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Unravelling the Hidden Value of Digitalization:

The Example of Non-Measured Consumer Surplus in Banking

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Abstract

There are few studies of the consumer surplus created by digitalization, and they have rendered very different results. In this paper we identify the consumer surplus generated by digitalizing bank transactions by applying a new methodology based on Brynjolfsson, Hu and Smith's (2003) method for calculating time optimization. We estimate a lower and an upper bound for the net consumer gains based on comparison with a low-digitalization reference group in order to create a benchmark for economic activity in the pre-digitalization era.

We identify a consumer value for digitalization of a specific type of financial service, namely 'bank transactions,' and find that it is far higher than is represented in the flat fee that the clients periodically pay for using these online services. We find that the value of the digitalization of transactions is higher for bank clients who have higher income and who live in sparsely populated areas. This can be attributed to the fact that the opportunity cost for making in-branch transactions is higher for those who have higher income and who the longer distance to a physical bank office.

Introduction

Quantifying the value of digitalization would help both individuals and managers make the right choice among different digital investment alternatives; both with the aim to improve the functioning of organizations and the welfare of individual clients, partners and stakeholders. Also, it is useful to develop new price models, to exercise price differentiation and to make the value offered to clients more transparent.

Furthermore, estimating hidden consumer surplus is an important input for fiscal and monetary policy makers. For instance, if value creation due to digitalization is perception of economic growth may be affected and public investment in digitalization, education and other areas may be re-evaluated.

Consumer surplus is defined as a value that is typically not embodied in traditional GDP calculations (Brynjolfsson and Smith, 2000; Brynjolfsson, Hu and Smith, 2003; Chen, Jeon and Kim, 2014). Digitalization could therefore conceivably create a larger consumer surplus than that historically created in the pre-digitalization era.[1] Consumer surplus can be defined as the value the consumer would obtain by

[1] In an earlier study (SOU:2016:85 "Digitaliseringens välstånd bortom BNP") we analysed hidden value creation due to digitalization.

receiving a good or service that they would be willing to pay for more than what they actually do.

Research regarding the growth of consumer surplus due to digitalization is so far relatively limited. This paper contributes to the literature in several ways. First, we present the past literature, take a closer look at the different aspects of consumer surplus and build on the existing literature in order to describe a theoretical approach on how one should define consumer surplus in the digital era. We identify the channels through which the value of digitalization is not counted in the traditional GDP calculations. In a nutshell, these are (1) insufficient quality adjustments; (2) time optimization in leisure time; (3) flat prescription price models with fallen marginal costs and, hence, an inability to measure per unit cost; (4) free digital goods and services; (5) increased variation of offers; and (6) the sharing economy that makes more efficient use of resources.

A conclusion from some previous studies is that the value of digitalization is underestimated in traditional GDP calculations. Our aim in the current study is to present a method to integrate this underestimated value into the GDP calculations.

In this study we use two approaches to measuring the consumer gain. First, we apply Brynjolfsson, Hu and Smith's (2003) method for calculating time optimization; i.e., the value of the alternative use of the time that consumers gain in terms of earned salary and the secondary costs due to the elimination of physical economic activity (e.g., transportation costs). To estimate a lower and upper bound for the net consumer gains, we specify a reference group in order to create a benchmark for and simulate economic activity in the pre-digitalization era.

Secondly, measuring the net consumer gain in banking transactions and comparing it with Statistics Sweden's measure of productivity in the financial sector from 1990 to 2016 would also proves the hidden values. Over the last two decades, banking services as well as other sectors such as music and entertainment industry have undergone a massive digital transformation. We believe that the methodology that we provide to measure the consumer gains due to digitalization would as well be applied to other sectors. In a further study, we aim at calculating the net impact of digitalization on the overall GDP.

Previous studies

Communication technologies, particularly Internet, transformed our lives and substantially improved economic performance (Baily and Lawrence, 2001). Recent research suggests that the growth in total factor productivity can be linked to the introduction of Internet technologies (Oliner and Sichel, 2000; Brynjolfsson and Hitt, 2000, 2003; Deloitte, 2014). On the consumer side, Internet and the availability of new communication technologies has simplified our lives. The gains include time saved from both completing the activity itself and traveling to the physical location where the activity can be performed (Chen, Jeon and Kim, 2014), lower prices than what brick-and-mortar businesses can offer (Brynjolfsson and Smith, 2000), and access to a wider range of products and services (Brynjolfsson, Hu and Smith, 2003).

Quality-wise, online economic transactions may reduce consumer satisfaction, especially when the product or service entails acquiring more robust information. In a study that compares web search with physical search at a library, Chen, Jeon and Kim (2013) conclude that consumers may obtain higher quality information from offline sources, despite the fact that online sources save time that can be used for multiple purposes. This points to a trade-off between online economic activities and saved time. In financial markets, however, this would only matter in economic activities such as financial transactions (e.g., savings decisions, portfolio choice decisions, retirement portfolio choice et cetera). Consumers typically receive better financial advice in the physical bank branch than the written information that they would obtain online. Absent such information issues, we believe that consumers certainly save time from and become more satisfied with making online transactions such as monthly payments, money transfers and so on.

