Impact of Customer Web Portals on Call Center: An Empirical Analysis[1]

Anuj Kumar, Rahul Telang

Carnegie Mellon University

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Abstract

Firms are investing millions to deploy web based self-services at their call centers primarily to reduce operating costs. The rationale is that the firm's cost of interacting with customers through the web based channel is an order of magnitude cheaper than the assisted channels like telephony. We conduct a field study at the call center of a prominent US health insurance firm to examine the cost saving rationale of web based self service. On one hand, the low cost- low quality web channel may substitute the high cost-high quality telephony channel in some cases. On the other hand, the web also exposes customers to more information that at times aggravates their concerns and thus leads to more telephone calls. We designed a quasi-natural experiment in our field setting and used diff-in-diff specifications to show that web based self service usage leads to 14% increase in telephone calls. We conduct several checks to show that our specifications are robust to any potential selection of customers in web self-service usage. However, we further show that the impact of web portal is moderated by the web portal characteristics and individual customer characteristics. We find that if information is unambiguous and easily retrievable on web, calls in respect to such information go down by 29%. Likewise, we also find that the absolute increase in calls due to web usage for younger customers (age<40 years) and older customers (age>70years) are much higher than the middle aged customers (age 40-70 years). In all, our research gives concrete prescriptions to managers in multichannel customer service management, web portal design and customer segmentation.

Keywords: Self-service, call center, customer support, Value of web portal, Multichannel service management

1. Introduction

Call centers and its contemporary contact centers have been firms' preferred medium for communication with their customers. Industry estimates suggest that 70% of all customer-business interaction takes place via call centers; Fortune 500 companies operate on average 30 call centers each; $700 billion worth goods and services were sold through call centers in 1997; 40% of the total AT&T's telephone traffic is 1-800 calls (Mandelbaum 2006). Firms have increasingly recognized that call centers offer opportunity to collect rich customer interaction data which can be analyzed to provide customized goods, services and experience to the customers. This, in turn, may lead to higher customer satisfaction and thus customer loyalty. As a result, several alternative channels of customer support have been introduced at call centers over time. On the one hand there are assisted channels where firm representatives assist customers via telephony, email, SMS. On the other hand, there are self-service channels where customers find desired information via interactive voice response units (IVRs/VRUs), web based self-service portals etc. The self-service channels are also popularly referred to as self services technology (SSTs) channels.

Since about 70% of the total call center cost is direct labor cost, firms are increasingly using SSTs like the IVR and web based self services to cut back on costly the customer service representative (CSR) costs. Yankee group research report (2006) estimates that the average cost of serving customer via self service channels (less than $ 1) is an order of magnitude cheaper than serving via assisted channels (between $5-$10). Within self service channels, the web based self service costs just $0.24 for an interaction as opposed to $5.50 for a CSR assisted interaction via telephony. Due to this compelling economics, the web based self service has grown from 7.7% of the total customer interaction in 2005 to 14.4% in 2007 (Yankee 2006). Market for the web based self-service solutions is expected to grow from US $ 309.3 million in 2005 to US $ 887.3 million in 2012 at a compound annual growth rate of 16.2% (Frost and Sullivan 2005). The web based self-services allow customers to not only execute transactions at convenience without any physical interface with the firm but also seek relevant information and manage their online account independently. It is expected that once customers learn and start availing the

convenience of this option, it should not only reduce the demand for assisted channels at call centers but also result in higher customer satisfaction leading to a higher customer retention and profitability (Anderson et.al. 1994). However, the benefits of SSTs can be realized only when customers embrace and use this new technology.

Prior research has explored the determinants for customer adoption of SSTs. Meuter et.al. (2000) find that the ability of SSTs to bail customer out of immediate troubling situation, ease of access and use, and fascination with capability of technology are the main sources of customer satisfaction with SSTs. Meuter et.al. (2005) show that customer readiness variables like role clarity, motivation and ability are key mediators in increasing the likelihood of customers trying SST. Dhabolkar et al. (2001) use attitudinal theories to propose a conceptual framework for predicting customer's decision to use SSTs. However, these studies rely on questionnaire or survey tools to elicit customers' adoption and use of SSTs but do not inform how adoption of self-service channels affects demand for other available alternative channels. The interaction among different channels of sale has been studied by marketing scholars. Deleersnyder et al. (2002) study 67 newspapers and find that the Internet format of newspaper cannibalizes sales of the paper format if their contents are similar. However, it may even enhance sales, if the contents in the two formats are different. Biyalogorsky et al. (2003) studied the impact of addition of internet channel to the existing brick-and –mortar store channel for a music records firm and found a negative but insignificant impact. The challenges and opportunities in multi-channel customer management have also been well recognized and studied in the marketing literature (Neslin et.al.2006). We, howevesxr, did not come across any empirical work that informs how the self service channel affects the demand for the assisted channels in multi-channel customer service setup like modern day call centers.

This work is also directly related to the studies that examine the role of IT in productivity. However, much of this literature uses aggregate data at the firm, industry or even country level (Siegel et.al 1994, Brynjolfsson et.al. 1995, Barua et.al 1995). To measure the impact of IT on productivity at more granular level, the IT researchers have focused on intermediate output measures like inventory, quality etc. Only a

few recent papers have explored the IT productivity issue at the individual level. Aral et al. 2007 find a positive effect of IT use and information flow on individual white collar worker performance. Bulkley et. al. 2006 find a positive effect of information flow and network structure on the white collar worker performance. We also have customer level data and we examine the effects of IT at the individual levels. In particular, we examine how individual customer use a widely available IT enabled self service tool like web portal and therefore how it impacts the direct call handling cost at the call center – a cleanly measureable productivity measure. Unlike productivity studies, we will show that sometimes adoption of an IT tool can have adverse effect on firm's intended productivity goals.

