How the Wuhan Coronavirus Outbreak Affects Consumers’ Valuations of Digital Goods

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We examine how the coronavirus pandemic affected consumer valuation of digital services. Governments responded to the pandemic with various forms of lockdowns and social distancing, leading to increased dependence on digital services for work, social engagement, and leisure activities. We identify consumer valuations through surveys where respondents express their reservation prices for digital services such as email, search, and social media. We compare our results to surveys done in 2016 and 2017 and find an about six-fold increase in valuations.

Keywords: COVID-19, consumer surplus, digital goods, GDP, coronavirus

JEL codes: D12, L86, E01

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The outbreak of the Coronavirus (COVID-19) has provided significant disruptions to the economy and people's everyday lives. The virus emerged in China in late 2019 and China first let the rest of the world know about the virus in early January 2020. Within four months one-third of the world's population was in lockdown, including roughly 80% of Americans. (Kaplan, Frias and McFall-Johnsen 2020; Page, Fan, and Khan 2020; Secon, Woodward, and Mosher 2020)

These lockdowns restrict people's abilities to work, spend, and conduct business, which slows economies: In March the United Nations Conference on Trade and Development estimated the slowdown would cost $1 trillion to $2 trillion worldwide. (UNCTAD 2020) At about the same time Goldman Sachs estimated that US gross domestic product could drop 34% in the second quarter of 2020, followed by a rapid recovery if the restrictions are removed quickly. (Cox 2020)

People in lockdown look for substitutes for physically congregating and for moving from place to place. For many people, this means increased reliance on the internet and related services. In the United States, NCTA (2020) reported that on a nationwide basis, downstream internet use (data flowing into people’s homes) increased 20.1% in March and upstream internet use (data flowing from people’s homes) increased 27.7%. In New York, the state most severely affected as of April 1, the increases were at or slightly above the national average: 20.1% downstream and 34% upstream.

People outside the US responded in similar fashion. Facebook (2020) reports that messaging is up about 50% in countries hardest hit by the virus. Network usage is also up in Europe, so much so that networks struggle to keep up, prompting the European Commission to ask video content providers to decrease the amount of bandwidth their services require. (Alexander 2020)

Government-imposed lockdown and voluntary social distancing – a term adopted to describe how people keep their physical distance from each other to decrease the chances of the virus moving from one person to another – affect also how people
use mobile communications. On April 2, 2020, Verizon reported decreases in mobile handoffs, the instances where a person’s communications session moves from one cell site to another as the person moves around: These were “significantly down in the New York Metro area (-53%) and Upstate New York (-49%) vs. a typical day. Other metro regions like the Mid-Atlantic/greater Washington, D.C. metro area and New England follow with declines of -39% and -37%, respectively, with Southern California declining -35% and Northern California down -27%. Nationally, mobile handoffs have dropped -29% versus a typical day.” (Verizon 2020)

People are moving around significantly less.

Verizon also witnessed a ten-fold increase in its customers’ use of collaboration tools, applications that enable customers to see and speak with colleagues, friends and family. Use of other services also increased: Gaming has more than doubled, use of virtual private networks is up 40%, video is up 33%, and web use is 24% relative to normal times. (Verizon 2020)

These increases in usage imply that the services have become more valuable to people during the pandemic. How much people increase their valuation is an important question for at least two reasons. One is that it indicates how central to people’s lives and work these services are during the pandemic. This informs policymakers as it helps put dollar values to developing information infrastructure and to policies that allow companies to quickly adapt to changed circumstances. A second reason is that valuation enables more accurate estimates of the economic impacts of the pandemic. As Brynjolfsson, Collis, and Eggers (2019) (hereafter, BCE) explain, the value of many digital services is missing from estimates of national income. So this increased value of digital services is missing from calculations of the magnitude of the economic downturn.

We estimate the increased value of digital services with surveys comparable to those done in 2016 and 2017 by BCE. We find that people’s valuations were about six-fold higher on average in March 2020 than three years earlier. More
specifically, we find that the median U.S. consumer consuming all nominally free digital services we study was unwilling to part ways with them even if compensated $14,524 to do so. We also find that the valuations rose during our survey period, providing support for the notion that the pandemic was responsible for much of the increased value.

Section I describes our approach. Section II provides our results and Section III provides discussion. Section IV is the conclusion.