While the availability of Internet and communication technologies decreases the time we spend on transactions, Goolsbee and Klenow (2006) argue that it also has a welfare reducing effect. Their argument is based on the fact that people spend on average 10% of their entire leisure time on online activities (in the year 2004), which could be used in alternative ways. We believe that this is personal preference just like watching TV, reading books or going to concerts and is therefore outside the ambit of the current investigation.

Aside from this, the availability of Internet and other communication technologies should increase consumer welfare. However, quantifying this increase has been a challenge for empirical research. One of the first attempts to quantify the customer value of Internet regarding online purchases was by Keeny (1999), who used a survey methodology to assess how customers valued certain aspects of online commerce. His method used a design approach to online commerce, rather than quantifying consumer gains from the availability of online shopping. In the context of obtaining online information, Khattak, Yim and Prokopy (2003) infer consumers' willingness to pay for travel information offered through a public–private partnership in the San Francisco Bay Area. Using data collected by phone interviews, they conclude that consumers' price elasticity for travel information is quite high. They do not, however, calculate consumer surplus for certain prices, nor change in the consumer surplus due to a hypothetical price change.

In a pioneering study, Brynjolfsson, Hu and Smith (2003) quantify the consumer surplus that is created due to the increased product variety offered by online booksellers like Amazon. As in the present study, they also face limitations in their data set, particularly concerning the estimation of the price elasticity of demand. As a result, they were forced to adopt an alternative strategy in order to estimate the price elasticity, which relied on the supply side information. As is well known, the inverse of the Lerner index for the whole market yields the price elasticity of demand that a firm faces. In contrast to Brynjolfsson, Hu and Smith, we do not follow this strategy because our data is limited in a different way, and we do not have the Lerner index for the financial sector that we deal with. As an alternative, we focus on a reference group of customers that mimics customer behaviour in the pre-digitalization era. To the extent that such a reference group would make more economic transactions on average than consumers used to make in the pre-digitalization era, our estimates of net consumer gains are likely underestimates. Furthermore, we also include in our calculations the gains from time optimization (i.e., due to the elimination of secondary costs associated with the elimination of a ride to the bank branch).

Another stream of literature focuses on the estimation of harmful effects of the availability of online digital media, such as music, movies, e-books and so on (see, e.g., Oberholzer-Gee and Strumpf, 2007; Liebowitz, 2006). An exception is Waldfogel (2015), who argues that the web functions like a new form of information platform for consumers, just like radio broadcast used to be. With the availability of online platforms, more variety of music (e.g., music released from independent labels) can reach customers, which increases the consumer surplus.

Methodology

We shall analyze two cases. To gain intuition, we will begin with analyzing the consumer gain due to a price decrease in a counterfactual world where there were no digital transaction opportunities and the price of an in-branch bank transaction went down from p_0 to 0. In this basic analysis, we will disregard secondary costs for making in-branch transactions, such as the cost of transportation and opportunity cost of time spent for completing an in-branch transaction. Following this, we will extend our analysis by embodying the costs for finalizing an in-branch transaction into our computations and the availability of digital transactions will eliminate these costs. Therefore, these costs will be counted as a gain for the consumers.

(a) Computing consumer surplus without digital transaction opportunities. We begin with assuming that consumers did not have the option of a digital transaction. We will consider a price cut from p_0 to 0. For now, we will disregard the secondary costs that the consumers pay to finalize in-branch transactions. We further assume that customers periodically need to make a certain number of transactions (e.g., by paying bills, housing rents etc.). That is, they have a nearly inelastic demand curve up till a certain level such as $\bar{q}_0$ in Figure 1 below. For simplicity, we also assume that, below the initial price p_0, consumers respond to price changes and substantially increase their demand for bank transactions at prices closer to 0 (i.e., around a quantity q_1). In other words, the demand curve for bank transactions is a convex curve that exhibits highly inelastic demand at higher prices, yet becomes more elastic at lower prices.

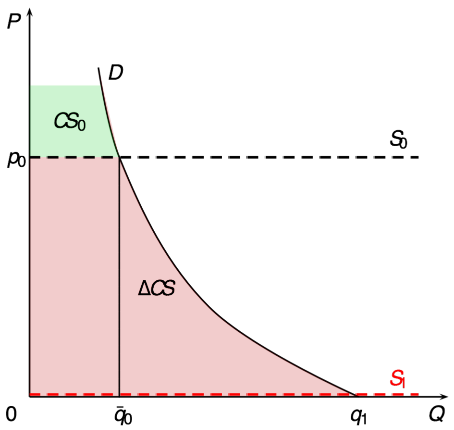

Figure 1: Demand curve and the change in consumer surplus

As shown in Figure 1, the initial consumer surplus is depicted as the green shaded area (i.e., CS_0), whereas the consumer surplus becomes the green shaded area plus the red shaded area after the price goes down to 0. Given these, the net change in consumer surplus due to a price change from p_0 to 0 would be equal to ΔCS (i.e., the light red shaded area shown in Figure 1).