In the present work, we conduct a field study at a major US health insurance firm with about four million customers. The firm was offering customer support via telephony through its call center. It recently introduced a web based self-service portal for its customers. Using the vertical differentiation framework in economics, we show that web portal usage could potentially substitute the telephone calls, especially for simple information search. We also use human decision making theories to indicate that web portal usage may expose customers to more information which may aggravate their concerns leading them to make more telephone calls. This is particularly true when information search is less directed and information is uncertain and complex. We set up a quasi-natural experiment and employ diff-in-diff specification to estimate the net impact of web portal usage on telephone calls. Our results show that web portal registration leads to 14% increase in the number of calls to the call center. We conduct several robustness checks to show that our specification is robust to any potential selection of customers in web portal registration. We also show that the effect of the web portal on telephone calls is moderated by the web portal and customer characteristics. We find that the web portal usage leads to 29% decrease in calls for which the related information is unambiguously provided on the portal. In contrast, the web usage leads to 66% increase in calls for which the information is ambiguous and comprehensive with no interactive features. We also find that the customers younger than 40 years and older than 70 years are the

ones who increase their calls more with web portal registration. In comparison, the middle aged customers aged 40-70 years show moderate increase in calls with web portal registration.

We believe our research is unique in many ways. To our knowledge it is the first study which examines the affect of web based self service usage on other traditional channel like telephony. Second, we estimate the impact of web based self service usage on the actual transactional data in a field study as opposed to survey data. Third, we conduct checks to ascertain that in our setting the diff-in-diff specifications is robust to any possible selection bias and thus estimate the causal affect of web portal usage on telephony channel. Last but not the least, we provide empirical evidence of value of web portal design in reducing calls to call center.

This paper is organized as follows. We describe our study setting in Section 2. Section 3 outlines our theoretical framework. We describe our data and econometric specifications in section 4. Finally, in section 5, we conclude with managerial implication of our research and outline limitations of the current work and future research directions.

2. Research Site

Our study setting is a large health insurance firm in the US. The firm sells several different health insurance plans to a customer base of approx. four millions. After the plans are sold, firm serves its customers through its operational unit. The operational unit performs three broad activities

1. Client Services – Initial setting up and routine periodic activities like issuing invoices etc.
2. Call Center Services – Resolving customer's queries through telephones calls.
3. Claims Services – Processing customer's claims through computer systems and manually.

Activities 1 and 3 are predominantly automated through the information systems set up in the firm. The call center services accounts for about 70% of the total operating cost of $47 million in 2007. The firm received over 3 million calls in 2007.

2.1 Web Portal –

To contain large call center costs, the firm set up a web portal. The firm hoped that some of the customers would find answers to their queries on the web portal and thus not use the call center - leading to reduction in its call center cost. Customers first register on the web portal by creating their secure username and password. Thereafter, customers can access information on the web portal. The web portal provides information to customers in five broad areas. First, it provides information on customer's plan coverage and membership details. Second, it allows customers to track their health care costs, monitor their claim status, get useful information about costs of health services and manage their spending account. Third, it allows customers to access their personal health records, explore treatment options and get support in health care decisions and preventive recommendations. Fourth, it allows customers to access health provider's information like location, profile, credentials and quality performance data. This helps customers make more informed choice of providers. Lastly the portal allows customers access to a health encyclopedia to get information on disease, care management, surgeries and procedures. Thus, the web portal hosts comprehensive information on customers plan benefits, spending and health records. It also hosts large information on health providers, general disease and health care management. The customer has to sift through this large information to search for the relevant information and then process it to find the desired answer to her query. This is very different from the situations where the customers can do transaction through the web portals by clicking on the provided links/buttons (account transfers / bill payments etc through member portal in banks web sites).

3. Theoretical Framework

Customers use available channels of inquiry to resolve queries pertaining to their health and health insurance plans. Before the web portal, telephony was the only choice available to customers for query resolution. After the introduction of portal, for a given query, the customer has a choice to either search and process this information on the web portal or call the customer service representative (CSR) at call center to provide him this information.

The web portal can be considered a low quality and low cost channel in line with the vertical differentiation models. The cost to access the web (after choosing to register) is relatively low but the customer has lower probability of finding answers to her questions, especially if questions pertain information search which is complex, uncertain and imprecise. In contrast, telephony is high quality and high cost channel. The wait times in call center are typically large and the call center is not 24/7. However, customers can find precise answers to their queries from CSR, who has superior expertise and resources. Literature on vertical product differentiation then provides a roadmap for how demand for both channels realizes (Thisse et al. 1979). [2] In the following we provide a simple model of how the web portal can affect telephony use. The goal is not a structural model to be estimated but a model that provides insights and testable hypothesis.

As a rational economic agent, the customer will consider the costs and benefits of choosing a particular channel. Let V be the economic value of query resolution to customer. The value of query resolution depends on the severity of health event.[3] The higher the severity, the higher is the value of its resolution. Let P_c & P_w be the expected probabilities of query resolution through telephone call and web visits respectively. Given that the web is a lower quality alternative to the telephony, we expect $P_c > P_w$. Let C_c & C_w be the cost (monetized disutility) of telephone call and web visits respectively to the customer. As per our assumption, we expect $C_c > C_w$. Thus the expected utility from the telephony is $U_c = P_c \bullet V - C_c$, and from the web is $U_w = P_w \bullet V - C_w$.

Before the web portal, customers had only the call center to resolve her query. Normalizing, the expected utility from doing nothing U_o to be zero, customers will choose to call if $U_c > U_0$ or if $V^{\wedge} \geq (C_c / P_c)$. Thus $V^{\wedge}$ is a threshold value of the query below which the customer does not bother to make a call.