I. Methods

We use a stated preference approach, which is a method often used in environmental economics to uncover how much people value goods and services, called their reservation prices. We conducted our survey using Google Survey and asking people how much they would need to be compensated to forgo various digital goods for one month. A person’s answer implies that the good in question is at least worth this much to the consumer, all other things being equal. To improve validity, we used multiple online surveys in which various price points were presented to randomly selected consumers in simple take-it-or-leave-it offers.

We began our surveys on March 20, 2020, and ended on March 29. Google Survey allowed us to choose our audience and ask up to ten questions at a time in a variety of formats. Google provides incentives for people to participate and protects the respondents’ privacy. To be timely and to provide results that could be compared to those of BCE, we chose to survey persons in the United States. Each person was asked a single question: “Would you give up y for one month with a compensation of $x?” where “y” is the service (e.g., email) and “$x” is a price randomly chosen within ranges that we chose. At each price point, 250 samples
were chosen.\textsuperscript{1} We ended up with anywhere between 14 to 20 price points per category, equating to a sample size of 3,500 to 5,000 per category of digital goods.

\section*{II. Results}

Table 1 shows our results and compares them with BCE’s findings. The first column lists the categories of digital goods as ranked by the 2017 valuations. Search was the most valuable and instant messaging was the least. The second column shows the 2017 median value found by BCE. The third column shows the median values from our surveys and the fourth column shows the change in value from 2017 to March 2020. The fifth column shows the percentage change of the value during the pandemic from the 2017 value. The last two columns show the ranks of the goods categories for 2017 and for March 2020.

The Table 1 values represent the estimated median willingness to accept payment to forgo these digital goods and services for one month, i.e. the reservation prices for which exactly 50\% the population will accept the amount and forgo the service and 50\% will refuse.

Our results are consistent with those of BCE, except that the valuations we find are several orders of magnitude higher, presumably reflecting the increased importance of digital goods during the pandemic. Each digital good’s rank in importance is the same in 2020 as in 2017, with two exceptions: Maps rose from fifth to third and instant messaging rose from eighth to sixth.

The first thing to notice in Table 1 is the magnitudes of individual value changes. Only two goods – search and email – have percentage changes less than 500\%. That their percentage changes are the lowest makes sense as they are the highest valued products in both years, which biases their percentage changes downward even

\textsuperscript{1} Due to Google’s weighting methodology to obtain a nationally representative model, the actual number of respondents per price point is around 200.
though they have the highest dollar changes: $8,623.60 for search and $1,435.70 for email. These high value changes also make sense because people working from home are more reliant on search to find work-related information that might normally be obtained by informally asking a colleague, and more reliant on email to asynchronously engage with co-workers, customers, and vendors. This is also true for home-bound students and teachers. People in lockdown also value search to find vital information on healthcare, government actions, and changes to essential services.

Table 1. Comparisons of consumers’ median valuations of digital goods, 2017 versus March 2020

<table>
<thead>
<tr>
<th>Digital Goods Categories</th>
<th>Reserve Price for One Month of Service</th>
<th>Percent change</th>
<th>Rank 2017</th>
<th>Rank 2020</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2017</td>
<td>March 2020</td>
<td>Change</td>
<td></td>
</tr>
<tr>
<td>Search</td>
<td>$1,460.80</td>
<td>$10,084.40</td>
<td>$8,623.60</td>
<td>590%</td>
</tr>
<tr>
<td>Email</td>
<td>$701.10</td>
<td>$2,136.80</td>
<td>$1,435.70</td>
<td>205%</td>
</tr>
<tr>
<td>Maps</td>
<td>$304.00</td>
<td>$1,017.82</td>
<td>$713.82</td>
<td>235%</td>
</tr>
<tr>
<td>Video</td>
<td>$97.75</td>
<td>$639.30</td>
<td>$541.55</td>
<td>554%</td>
</tr>
<tr>
<td>E-Commerce</td>
<td>$70.16</td>
<td>$758.44</td>
<td>$688.28</td>
<td>981%</td>
</tr>
<tr>
<td>Social Media</td>
<td>$26.80</td>
<td>$172.24</td>
<td>$145.44</td>
<td>543%</td>
</tr>
<tr>
<td>Music</td>
<td>$14.00</td>
<td>$99.73</td>
<td>$85.73</td>
<td>612%</td>
</tr>
<tr>
<td>Instant Messaging</td>
<td>$12.90</td>
<td>$473.83</td>
<td>$460.93</td>
<td>3573%</td>
</tr>
</tbody>
</table>

Sources: Authors’ calculations and Brynjolfsson, Collisa, and Eggers (2019). “Video” means streaming video, such as YouTube and Netflix.