To estimate the change in consumer surplus (i.e., ΔCS) in equations (1) and (2), one would need to estimate the curvature of the demand curve at different prices. Since we do not have that much detailed data, we are forced to simplify our analysis. In fact, the availability of data is due to the fact that banks do not frequently change prices, rather than our inability to obtain a more detailed data spanning a longer time period, which would have supposedly captured price changes. An alternative strategy could have been resorting to the supply side data (i.e., Lerner index for the industry) to estimate the consumer surplus as Brynjolfsson, Smith and Hu (2003) did. However, we are unable to follow a similar strategy for the industry and the product / service type that we deal with here. To overcome this difficulty, we shall try to compute an approximate value for the change in the consumer surplus by assuming that the demand curve is linear between and , as shown in Figure 2 below.

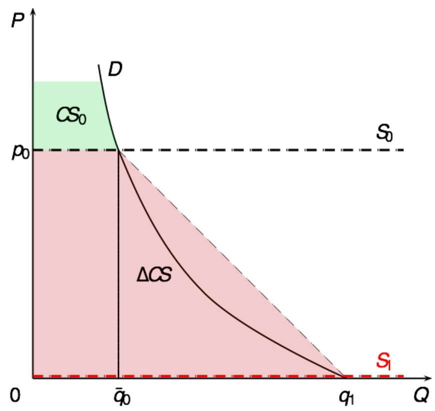

Figure 2: Simplifying assumption: approximation to the demand curve

With this simplifying assumption, ΔCS would be equal to the trapezoid area in light red shown in Figure 2, which is equal to

$$(1)\ Net\ consumer\ surplus = \overline{\Delta CS} = p_0 \times \frac{\bar{q}_0 + q_1}{2}.$$

This calculation, however, only provides us with an *upper bound* for the change in consumer surplus due to a price change from p_0 to 0. To find a lower bound, one would consider an intermediate quantity between $\bar{q}_0$ and q_1, such as the one shown in Figure 3 (i.e., q_m).

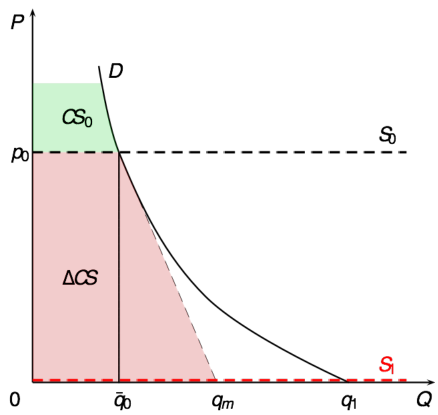

Figure 3: Lower bound for the change in consumer surplus

Setting an appropriate value for q_m would not be possible since we do not have enough information about the curvature of the demand curve. In turn, any such value would be discretionary and may not provide us an area that is properly located under the demand curve. That said, setting q_m simply to $\bar{q}_0$ would provide us a natural lower bound for ΔCS, though it would yield a crude estimate only. Hence, we formulate the lower bound for ΔCS as,

$$(2)\ Lower\ bound\ for\ net\ consumer\ surplus = \underline{\Delta CS} = p_0 \times \bar{q}_0.$$

After this simple exercise, we shall embody in our analysis the option of making digital transactions at zero marginal cost.

(b) Computing consumer surplus with digital transaction opportunities. With the insights we gained from the previous exercise, we will investigate the case with digital transaction opportunities. In the previous case, we ignored the gains from not visiting the nearby bank branch. The availability of digital transactions at zero marginal cost will not only eliminate the fees charged for in-branch transactions but also the secondary costs to the consumers such as a ride to the bank branch and also the opportunity cost of the time spent to finalize an in-branch transaction. Therefore, the increase in the amount of transactions after the introduction of digital transactions will be partly due to the price change and partly due to the elimination of the secondary costs.

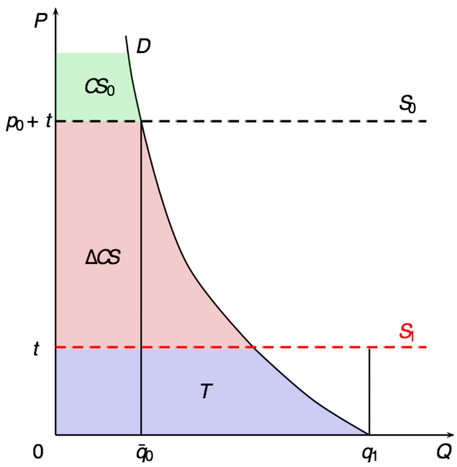

Figure 4: Net consumer gain from the availability of digital transactions

As a result, the availability of digital transactions at zero marginal cost creates a net consumer gain that is equal to ΔCS (i.e., the light red shaded area in Figure 4) plus the total secondary costs (i.e., the light blue shaded area in Figure 4, which is denoted as T) minus the fixed subscription cost for digital transactions (denoted as c, henceforth).

$$(3)\ Net\ consumer\ gain = \Delta CS + T - c.$$

As we mentioned before, we do not know the exact curvature of the demand curve. To estimate the net consumer gain, we therefore have to resort to methods similar to those we showed in the previous case (i.e., case (a)). In other words, we will estimate upper and lower bounds for the net consumer gain. Figure 5 below depicts and upper bound for the net consumer gain.