[2] Unlike a vertical differentiation model, the web and the telephony need not be a perfect substitute. Consumption of telephony need not completely eliminate the need for consumption of the web. For example, sometimes the web may provide some complementary information. As long as, on average, users perceive telephony to be a higher quality than the web, our model insights will go through.

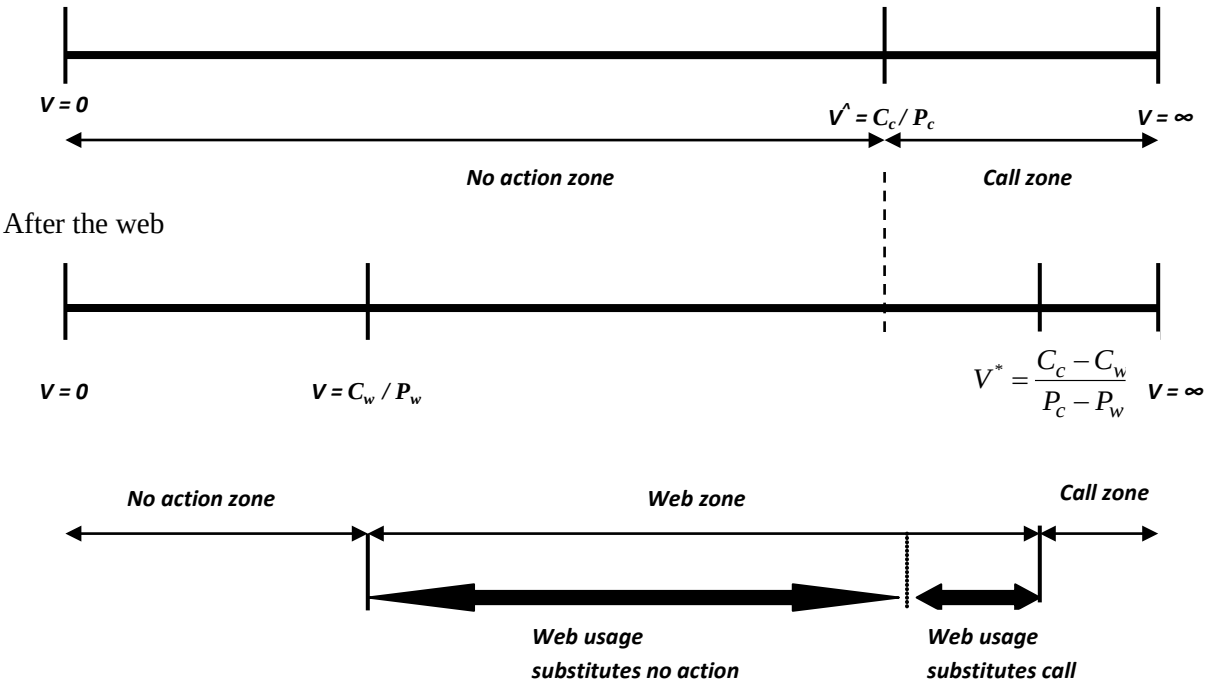
[3] We will elaborate this in more detail in our data section.

After introduction of the web portal, the customer has another channel available for query resolution. As we argued, the web is a lower quality and lower cost alternative. Therefore, for a given V, customers have a decision to make: they can either choose telephony or the web portal or to do nothing. Given a clear order for telephony and web, customers will choose telephony if $U_c > U_w$ for a given V. Thus, the indifference V^* that separates phone versus web portal use is given by

$$U_c(V^*) = U_w(V^*), \qquad \text{Or, } V^* = (C_c - C_w)/(P_c - P_w).$$

Similarly, the customer will choose web portal over doing nothing if $U_w(V) > U_0$ and $V < V^*$. Thus customers choose portal when $C_w / P_w < V < V^*$. We can outline these regions pictorially in Figure 1.

Figure 1- Effect of web usage



Note that it is immediate that $V^* > V^\wedge$. Therefore, after the web becomes available, customers use web instead of telephony when $V^\wedge < V < V^*$. This is evident from Figure 1. Therefore, if the web were to be a substitute for telephony (the amount of substitution depends on how effective the web is compared to the

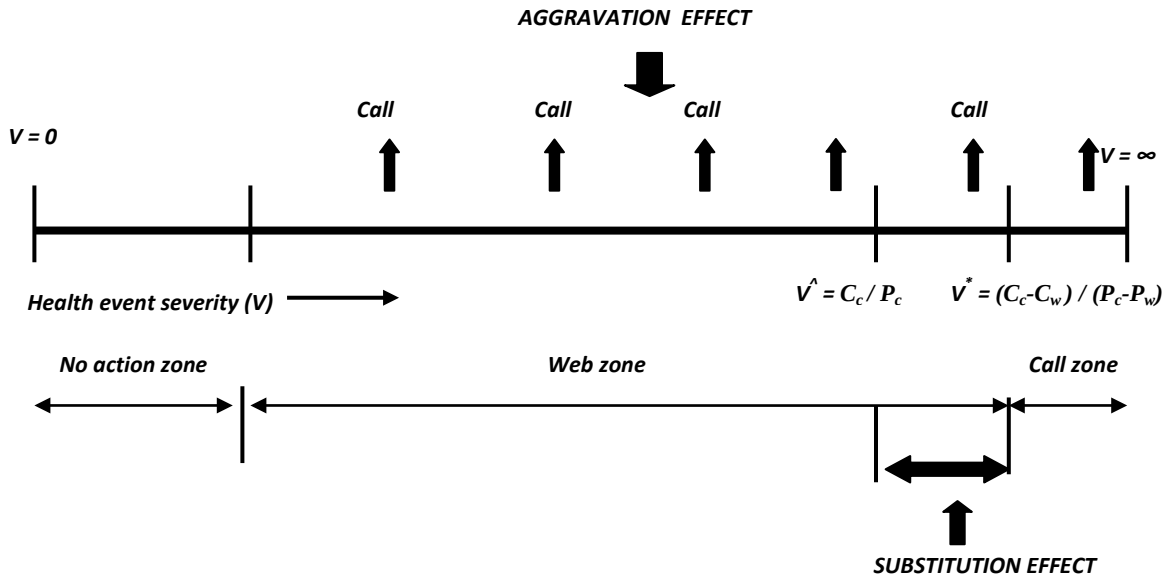
telephony after controlling for their costs), we would expect a reduction (or at most no change) in phone calls. What is more striking is that there is a large region where users chose to do nothing before the web but now visit the web (see the region from V to $V^{\wedge}$). We will show that our data matches this aspect quite well. This suggests that the web provides an opportunity for the users to visit the portal and gather information about their claims, health status etc for low and medium severity events when they would have done nothing otherwise.