Edelman (2020) describes in its special report on trust and the coronavirus that Americans place low trust in the media and politicians for accurate coronavirus information. So rather than accept the word of traditional media and government officials, Americans search the internet for what health professionals are saying.
Video streaming also rises in value for both work and personal reasons. People working from home and engaging in education from home may be using video streaming, such as YouTube, as an information source. Video streaming for entertainment, such as Netflix, has also increased in value since entertainment is less available from sporting events, movies, eating out, etc.

Social media’s value increased 543%, but it had the second lowest dollar increase. This might reflect social media’s relative unimportance for working remotely and for online education. And while it has its usefulness for staying in touch with others on a social basis, social media conversations are perhaps too public to make up for in-person conversations. It also appears that consumers view social media’s information on healthcare and the like is less relevant than what is found with traditional search. (Edelman 2020)

Regarding the slight change in rankings, we were of course unable to ask people why their order of preferences might have changed from 2017 to 2020. But the changes appear reasonable. The rise in the importance of maps could be because the lockdowns increased the number of people providing delivery services. Also, individuals looking for products that they perceive as being in short supply, such as certain paper products and cleaning products, often seek locations of stores that they did not normally visit. And digital maps often provide information on store hours, which can be particularly useful when store availability is uncertain. Maps had the third largest change in value, 713.82, behind only search and email.

Instant messaging’s rise in the ranking also makes sense in the pandemic environment. Messaging apps, such as WhatsApp, are popular outside the United States and so are convenient, low-cost ways for US families to stay in touch with foreign relatives and include multiple family members in relatively private conversations. Instant messaging also allows people working from home to utilize a silent communication channel while on video or audio conferences and webinars. Instant messaging had the highest percentage increase, 3,573%, but that is largely
because of its low 2017 value. It had the third lowest increase in dollar value, $460.93.

Our results also show how price insensitive customers are for these digital products. While conducting this research, we noticed that expressing reservation prices in $50 or even $100 dollar increments barely affected the number of consumers rejecting the offers. Graph 1 illustrates.

**Graph 1. Valuations and Percent Keeps by Digital Product**

Sources: Authors’ calculations.

Graph 1 shows the relationships between reserve prices and the percent of respondents choosing to keep their digital goods. Relative to consumer valuations
in 2017, the coronavirus outbreak appears to have caused consumer valuation of these digital goods to shift upward and become more insensitive to reservation prices. For each category, 10% to 25% of the population is readily willing to give up these services for even $1. But the remaining consumers are largely insensitive to price, to the point that for any category, there is always some portion – generally 20% to 40% -- that is unwilling to give up the service even at high prices.\(^2\)

In summary, Graph 1 implies that users of these digital services are largely insensitive to price above a small level. For example, at a reservation price of $50 versus $200 (a 300% increase), only 14% fewer consumers were willing to forgo social media for the next month. This implies a price elasticity of demand\(^3\) of 0.14 in absolute value.\(^4\) This level of inelastic demand implies that at least half the population of the United States these digital goods and services are viewed as necessities in times of pandemic, possibly because users would not find alternatives in the compressed amount of time.

Finally, we’ve just scratched the service in terms of how much the digital economy contributes in value to economic welfare. Other than these categories, an important need that arose in response to the coronavirus outbreak is video conferencing. With our estimates, broad categories of all video conferencing have a median monthly estimated value of $318.02.\(^5\) We do not have comparable 2017 values, but it seems reasonable to believe that our March 2020 result is higher than it would have been in 2017 because of the lockdowns and working from home. We estimate the price elasticity of demand for videoconferencing to be 0.1 in absolute

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\(^2\) The functional form for the solid curves in Graph 1 is linear in elasticity.

\(^3\) Table1 represents median valuations of digital goods from the perspective of what economists call Hicksian or compensated demand, i.e., the consumers are given additional income to make up for the value they lose in giving up the products. As a result, it cannot be said that consumers would pay these amounts for these services since that would mean lowering the amount of income they would have available for other purchases.