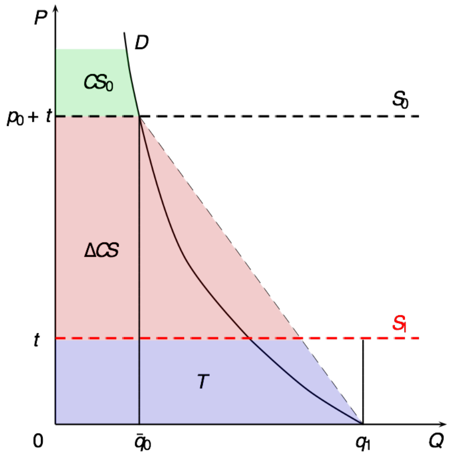

Figure 5: Upper bound for the net consumer gain

To compute the upper bound for the net consumer gain, we simply calculate the sum of the trapezoid area shaded in red and blue in Figure 5 and deduct the fixed subscription cost for digital transactions (i.e., c). This yields the following expression for the upper bound:

$$(4)\ Upper\ bound\ \ for\ the\ net\ consumer\ gain =$$

$$\Delta CS + T - c = (p_0 + t)\times\frac{\bar{q}_0 + q_1}{2} - c,$$

where t denotes the sum of the value that corresponds to the alternative use of the time saved and the saved transportation costs per transaction.

Next, we derive an expression that gives us a lower-bound estimation for the net consumer gain. Figure 6 below depicts a lower bound, which takes the consumer surplus as in Equation (2). This method disregards the additional consumer surplus created due to the increase in the quantity demanded. Furthermore, the gains from the elimination of secondary costs are also discounted.

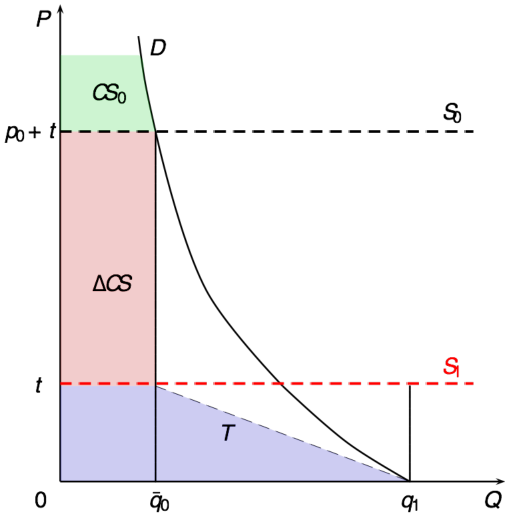

Figure 6: Lower bound for the net consumer gain

To compute the lower bound, we sum the areas shaded in light red and blue in Figure 6, which yields

$$(5)\ Lower\ bound\ \ for\ the\ net\ consumer\ gain =$$

$$\Delta CS + T - c = (p_0 + t)\times\bar{q}_0 + \frac{(q_1 - \bar{q}_0)}{2}\times t - c.$$

To be able to compute the net consumer surplus, we also need to know the values of each parameter in equations (4) and (5). In the formula we derived above, the cost for making an in-branch transaction (p_0) is typically 50 kronor, whereas the flat rate for subscription to digital transactions services (c) is 175 kronor per year.

Recall our assumption that customers periodically need to make a certain number of transactions. In order to pin down the value of $\bar{q}_0$, we will take seniors (i.e., people who are older than 65) with the lowest income as a reference group for a comparison of the number of transactions people used to make before and have been making after the introduction of digital transaction possibilities. More precisely, we assume that senior people with the lowest income level make only the most essential transactions and that, before the availability of digital transactions, people used to make only the transactions that are similarly essential (i.e., at the level that seniors with the lowest income level currently do).

To calculate the impact of the introduction of digital transactions on consumer behavior, as a first attempt, we will take the difference between the number of transactions on average a senior person and another person in question would make. Furthermore, q_1 will typically be the average number of transactions for a certain group of customers, such as people aged between 25 and 40 and / or with certain income levels. Later, we will make use of ordinary least square regressions to estimate the impact of age and income on the number of transactions per quarter. This will help us to estimate more accurate values for $\bar{q}_0$ and q_1 for each income and age group.

For the transportation costs, it is reasonable to think that people often visit the bank branch either during a time off from work (i.e., during a lunch break) or combine the visit with other activities, such as when shopping. Therefore, except for urgent transaction, people do not really pay for a ride exclusively for the purpose of visiting a nearby bank branch. Secondly, people do not visit a bank branch for every single transaction. Rather, they typically combine a number of transactions due a certain date and complete these transactions perhaps once or twice a month. Also, it is arguable that some of the banking transactions are posted via traditional mail. Consequently, we will assume that only one in ten visits to the bank branch generates an additional travel cost to the typical customer. Furthermore, we will take the cost of a ride to the bank branch as 50 kronor, which is equivalent to the cost of a round trip using public transportation (i.e., price of two tickets) in Stockholm. This implies that a typical customer would spend 5 kronor on average for transportation per in-branch transaction.