However, this stylized model relies on the fact that web portal is at least a weak substitute and that visiting the web portal eventually resolves the query just as in telephony. However, in our setting, the web portal provides large and passive information to customers. It does not actively provide any tool for a particular query resolution. If the customer searches for unstructured and uncertain information then web portal may not only fail to resolve the query but it may also bring additional information to customer notice. There is a large literature in human decision making that suggests that provision of more information (if it creates ambiguity) may lead to humans asking for more information (Cox 1967, Murray 1991). Dermer et al. (1973) found in a laboratory experiment that subjects intolerant to ambiguity prefer greater amount of information and more readily interpretable signals. Similarly, Miller (1972) found in his experimental study that financial investors seek more data when faced with uncertainty. In view of these findings, we would expect that if customer finds any information on the portal that creates ambiguity or confusion, she is likely to call for its resolution.

Notice from Figure 1 that customers are more likely to visit web either for moderate economic value query resolution, or they may visit the web with no particular query in mind. This is also different from the telephony channel where customers almost always have a specific query to resolve. Put another way, in the absence of web portal availability, customers would have done nothing in such cases. Web portal contains comprehensive information on customers' product benefits, customers' spending, customers' health records and health providers. So the customer gets to see all information on desired topic, some of it is relevant and some irrelevant, depending on the context. In processing this information, it is

conceivable that sometimes this information raises additional questions (For example, a customer, who has been prescribed spinal manipulation, finds four different types of spinal manipulation listed in her health plan benefits with different coverage on the web portal). Since the customer has the alternative telephony channel available in the present setup, she can possibly call up the CSR and mitigate her uncertainty. In our setup, this suggests that a visit to the web portal may lead to aggravation of query, which may necessitate a phone call. This is explained in the figure 2.

Figure 2- Combined model for call generation with web usage



Customers start using web at moderate economic value of resolution levels. But some of the web usage results in the calls due to exposure to more information to the customer.

Thus the impact of web portal on telephony will depend on the strength of substitution or aggravation effect. In the following, we empirically estimate the relationship between web portal and telephony usage and highlight when aggravation or substitution effect is more dominant.

4. Data and Econometric Specifications

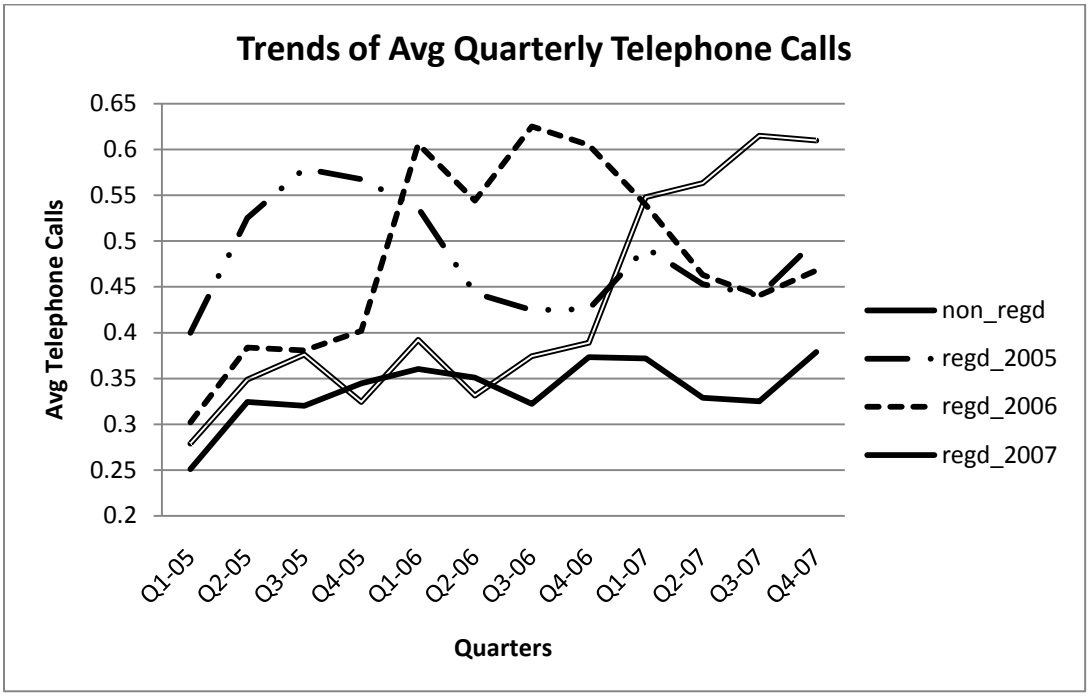
We collected telephone usage data, claims data and web portal usage data for the period March 05- Dec 07 for a random sample of 60000 customers from the entire population of the firm customers. We also

collected some demographic data like age for these customers. The firm started offering web portal services to its customers since 2005 onwards. We get a useable sample of 59280 customers after data cleaning, out of which 48631 customers did not register on the web portal at all and the remaining 10659 customers registered on web portal up to Dec 07 (5918 customers registered till December 2005, 2715 customers registered in year 2006 and remaining 2626 customers registered in year 2007). Thus our data offers us a quasi-natural experiment setting where we can compare phone calls of users before and after web registration.