\(^4\) Although not directly comparable, Franz et al. (2008) estimated the price elasticity of demand for cigarettes is about 0.37, or about two times larger.

\(^5\) We used the linear elasticity form for this estimate, too.
value, implying its importance. At a price of $10,000, 35.5% of those surveyed elected to keep video conferencing services.

III. Discussion

We now examine the value of these goods to the economy at large and policy implications.

The digital goods we study come mostly to users at zero monetary prices, asking only that users provide their time and attention, and that service providers be allowed to gather data on user behavior. The exceptions in our categories are e-commerce and music, where service fees are the norm. If willingness to accept payment to forgo is indeed a good measure of flow of benefits to the consumers from the zero-price services, in total, the median consumer using all of the nominally free services enjoys a monthly benefit of $14,524.39, compared to a 2017 benefit of $2,603.35.6

We develop a conservative estimate of the aggregate value of the nominally free services in March 2020 of $3.49 trillion, or $41.82 trillion on an annualized basis. This is an over 460% increase over the 2017 value. Table 2 shows these results. The first column lists the services for which there was a zero nominal charge for users. The last column shows the number of users that we assume for our calculations. They are conservative in that they underestimate the number of actual users. For search, we used number of Google search users for the United States for 2019. This omits people that used only non-Google search. Google’s share of general search in the United States was 62.5%. (Statista 2020) For email, we used the total number of US adults using email in 2019. For maps, we used the number of Google Maps user for 2018, omitting the users of Waze, Mapquest, and the like.

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6 The sum of the 2017 reservation prices in Table 1 for search, email, maps, video streaming, social media, and instant messaging is $2,603.35, and for 2020 is $14,524.39.
For streaming video, we used the number of YouTube users in the US for 2019. This includes users that pay for YouTube, but omits users of other free streaming services, such as some AMC Networks and HBO offerings made free during the lockdowns, Crackle, Hoopla, and IMDb. For social media we only count Facebook users for the United States for 2019. For instant messaging, we count users of Facebook instant messaging in 2018. The second and third columns show the annual value in 2017 and 2020 respectively, which we derive by multiplying the number of users by the respective monthly values in Table 1 and annualize the products. The fourth column is the change.

### Table 2. Total Value Estimate

<table>
<thead>
<tr>
<th>Digital Goods Categories</th>
<th>Annual Value in Trillions</th>
<th>Users in Millions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2017</td>
<td>March 2020</td>
</tr>
<tr>
<td>Search</td>
<td>$4.54</td>
<td>$31.34</td>
</tr>
<tr>
<td>Email</td>
<td>$2.12</td>
<td>$6.46</td>
</tr>
<tr>
<td>Maps</td>
<td>$0.56</td>
<td>$1.89</td>
</tr>
<tr>
<td>Video</td>
<td>$0.15</td>
<td>$0.97</td>
</tr>
<tr>
<td>Social Media</td>
<td>$0.07</td>
<td>$0.46</td>
</tr>
<tr>
<td>Instant Messaging</td>
<td>$0.02</td>
<td>$0.72</td>
</tr>
<tr>
<td>Total</td>
<td>$7.46</td>
<td>$41.82</td>
</tr>
</tbody>
</table>

Sources: Authors’ calculations and Brynjolfsson, Collisa, and Eggerssc (2019); Statista (2019a, 2019b, 2019c, 2020); 99 Firms (2020); and Review 42 (2020).

While the high valuations of these digital products certainly represent a change in demand, they also reflect how well the service providers responded to market demand by adding capacity and adapting services. Amazon hired thousands more workers and prioritized household staples and medical deliveries. (Amazon 2020a; Amazon 2020b) Internet service providers are adapting their networks to education
and work-at-home needs. AT&T is providing free service to healthcare workers on FirstNet. (AT&T 2020) Zoom expanded to accommodate a 378% increase in video-conferencing. When uninvited guests began “Zoombombing,” Zoom adapted with new security measures. (Bary 2020; Hodge 2020)

Light-handed regulatory constraints are critical for this kind of adaptability. Some network responses would likely have violated the FCC’s now dismissed net neutrality restrictions. Europe kept such regulatory holds and now faces network congestion problems. (Layton 2020) While it cannot be proven that these problems result from over regulation, the evidence in the economic literature is that such controls discourage network investment. (Jamison 2019)

