survey we asked the following question: "Now imagine you have to give up one of the following for [1 month/12 months]. From the options below, select which one you would be most willing to give up and which one you would be least willing to give up." Half of respondents were randomly asked to consider 1 month and the other half 1 year.

We provided participants with the following seven options:
1. Facebook
2. Personal email
3. WhatsApp
4. Online search engines, e.g. Google search
5. Wikipedia
6. Earning [x] less for the [month/year]
7. Access to any public park

Earnings were randomly drawn from five options for 1 month / 12 months respectively:
- £1,000 / £10,000
- £500 / £5,000
- £100 / £1,000
- £50 / £500
- £10 / £100

Participants were first asked to choose which option from the seven they were *most* and *least* willing to give up. Following this, we asked them the same question but now only presenting them with the remaining five options. In the third step they were given the final three options. We thus obtained the individual set of preferences among seven options for all respondents.

In the first stage, we obtained the following choices for 1 and 12 months. For example, the 2020 figures were as shown in Table A2-1.

Table A2-1 – **Best-worst scaling results, 1 & 12 months, February 2020 (%)**

	1 month		12 months	
	Most willing	Least willing	Most willing	Least willing
Facebook	31.26	6.64	32.87	5.43
Personal email	1.23	31.51	1.32	25.76
WhatsApp	13.97	10.48	14.22	8.25
Online search engines, e.g. Google search	1.35	15.51	1.18	13.88
Wikipedia	27.62	0.89	28.62	0.77
Earning [x] less for the [month/year]	6.53	16.89	5.17	25.93
Access to any public parks	13.80	13.84	12.47	15.81
Don't knows'/no replies	4.23	4.23	4.16	4.16

We can also break down the share of participants choosing one of the seven options depending on the size of the decrease in earnings presented to them. In the 1 month case, the choices stated were as in Table A2-2.

Table A2-2 – **Best-worst scaling results, 1 month, February 2020**

Loss of earnings (£)	Facebook (%)	Personal email (%)	WhatsApp (%)	Online search (%)	Wikipedia (%)	Earn less (%)	Public parks (%)
1,000	5.53	25.74	8.48	12.49	1.05	31.94	10.77
500	6.62	29.11	10.30	11.34	0.57	24.67	12.76
100	5.82	33.56	10.86	17.07	1.07	12.03	15.62
50	7.07	33.58	11.26	16.47	0.84	10.88	15.16
10	8.15	35.55	11.47	20.19	0.95	5.02	14.88

Note: "Don't knows'/no replies" are omitted from this table.

In the 12-month case, the stated choices were as in Table A2-3.

Table A2-3 – **Best-worst scaling results, 12 months, February 2020**

Loss of earnings (£)	Facebook (%)	Personal email (%)	WhatsApp (%)	Online search (%)	Wikipedia (%)	Earn less (%)	Public parks (%)
10,000	5.52	20.95	8.33	8.14	0.75	40.60	11.60
5,000	4.97	21.75	7.65	10.53	0.79	36.74	13.60
1,000	4.53	23.74	8.87	14.98	0.49	24.83	17.04
500	5.98	29.25	6.81	15.00	0.83	20.15	18.31
100	6.05	32.28	9.56	20.18	0.96	9.12	18.25

Note: “Don’t knows’/no replies” are omitted from this table.

APPENDIX 3

CONFIDENCE INTERVALS

We calculated confidence intervals based on weighted mean valuations, standard errors and the share of respondents opting for each response. Considering the large sample sizes, at least of the first and third waves, our confidence intervals are generally very narrow, as show in in Figure A3.

Figure A3 – **Confidence intervals 1-month valuations: February 2020**