We collected call data for each customer in our sample from the Automatic Call Distributor (ACD) of the call center. The firm classifies customer calls based on the reason for call like claims information, plan /drug / network coverage information, web related technical and usage information, membership /ID card related information, provider information etc. Since the web use itself may prompt calls like password reset calls, technical queries, web search related queries etc, it is important to distinguish and exclude such calls. Because the firm classifies each call, related calls, we exclude all calls pertaining to issues surrounding web portal usage for the purpose of our current analysis (hereinafter calls or telephone calls means that the web related calls are excluded). We plot the average quarterly telephone calls for the non-web registered customers, 2005 registered customers, 2006 registered customers and the 2007 registered customers as given in figure 3.

Figure 3 suggests three things: (1) Trends in calls are similar for the web registered customers and the non-web registered customer in pre-web registration period. (2) Telephone calls increase substantially for web portal registered customers during the registration period. (3) Telephone calls stabilize and stay at a higher level for web portal registered customers as compared to non-web registered customers after the registration year. Thus the figure indicates that prior to the registration, users' calls were similar to non registered users but after the web portal registration their calls are higher than the non registered users.

Figure 3 – Trends in telephone calls



While we have data for customers registered on web portal in 2005 and 2007 as well, for this study we focus on only those customers who registered in 2006. A simple rationale is that, for this cohort, we have 10 months of data before registration (period 2005 or pre-period) and same calendar 10 months of data after registration (period 2007 or post period). For other cohort (2005 registration or 2007 registration), we have unbalanced data. Either we have less pre-period data or less post-period data. Focusing on 2006 registered cohort allows us a clean identification test as we can control for same calendar month for the whole sample. Moreover, with this setup we compare the stable calls data for 2006 cohort in pre and post period (i.e. avoid the transient call increase / decrease during the year of registration for 2006 cohort). In subsequent sections, we show that we get similar results with all the registered customers in the analysis. Along with the users who registered for the web, we also have a control group of non-web registered customers, who did not register. Their data is also available for the entire period. The setting is pictorially shown in figure 4.

Figure 4 – Quasi-natural experimental setup

	Pre-portal period 05	*Post-portal period 07*
2006 Web regd. customers (Treatment Gr)	• CALLS • CONTROL VARIABLES	• CALLS • CONTROL VARIABLES
Non-web regd. Customers (Control Gr)	• CALLS • CONTROL VARIABLES	• CALLS • CONTROL VARIABLES

After listening to over 100 live calls and extensive discussions with CSRs and call center managers, we gathered that a health event and associated severity of that health event is a major driver of customer calls. [4] We use three separate measures as proxy for health severity. We use number of claims for a customer to indicate number of her health events. We use the amount paid (negotiated charges) by the insurance firm to the health provider to capture the intensity of health procedures.[5] We also compute the total dollar amount due from the customer in her claims to indicate customer liability. Note that these three variables put together provide good control for customer calls in different health situations e.g. many minor health events may attract more calls than one intensive health event even though the negotiated charges may be similar in the two or for similar negotiated charges and number of health events customer may call more in cases where she has higher out of pocket expenses. We compute these three variables for customers in each period and use as control variables in our analysis.

The summary statistics of all variables discussed above for the 2006 web portal registered customers and non-web portal registered customers is given in Table 1. We also provide summary statistics for those web portal registered customers who used the web portal in period 2007 (Note that not all web portal registered customers actually used the portal in period 2007). Table 1 indicates a higher increase for the 2006 registered web portal customers (1.32 to 1.55) compared to non registered users (1.10 to 1.13) and

[4] One of the authors accomplished these during his three months internship with the firm.

[5] We used negotiated charges that the insurance firm pays to the health provider rather than the billed provider charges (amount the provider bills to the customer) as proxy for health event intensity because different quality providers will bill different charges for same procedure but the insurance firm will negotiate similar charges from such diverse providers for similar procedures.

highest for the actual web portal users in period 07 (1.29 to 1.99). This suggests that web portal registration and usage is associated with an increase in telephone calls. However, Table 1 also indicate change in health event severity and customer liability from period 05 to period 07 and it could be the cause for increase in telephone calls.