When calculating the average cost of the time spent for completing an in-branch transaction, we apply similar reasoning to when we calculated average transportation costs. That is, we assume that it takes 1 hour on average to make a round trip to the nearby bank branch and that this time is devoted exclusively to a completing an in-bank transaction only in one in ten transactions. We will also assume that a customer would have spent on average half an hour to complete a set of in-branch transactions and made on average two transactions per visit to the bank branch had there been no other means to do that. Furthermore, our simulations indicate that the average time to complete an online transaction is around 2 minutes. So, on average, a typical customer spends 6 minutes for transportation, 15 minutes for queue and processing time, minus 2 minutes for online transaction, which implies a net gain of 19 minutes per transaction. Considering that the hourly average wage was 158 kronor (source: Statistiska Centralbyrån) over the time period that our data spans, this corresponds to a pecuniary gain of 50.03 kronor per transaction.

Consequently, our estimate for t (i.e., average pecuniary gains from saving time and transportation costs per transaction) becomes $5 + 50.03 = 55.03$ kronor. Given the estimates / values for the parameters in equations (4) and (5), to be able to calculate the net consumer gains, it remains to find out the values of $\bar{q}_0$ and q_1.

The data

Our data originate from a private bank in Sweden and span from the first quarter of 2013 to the last quarter of 2015 and contains the total number of transactions of 4 different types (i.e., in-branch, mobile, internet, telephone) for each age group and income level in each district (i.e., geographical division according to the bank's own organizational structure). We will use the term "digital transactions" to refer to the sum of mobile, internet and telephone transactions, and the term "non-digital transactions" to refer to the sum of in-branch transactions.

Despite the fact that the data we have is not at the individual level, it allows us to evaluate *on average* the net consumer gains of certain groups of consumers. We begin with presenting simple descriptive statistics of our data. Since we have aggregated data, the averages and standard deviations we present will be weighted statistics (i.e., weighted averages and weighted standard deviations).

According to our data, an average customer made 4.5425 transactions per quarter (*st. dev.* = 5.4729), while 4.5399 of these were digital transactions (*std. dev.* = 5.4692). Since the average number of in-branch transfers was negligibly low, we will not be reporting the statistics for this sort of transfers. The weighted average number of transactions for each age group is shown in Table 1.

Table 1: Weighted averages for the number of digital transactions by age group

age group	obs.	mean	std. dev.	min	max
0-17	1323	0.0401	0.0315	0	20
18-24	3872	5.1809	3.0802	0	31.5
25-44	3989	7.2219	6.3110	0	113
45-64	3981	6.1398	6.1354	0	57
65-	3881	1.6925	2.0352	0	47
18-64	11842	6.4952	5.9634	0	113

As can be seen in the table above, on average, the 0-17 age group made the least number of digital transactions, while the 25-44 age group made the highest number of digital transactions per quarter. Since the average transactions for the former group is almost negligible, we will drop this group from our analysis.

On the other hand, seniors, when compared with other age groups, made on average markedly lower transactions per quarter. Simple two-sample t-tests reveal that the mean digital transactions for senior age group is significantly different than the other age groups that we focus on (t = 58.8181, t = 52.5972, t = 43.3537 for the comparison of the senior age group with the age groups 18-24, 25-44, and 45-64, respectively; the corresponding p-value is 0.00 for all the t-statistics). These statistics support our assumption that the senior age group in fact makes transactions that are absolutely necessary.

Table 2: Weighted averages for digital transactions per quarter by income level

income level	obs.	mean	std. dev.	min	max
< 18000	4918	2.6330	1.6537	0	8.7
18000 - 25000	4029	16.9084	2.4938	0	23.7
25001 - 30000	3907	19.2345	2.2415	0	45
> 30000	3990	21.3907	2.3500	0	41
unspecified	202	20.6191	16.2862	0	113

Table 2 depicts a clear positive relation between the level of income and the average number of transactions per quarter. This suggests that the introduction of digital transactions benefited the customer groups with higher income most. The same patterns can be observed once we take a look at the summary statistics by age and income, as shown in Table 3 below.

Table 3: Weighted averages for digital transactions per quarter by age and income

age group	income level	obs.	mean	std. dev.	min	max
18-24	< 18000	986	4.3528	0.9374	0	7.1
25-44	< 18000	986	4.1713	0.9648	0	7.6
45-64	< 18000	988	3.2058	1.0214	0	8.7
65-	< 18000	984	1.3527	0.3483	0	2.9
18-24	18000 - 25000	960	15.3416	1.2680	10.8	20.5

25-44	18000 - 25000	970	18.9129	1.2256	0	23.7
45-64	18000 - 25000	964	15.9439	1.2210	0	21.3
65-	18000 - 25000	960	11.2396	1.3849	7.5	18.6
18-24	25001 - 30000	959	16.0218	1.7776	6.8	31.5
25-44	25001 - 30000	966	20.3486	1.5192	0	26.7
45-64	25001 - 30000	966	19.1131	1.4449	13	25.6
65-	25001 - 30000	970	13.9095	1.8861	5.9	45
18-24	> 30000	960	15.2851	2.4649	1.5	25.6
25-44	> 30000	967	21.8494	1.7147	1.7	28.5
45-64	> 30000	972	21.9842	1.4847	0	33
65-	> 30000	963	16.5793	1.9388	7.7	41

Regression analysis

In addition to the summary statistics provided above, we also perform a weighted OLS regression, where the dependent variable is per person digital transactions per quarter across districts. The regression is weighted with the number of customers in each district. That way, in each district, the OLS regression clones the average customer, who makes precisely the average number of digital transactions per person and per quarter, by the number of customers in that district, so that the regression is run as if all the customers in each district were average customers of that district.