Unwarranted threats of antitrust and other regulatory action are also problematic as they incentivize digital companies to be risk averse in their efforts to help during the pandemic. Such threats come primarily from supporters of expansive antitrust action. For example, Morton (2020), a well-known antitrust economist, tweeted that Zoom’s growth during the pandemic is good reason for greater scrutiny should another company seek to merge with Zoom. Senator Josh Hawley of Missouri wrote to the CEOs of Apple and Google letting them know that he thought each should be held personally liable if there were to be a security breach in their collaborative effort to trace the spread of COVID-19. (Hawley 2020) Sussman (2020) argues that Amazon’s prioritization of home staples and medical supplies during the pandemic should be investigated post-crisis to ensure that the company did not benefit.

Morton’s opinion expresses a belief that market share and/or company size equate to market power. This is a view shared by many, including the European Union, which considers a 40% market share to be conclusive evidence of market dominance. (Jamison 2020) The growth of digital services during the pandemic demonstrates the falseness of such beliefs. Customer choices have driven the size of Google, Zoom, Apple, and the like. Certainly the companies played active roles in achieving their success by developing products that customers prefer and taking
those products to market. As Jamison (2020) explains, size and market share are more likely indicators of providers serving customers well than of having control over customers.

It would appear that those putting digital companies on notice that their actions will be scrutinized post-pandemic intend to alter the companies’ behaviors. Otherwise, what would be the point of making the pronouncements during the pandemic? But suppose the critics are successful? The result would be services that are less responsive to customer changes and thus less valuable, as well as a decline in public services, such as the voluntary work some do to track the virus, provide expanded and free service to healthcare workers, and small business support.

Our valuations also provide input to hole in public policy in the United States, namely a serious cost-benefit analysis of government efforts to expand broadband access. Several government agencies have subsidized broadband development for many years. There is little evidence that these subsidy programs have had positive effects. But valuing the effects that have been achieved has been hard because we have lacked estimation of the economic value created by subsidized broadband. Our valuations of digital services provide a useful datapoint that can be used to assess the economic loss of not having broadband available in some areas during the pandemic.

IV. Conclusion

We examine how the coronavirus crisis in the US affected people’s valuations of digital services. The valuations are based on responses to the hypothetical question, “Would you rather give up y for one month with a compensation of $x?” Inevitably, these types of surveys suffer a hypothetical bias, because people do not face real choices in the survey. It would be cruel and impractical to run these surveys as real experiments during a pandemic. However, if we were to believe that people’s
hypothetical bias remained relatively constant during this time period from 2017 to today, we can say with confidence that digital goods and services provided tremendous value on top of what they already provide to users. Indeed some users appeared to believe that some of these digital services were essential in their daily lives.

We analyze how much people benefit from digital products, and how much that welfare is affected by context. We do not examine what users would have substituted for these services if they had to give them up. And while the valuation is an indication of the gross value that these digital services provided, we do not estimate the net value, i.e., the differences between the digital services values and the values of the closest substitutes from the users’ perspectives.

How quickly these digital products adapted to the changed circumstances and how quantities consumed responded so quickly to changed demand tells us something about the importance of responding to market forces. Some regulators have wisely stayed out of the way of consumer choice. The Federal Communications Commission’s deregulatory policies encouraged internet service providers to build networks that are handling the traffic surge. This isn’t the case in pro-regulation Europe where internet networks have been overwhelmed.

These are extraordinary times, with never-seen-before unemployment numbers and negative oil prices. In these times when people are experiencing the tightening of their budget and forgoing of some luxuries, our research shows that their “willingness to accept payment” to forgo digital goods and services spiked. The significance of the value from digital goods presented in this paper during the coronavirus outbreak can be illustrated by imagining how the society would have operated without. Without these digital goods, more jobs will be lost, productivity will be even lower for the working without web searches or video conferences, and the always online netizens will have a hard time obeying stay at home orders, possibly elongating the pandemic.
More research is needed. We have not focused on minority and rural populations. Doing so would inform us about distribute effects. We have also omitted analyses of impacts by type of employment, geographic area, lockdown provisions, and the like. Nor have we focused on the implications for entrepreneurs and small businesses.
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