Table 1 – Summary statistics

Variables	Observations	Period 05		Period 07	
		Mean	Std. Dev.	Mean	Std. Dev.
Non-web portal registered customers					
No of Telephone calls	48631	1.1	2.02	1.13	2.15
Customer Liability ($)	48631	1569.65	10797.57	1276.75	9470.65
Negotiated charges ($)	48631	5333.64	15765.86	6010.5	17281.9
Number of claims	48631	21.76	24.56	24.59	27.25
Number of web visits	48631	0	0	0	0
2006 web portal registered customers					
No of Telephone calls	2715	1.32	2.17	1.55	2.48
Customer Liability ($)	2715	864.95	4807.14	991.57	3738.43
Negotiated charges ($)	2715	5220.99	12156.81	6837.23	20108.34
Number of claims	2715	24.96	24.99	28.51	26.95
Number of web visits	2715	0	0	1.66	6.63
2006 web portal registered customers who used web portal in 2007					
No of Telephone calls	838	1.29	2.11	1.99	3.01
Customer Liability ($)	838	687.46	2795.86	1238.4	4933.09
Negotiated charges ($)	838	4812.5	10414.69	7260.25	12733.68
Number of claims	838	24.54	23.5	30.92	27.59
Number of web visits	838	0	0	5.39	11.06

Since we have a treatment group (portal registered customers), and a control group (no registration), we can employ the Difference-in-Difference specification, which is widely used in the economics literature with natural and quasi-natural experimental settings. This is a preferred specification in these settings, as it weeds out the confounding effect of unobserved factors from treatment effect (Meyer 1995, Angrist and Krueger 1999, Gruber 1994, Card 1992). The specification requires that the control group and the

treatment group exhibit similar trends before the treatment. Figure 1 confirms that and allays any concerns regarding selection problem.[6]

We utilize the fixed effect diff-in-diff specification (A) to examine how web portal usage impacts customers' telephone calls. We control for other observable variables that influence telephone calls viz, number and severity of health event and the financial liability of customer.

$$tel_{it} = \beta_i + \beta_1 X_{it} + \beta_2 reg_i + \beta_3 post_t + \beta_4 reg.post_{it} + \varepsilon_{it} \quad \text{--------- (Specification A)}$$

Where *i* index the customers and *t* indexes period (period 05 and period 07)

tel_{it} = Number of telephone calls by customer *i* in period *t*.

reg_i = 1 if the customer *i* is registered on the web portal and 0 otherwise

$post_t$ = 1 for period 07 and 0 otherwise

X_{it} = Control variables (number of claims, negotiated provider charges in the claims and total customer liability in the claims) for customer *i* in period *t*.

β_i = fixed effect for customer *i*.

Thus specification (A) estimates, how the number of phone calls change for a customer if she registers on the portal compared to the customer who does not register. The coefficient estimates (β_4) for *reg.post* is of interest. The fixed effect specification controls for the time invariant unobserved factors that influence telephone calls. We scaled negotiated provider charges values in ten thousand dollars and customer liability values in thousand dollars to make the estimate β_1 more readable. We found similar results with taking logarithm of these two variables. Notice that we use a dummy variable (*reg*) to indicate web portal registration or not. It may be tempting to use the number of actual web portal visits in the post period but that measure may likely suffer from reverse causality as sometimes, the CSRs encourage customers to visit the web after the phone call. Results of specification (A) with robust standard errors are given in Table 2.

[6] The selection problem is that the treatment group is different from control group to begin with. Thus the effect of treatment cannot be identified by comparing them with the control group.

Table 2 – Estimates for specification (A)

Dependent variable: Telephone calls	Coefficient estimates (Standard errors in parenthesis)
post dummy	-0.02* (0.011)
***reg.post* dummy**	**0.180*** (0.005)**
Customer liability (in 1000 $)	0.006*** (0.001)
Negotiated charges (in 10000 $)	0.021** (0.012)
Number of claims	0.018*** (0.001)
Constant	0.701*** (0.01)
N	51346
R-sq (adj. R-sq)	0.69 (0.39)

Note - ***, **, * = statistically significant at the 1%, 5% and 10% levels (two-sided test) respectively

First note that the coefficient estimates for the control variables have the expected signs. Higher health severity (liability, frequency of claims etc) leads to more phone calls. We find a positive and significant estimate for web portal registration *(reg.post)* indicating that even after controlling for other observable factors, customers make higher telephone calls after the web portal registration. The magnitude of coefficient estimate for *reg.post* suggests that after the registration, the telephone calls, on average, increase by 0.18, which translates into 14% increase in telephone calls for web registered customers. This is a significant increase, both statistically and economically. This also indicates that, in our sample, the web portal seems to have a stronger aggravating effect as opposed to substitution effect. We now explore this in more detail in the subsequent section. Before that, we provide some robustness checks on our findings.

4.1 Selection Problem

Note that the only identifying assumption in specification (A) is that the change in calls for the treatment and control group are similar in absence of treatment. We find from Figure 3 that the calls for treatment and control group track each other well in pre-treatment period. However, we now provide additional evidence to alleviate any concerns to our specifications due to user selection. In particular, one may worry

that for a given health severity, an inherently anxious customer is more likely to call and also more likely to register on the web portal.

First, we show formally that the call pattern of control and treatment users before portal registration is similar. We test this assumption in our data by comparing the trends in telephone calls for the treatment and control group over multiple pre-treatment periods (Meyer 1995). So we run specification (A) for the treatment group and control group in two pre-treatment periods, March-July 05 and Aug- Dec 05. A significant coefficient estimate for the dummy variable *reg.post* in such specification would indicate the differential trends in calls between the treatment and control group. The results are given in column (A) of Table 3. We find an insignificant coefficient estimate for variable *reg.post* which indicates that the treatment and control users had similar call trends before registering in absence of treatment.

Table 3 –Estimates for trends of calls in pre-registration period

Dependent Variable : Telephone calls	(A) 2006 regd customers as treatment group	(B) 2007 regd customers as treatment group
***reg.post* dummy**	**0.010 (0.03)**	**-0.022 (0.05)**
Customer liability (in 1000 $)	-0.004 (0.004)	0.003 (0.004)
Negotiated charges (in 10000 $)	0.007 (0.02)	0.009 (0.02)
Number of claims	0.015*** (0.001)	0.018*** (0.001)
Constant	0.514*** (0.11)	0.417*** (0.19)
N	51348	51259
R-sq (adj. R-sq)	0.45 (0.34)	0.60 (0.36)

Note - ***, **, * = statistically significant at the 1%, 5% and 10% levels (two-sided test) respectively (Standard errors are in parenthesis).