The explanatory variables were all indicator variables for each age group, income level, quarter and district. The reference age group and income level were naturally the seniors (i.e., 65+) and monthly income of less than 18000 kronor, whereas the reference quarter and district were the first quarter of 2013 and central Stockholm, respectively.

We report the coefficient estimates below. Despite the fact that our data includes transaction data for 83 districts, we report only 12 of these. That way, we believe that the essential message of our results is illustrated. Our selection criterion for the chosen districts was based on reflecting results from two contrasting (one small, and one bigger) districts (kommun) from 6 different provinces (landskap).

Table 4: OLS regression for per person digital transactions

Dependent var.: per person digital transactions per quarter. *No. of observations: 15521, F = 8093.78, p-value = 0.000*

age group	*coefficient estimate*	*std. error*	*t-statistics*	*p-value*
18-24	2.8861	0.0236	122.34	0.000
25-44	3.2466	0.0160	202.79	0.000
45-64	2.0649	0.0160	128.79	0.000

income level	*coefficient estimate*	*std. error*	*t-statistics*	*p-value*
18000 - 25000	13.0983	0.0235	556.53	0.000
25001 - 30000	15.5235	0.0381	407.51	0.000
> 30000	17.8190	0.0365	487.67	0.000

quarter	*coefficient estimate*	*std. error*	*t-statistics*	*p-value*
2013 Q2	0.2414	0.0304	7.95	0.000
2013 Q3	0.1582	0.0304	-5.21	0.000
2013 Q4	0.3125	0.0303	10.30	0.000
2014 Q1	0.4287	0.0303	14.17	0.000
2014 Q2	0.0536	0.0302	1.77	0.076
2014 Q3	0.0733	0.0302	2.43	0.015
2014 Q4	0.2723	0.0302	9.02	0.000
2015 Q1	0.2957	0.0301	9.83	0.000
2015 Q2	0.1068	0.0301	3.55	0.000
2015 Q3	0.0176	0.0301	0.59	0.559
2015 Q4	0.4629	0.0300	15.43	0.000

district	*coefficient estimate*	*std. error*	*t-statistics*	*p-value*
Malmö	1.1135	0.0558	19.94	0.000
Trelleborg	1.9016	0.0706	26.94	0.000

Jönköping	1.6555	0.0642	25.81	0.000
Nybro / Emmaboda	2.5083	0.0966	25.98	0.000
Örebro	1.6568	0.0644	25.74	0.000
Hallsberg	3.0005	0.1009	29.78	0.000
Luleå	0.8099	0.0681	11.89	0.000
Kalix	2.6172	0.1282	20.41	0.000
Göteborg	0.7730	0.0616	12.55	0.000
Skaraborg	2.3342	0.0623	37.46	0.000
Linköping	1.3228	0.0650	20.35	0.000
Mjölby	3.1755	0.0897	35.41	0.000

	coefficient estimate	*std. error*	*t-statistics*	*p-value*
constant	-0.6061	0.0535	-11.34	0.000

According to our results, *ceteris paribus*, consumers in the age group 25-44 made on average $3.2466 - 0.6061 = 2.6405$ digital transactions more than the consumers in the senior age group, while for those in the 18-24 and the 45-64 age groups the same differences were only $2.8861 - 0.6061 = 1.2800$and $2.0649 - 0.6061 = 1.4588$, respectively. Likewise, ceteris paribus, consumers who have a monthly income greater than 30000 kronor made on average $17.8190 - 0.6061 = 17.2129$ more than those who have a monthly income lower than 18000 kronor. Similar calculations for those with 18000 - 25000 and 25001 - 30000 income levels point to somewhat lower differences. More precisely, consumers at these income levels made on average 14.9174 and 12.4922 more digital transactions per quarter, respectively, than the average transactions per quarter made by those at the reference income level. This corroborates the link between income and the average number of transactions that we observed in the summary statistics presented in Table 2. That is to say, income is significantly positively related with the average number of transactions.

When it comes to the timespan of these transactions, our results display seasonality throughout the quarter years that our data spans. This is reflected by the lower coefficient estimates for the third quarters within each year that our data covers. We believe that this seasonality is due to the lower economic activity during the summer season, when a majority of Swedes are on holiday. Due to this seasonality, it is hard, if not impossible, to comment on the question of whether or not the average number of digital transactions increased. A comparison of the years 2014 and 2015 shows that, everything else being equal, the average change in per person digital transfers from the reference quarter for the year 2015 (-0.3854) was slightly higher than that for the year 2014 (-0.3991), yet still lower than that for the year 2013 (-0.3687).

Having district-level data, we are also able to comment on whether or not there is a difference in the average number of digital transactions between a reference metropolitan city centre (i.e., Stockholm) and other cities. Our regression results indicate that, except for a few of the 83 districts, the number of transactions per person made in a quarter year in smaller districts is significantly higher than that in central Stockholm. Furthermore, comparisons of more populated districts and less populated districts in the same province point to similar conclusions. For instance, the number of digital transactions per person in central Göteborg is only slightly higher (0.1669, ceteris paribus) than that for central Stockholm, while the same difference for the nearby county Skaraborg is much higher (1.7281, ceteris paribus). This suggests that consumers living in provincial towns benefit more from the availability of digital transactions, which is more noticeable for smaller provincial towns. Presumably, this behavioural difference appears due to the differences in the distance to the nearest bank branch between the larger and smaller towns.