We also ran the same test but with 2007 web registered customers as treatment group and non-web registered customers as control group on pre-treatment periods, period 05 and period 06 (March-Dec 06). Note that in these periods, 2007 web registered customers did not have access to web portal. The results for the specification are given in column (B) of Table 3. We find an insignificant estimate for the variable *reg.post.* This indicates similar trends in calls for the 2007 web registered customers and non-web registered customers in the pre- web registration period. In all, results in Table 3 indicate that the trends in

calls for the web registered customers and the non-web registered customers in our sample are similar in the pre-web registration period.

Note that we dropped customers other than 2006 web registered customers form our total sample of web-registered customers for our analysis so far. We took several different samples out of web registered customers (e.g. customers registered on web from Aug-05 to Aug-07) and used them as treatment group with non-web registered customers as control group. We find qualitatively similar results indicating the increase in calls due to web registration. This further indicates that our results hold for the entire sample including the dropped sample.

We can further allay the selection concerns by running specification (A) with the treatment group as web registered customers who actually use web in period 07 and control group as web-registered customers who did not use web in this period. Here customers in our treatment group and the control group are both registered on web portal and thus are likely to be similar. The dummy for web portal usage (*wb*) is the treatment variable instead of the web portal registration. The results are given in column (A) of Table 4. We find positive and significant coefficient estimate for variable *wb.post*. This indicates that the customers who actually use web portal call more or in other words web usage causes calls.

Table 4 –Estimates for actual web portal usage

Dependent variable: Telephone calls	**(A) web registered & web users versus registered non-web users**	**(B) web registered & web users versus non-web registered users**
post dummy	-0.04 (0.06)	-0.02* (0.011)
***wb.post* dummy**	**0.454*** (0.11)**	**0.594*** (0.081)**
Customer liability (in 1000 $)	0.02** (0.01)	0.006*** (0.001)
Negotiated charges (in 10000$)	-0.03 (0.03)	0.021** (0.012)
Number of claims	0.028*** (0.002)	0.018*** (0.001)
Constant	0.628*** (0.062)	0.701*** (0.01)
N	5430	51346
R-sq (adj. R-sq)	0.70 (0.39)	0.69 (0.39)

Note - ***,**,* = statistically significant at the 1%, 5% and 10% levels (two-sided test) respectively

We also ran specification (A) with the actual web *users* as the treatment group and the non-web registered customers as control group. The results are given in column (B) of Table 4. It is evident that we get similar sign and significance but higher magnitude of the coefficient estimates for the actual web portal usage variable providing some evidence that the phone calls increase particularly for those users who start using the portal.

4.2 Instrumental Variable Specifications –

Although all robustness specifications suggest that we have no selection concerns, to be doubly sure, we now use an instrumental variable technique to rule it out. We need an instrumental variable (IV) that provides the source of exogenous variation in endogenous variable (*reg*). Such IV should be uncorrelated to the structural error (ε) but correlated to endogenous web portal registration variable (*reg*). Intuitively we expect that younger users are more likely to register for web portal. Age should be uncorrelated with the outcome variables to be valid instrumental variables. Since our outcome variable is not "number of calls" but the "difference in number of calls", we feel more comfortable that any possible relation between age and telephone calls is likely to be differenced out in our outcome variables. We provide more details on our instrument and results in the appendix. In short, we find that even with instrumental variable, our results remain robust and that web portal registration causes more phone calls.

4.3 Web portal and Aggravation effect

So far we used aggregated data (pre and post period) and shown that registering (and using) web portals lead to more phone calls. However, during this time period, consumers experience different health events and some are more severe than others. Data aggregation precludes us from exploring these in more detail. We now disaggregate our data in more granular time dimension. In particular, we show that we can identify the aggravation effect of web portal use , which we established in the model section of the paper. Note from Figure 1 that once customers register on the portal, they are likely to use the portal for medium severity events where they would do nothing if telephony was the only available channel. In short, in absence of the portal, they are not likely to call for medium severity event. Therefore, if the web causes

aggravation effect, our model predicts that we should see an increase in the calls related to medium severity health events.

Table 5- Summary statistics for different severity health events

Variable	Period 05		Period 07	
	Observations	Mean	Observations	Mean
Non-web registered customers				
Low liability health event				
Telephony use	14605	0.052	17582	0.044
Web usage	14605	0	17582	0
Medium liability health event				
Telephony use	8415	0.069	9348	0.052
Web usage	8415	0	9348	0
High liability health event				
Telephony use	9544	0.076	11361	0.069
Web usage	9544	0	11361	0
Web registered customers				
Low liability health event				
Telephony use	13914	0.048	14214	0.047
Web usage	13914	0	14214	0.043
Medium liability health event				
Telephony use	8934	0.066	9835	0.063
Web usage	8934	0	9835	0.061
High liability health event				
Telephony use	9222	0.103	12026	0.092
Web usage	9222	0	12026	0.076

To test this, we used the same treatment group of 2715 customers who registered on web portal in the year 2006. We included in the control group, a random sample of 3000 customers from the total 48631 non-web portal registered customers. We divided the entire period 05 and period 07 for each of these selected customers in 15 days intervals to signify their individual health events (We found similar results by making 30 days health events). For each of these windows, we compute the severity and customer liability of these health events in terms of number of claims, total negotiated provider charges and total dollar amount due from customers respectively. To keep the analysis more intuitive, we classify these 15 days windows into three separate health severity categories: (i) *low severity* if the aggregated liability for

a window is less than $50, (ii) *medium severity* for liability between $50-150 and, (iii) *high severity* for liability more than $150 (These health event categories were created with highly skewed distribution of health severity variables. However, we get similar results with different numerical categorization of health events). The summary statistics of health severity variables, number of telephone calls and number of web visits for these 15 days windows is given in Table 5.