Calculations

After deriving the expressions for net consumer gains and estimations for per person digital transactions, we are ready to present our calculations of the net consumer gains. We will first present our calculations based on differences in average digital transactions between certain groups and our reference group (i.e., consumers in the senior age group with an income lower than 18000 kronor per month). Then, we repeat the same exercise using the estimates that we obtained from the OLS regression. In both cases, we provide upper and lower bounds for the net consumer gain. Lastly, we present calculations that are adjusted for varying opportunity cost of time. That is, we vary in our calculations the hourly wage that we used when calculating the parameter t in the equations presented above.

We start with the means-based calculations.

(a) Means-based calculations. Recall that customers made on average 4.5399 digital transactions per quarter year. Using equations (4) and (5), the lower and upper bounds for the net consumer gains become 744.08 kronor and 1062.80 kronor per year, respectively. While these are calculations for the average consumer, we provide below group-specific values of these bounds.

We start with the calculations for each age group. As seen in Table 5, the gains range from 430.70 kronor up to 1626.18 kronor, and the 25-44 age group has the highest gains.

Table 5: Upper and lower bounds for net consumer gains for each age group

age group	mean transactions per quarter	lower bound for NCG per year	upper bound for NCG per year
18-24	5.1809	814.6280	1197.4480
25-44	7.2219	1039.2605	1626.1805
45-64	6.1398	920.1646	1398.8746

65-	1.6925	430.6947	464.6747
18-64	6.4952	959.2799	1473.5299

Next, we provide calculations for each income group. As seen in Table 6, the gains range from 534.21 kronor up to 4602.48, where consumers with the highest income level have the highest gains from the availability of digital transactions.

Table 6: Upper and lower bounds for net consumer gains for each income level

income level	mean transactions per quarter	lower bound for NCG per year	upper bound for NCG per year
< 18000	2.633	534.2061	662.2361
18000 - 25000	16.9084	2105.3567	3660.9267
25001 - 30000	19.2345	2361.3672	4149.5472
> 30000	21.3907	2598.6786	4602.4786

We can as well present calculations for a finer customer partition. Specifically, we repeat the same exercise in Table 7 below for each age group and income level. This time, the gains range from 393.30 kronor up to 4727.15 kronor.

Table 7: Net consumer gains for each age group and income level

age group	income level	mean transactions per quarter	lower bound for NCG per year	upper bound for NCG per year
18-24	< 18000	4.3528	723.4873	1023.4973
25-44	< 18000	4.1713	703.5114	985.3714
45-64	< 18000	3.2058	597.2485	782.5585
65-	< 18000	1.3527	393.2963	393.2963
18-24	18000 - 25000	15.3416	1932.9147	3331.8047
25-44	18000 - 25000	18.9129	2325.9719	4081.9919
45-64	18000 - 25000	15.9439	1999.2038	3458.3238
65-	18000 - 25000	11.2396	1481.4485	2470.1385

18-24	25001 - 30000	16.0218	2007.7775	3474.6875
25-44	25001 - 30000	20.3486	2483.9851	4383.5751
45-64	25001 - 30000	19.1131	2348.0060	4124.0460
65-	25001 - 30000	13.9095	1775.2977	3030.9777
18-24	> 30000	15.2851	1926.6963	3319.9363
25-44	> 30000	21.8494	2649.1631	4698.8331
45-64	> 30000	21.9842	2663.9992	4727.1492
65-	> 30000	16.5793	2069.1359	3591.7959

(b) Calculations based on OLS estimates. We repeat the exercise above using the OLS estimations instead of the simple (and less accurate) group means. Since our OLS estimates are based also on districts, we will do the calculations first for Stockholm city centre, which has been our reference district in the OLS regression, and then for a provincial district. That way, we will be able to compare the net consumer gains in a metropolitan city centre with that for a provincial town. Moreover, we will base our calculations for the base quarter year (i.e., 2013 Q1).

Table 8: Net consumer gains for central Stockholm based on OLS estimates

age group	income level	mean transactions per quarter	lower bound for NCG per year	upper bound for NCG per year
18-24	18000 - 25000	15.3783	1936.9539	3339.5139
25-44	18000 - 25000	15.7388	1976.6305	3415.2405
45-64	18000 - 25000	14.5571	1846.5726	3167.0126
18-24	25001 - 30000	17.8035	2203.8714	3848.9514
25-44	25001 - 30000	18.164	2243.5480	3924.6780
45-64	25001 - 30000	16.9823	2113.4901	3676.4501
18-24	> 30000	20.099	2456.5141	4331.1441
25-44	> 30000	20.4595	2496.1907	4406.8707
45-64	> 30000	19.2778	2366.1328	4158.6428

Compared with the values we computed in Table 7, the values we found in Table 8 are similar, yet the differences across income level and age groups are smaller.

As a comparison, we perform the same exercise for a smaller provincial town, Mjölby. According to our OLS estimation, the difference between the two districts is that the customers in Mjölby made on average 3.1755 digital transactions more than those in central Stockholm. In turn, customers in Mjölby had gains roughly between 300 and 700 kronor more than those in Stockholm due to the availability of digital transactions.

Table 9: Net consumer gains for Mjölby based on OLS estimates

age group	income level	mean transactions per quarter	lower bound for NCG per year	upper bound for NCG per year
18-24	18000 - 25000	18.5538	2286.4494	4006.5594
25-44	18000 - 25000	18.9143	2326.1260	4082.2860
45-64	18000 - 25000	17.7326	2196.0681	3834.0581
18-24	25001 - 30000	20.979	2553.3669	4515.9969
25-44	25001 - 30000	21.3395	2593.0435	4591.7235
45-64	25001 - 30000	20.1578	2462.9856	4343.4956
18-24	> 30000	23.2745	2806.0096	4998.1896
25-44	> 30000	23.635	2845.6863	5073.9163
45-64	> 30000	22.4533	2715.6284	4825.6884

(c) Calculations adjusted for varying opportunity cost of time. Since the value of time lost due to completing an in-branch transaction would be different for each consumer group with different income levels, we will also present calculations adjusted to varying opportunity cost of time. For simplicity, we take the lower bounds of each income level to calculate the hourly wage rate corresponding to each income level. Furthermore, we use the fact that Swedes work on average 137 hours per month (source: Statistiska Centralbyrån). So, the hourly wage rate becomes 218.98, 182.48, and 131.39 kronor for monthly incomes of 30000, 25000, 18000 kronor, respectively. In turn, the corresponding values for the parameter t become 74.34, 62.79, and 46.61 kronor, respectively.

Calculations for central Stockholm based on these wage rates and OLS estimates becomes as shown in Table 10. Notice that, due to the opportunity cost adjustment for each income level, the gap in gains between customers with low and high incomes has widened.

Table 10: Adjusted net consumer gains for central Stockholm

age group	income level	mean transactions per quarter	lower bound for NCG per year	upper bound for NCG per year
18-24	18000 - 25000	15.3783	1655.0646	3057.6246
25-44	18000 - 25000	15.7388	1688.6674	3127.2774
45-64	18000 - 25000	14.5571	1578.5192	2898.9592
18-24	25001 - 30000	17.8035	2501.0181	4146.0981
25-44	25001 - 30000	18.164	2546.2867	4227.4167
45-64	25001 - 30000	16.9823	2397.8985	3960.8585
18-24	> 30000	20.099	3285.1103	5159.7403
25-44	> 30000	20.4595	3338.7116	5249.3916
45-64	> 30000	19.2778	3163.0092	4955.5192

If we apply the wage rates for each income level for Mjölby, the gap in net consumer gains becomes even wider, as shown in Table 11.

Table 11: Adjusted net consumer gains for Mjölby

age group	income level	mean transactions per quarter	lower bound for NCG per year	upper bound for NCG per year
18-24	18000 - 25000	18.5538	1951.0583	3671.1683
25-44	18000 - 25000	18.9143	1984.6611	3740.8211
45-64	18000 - 25000	17.7326	1874.5129	3512.5029
18-24	25001 - 30000	20.979	2899.7712	4862.4012
25-44	25001 - 30000	21.3395	2945.0399	4943.7199
45-64	25001 - 30000	20.1578	2796.65169	4677.1617

18-24	> 30000	23.2745	3757.2631	5949.4431
25-44	> 30000	23.635	3810.8645	6039.0945
45-64	> 30000	22.4533	3635.1620	5745.2220

Summary

New technology, changing price models, value chains and value creation due to digitalisation increase the need for new methods and models to capture economic development and to make economic forecasts. Using the model presented in this study, we quantified the consumer surplus due to digitalization and made it tangible. We estimated net consumer surplus by using a reference group and also embodying the opportunity cost due to time optimization. We pinned down a value for the net consumer surplus due to digitalization for consumer groups that differ by age, income level and geographical location. One of our main findings is that we identified a positive correlation between income and net consumer gain. The higher income is, the higher opportunity costs become and, therefore, a higher net consumer surplus is obtained for those with higher income due to the availability of digital economic activities. We also found a higher net consumer surplus in the sparsely populated areas relative to the large city centres, presumably due to higher opportunity cost of travel.

Concluding remarks

Both from a societal and corporate perspective new models are crucial in order to identify their value for the client or citizen. For example, with the introduction of digital channels and Bank ID for providing services to citizens, tax authorities (such as the Swedish Skatteverket) have created a large consumer surplus in terms of time optimization. If this could be measured, it would allow both those providing services, individual consumers and state agencies to serve people in a more effective and consumer friendly ways, while also incentivising other public agencies to be more cost effective. For the government, being able to measure the gain from digitalization is helpful when setting targets and incentive models for the public agencies. Also, fiscal policy needs an adequate ground for taking the right policy and regulatory decisions. If there exist hidden values in the economy that are not incorporated in the GDP, tax and redistribution policies that fail to take account of this would be misdirected, which would potentially impose a social cost on citizens and firms.

From a corporate perspective, it would be crucial to know the values that different digital investments create for their customers. This would help form the basis for the development of new differentiated pricing and delivery models.

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