Table 5 indicates that the probability of telephone usage is highest in high liability health events, lower in medium severity health event and least in the low severity health events. We also find that after the web registration, we see similar trend for the web usage i.e. customers use least web in low severity health event, higher in medium severity and highest in high severity health events. Thus the field data is in broad agreement with our proposed theoretical model of web and telephone usage in Figure 1 & 2.

We now formally explore how the web portal usage and telephony usage varies with health severity. As per our theoretical model, we would expect that the web registered customers would use more web portal in medium and high severity health events compared to the low severity health events. We estimate the following fixed effect Logit specification (C).

$P(wb)_{it} = \beta_i + \beta_1 . M_{it} + \beta_2 . H_{it} + \varepsilon_{it}$ --------- (Specification C)

Where i specify customer and t specify the window.

wb_{it} = 1 if customer i uses web in window t and 0 otherwise,

M_{it} = 1 if health event is medium severity during window t and 0 otherwise,

H_{it} = 1 if health event is high severity during window t and 0 otherwise

β_i = Group fixed effect for customer i.

We similarly estimate specification (D) for telephony usage of web registered customers the in pre-web registration period

$P(tel)_{it} = \beta_i + \beta_1 . M_{it} + \beta_2 . H_{it} + \varepsilon_{it}$ --------- (Specification D)

Where, tel_{it} = 1 if customer i uses web in window t and 0 otherwise,

We expect that users will not use telephony in low and medium severity health event, as the cost of telephony is high.

The results of specification (C) and (D) are given in Table 6. We have cluster corrected the standard errors to account for both correlation and heteroskedasticity of error terms due to multiple health events for the same customer.[7] Notice that the low liability event is the baseline here. For web usage, the coefficient estimate for both medium severity health event and high severity health event are positive and significant. This indicates that the probability of web usage is higher for medium and high severity health events compared to the low severity health events. For telephony usage, the coefficient estimate for medium severity health event is insignificant but we find a positive and significant estimate for high severity health event. This suggests that in the pre-web registration period users are not very likely to use telephony for medium severity events. In short, users use telephony for high severity events but are willing to use the web portal for medium severity event as well. This indicates the potential low access cost of the web portal.

Table 6 - Estimates for Specification (C) and (D)

Fixed effect logit model	(A) Web usage	(B) Telephony usage
Medium liability health event (β_1)	0.214^{***} (0.1)	0.038 (0.07)
High liability health event (β_2)	0.626^{***} (0.1)	0.358^{***} (0.08)
Observations	36075	32070

Note - ***, **, * = statistically significant at the 1%, 5% and 10% levels (two-sided test) respectively (Cluster corrected standard errors are in parenthesis).

If the web portal usage actually aggravates customer concerns leading her to use telephony, we should see a higher increase in the calls in medium severity health event for the web portal registered customers. Since users do nothing in case of low severity health event, the web is unlikely to lead to aggravation. Similarly, since users are anyway likely to use telephony for high severity events, web is not likely to

[7] We also used lagged dummy variables for similar severity health event in immediate preceding window to capture lower probability of calls in similar health events in later periods for repeated health events for a customer like dialysis, chemotherapy etc. and find qualitatively similar results.

cause significant aggravation there as well. However, web portal get utilized quite a bit during medium severity events while usually few telephone calls occur in this window before web portal use. Thus if web causes aggravation, then we should see higher increase in the calls in the medium severity health events for the web registered customers.

We test this intuition by a difference-in-difference design for fixed effect Logit specification (E).

$P(tel)_{it} = \beta_i + \beta_1 . post_{it} + \beta_2 . reg_{it} + \beta_3 . reg.post_{it} + \varepsilon_{it}$ ---------- (E)

Where, tel_{it} = 1 if customer *i* uses telephone in window *t* and 0 otherwise.

$post_t$ = 1 for period 07 and 0 otherwise

reg_i = 1 if customer *i* is web portal registered and 0 otherwise

The *reg.post* dummy in the specification (E) indicates the net increase in probability of calls due to the treatment of web registration. We run the specification (E) separately for high, medium and low severity health events for customers. The estimation results with cluster correction at the customer level are summarized in the Table 7

Table-7: Differential impact of web treatment on low, medium and high severity health event

Dependent Variable – Probability of phone call	Coefficient estimates (Cluster corrected standard errors in parentheses)		
	Low severity health event	Medium severity health event	High severity health event
post dummy	-0.144** (0.068)	-0.38*** (0.088)	-0.237*** (0.074)
***reg.post* dummy**	**0.142 (0.100)**	**0.32*** (0.12)**	**0.127 (0.102)**
N	43668	36532	42153

Note - ***, **, * = statistically significant at the 1%, 5% and 10% levels (two-sided test) respectively

Note that the *reg.post* dummy is only significant (economically and statistically) in medium severity health events. This clearly indicates that the treatment effect of web leads to higher calls in only medium severity health events. Thus consistent with our model of aggravation effect, we find that availability of the web portal leads users to visit the portals for medium severity events. However, it seems visits to portals leads to consumers seeking more information by calling the call centers (absent web portal they

would not have made as many phone calls for these events, see Table 6 as well). These provide evidence in support of our theoretical model for call generation process.

4.4 Types of Calls affected by Portals and implications for Portal Design.

As noted earlier, the web portal in general provides vast amount of passive information with no interactive tools. This sometimes leads to customer uncertainty leading them to use telephone calls. We now analyze the effect of web portal design on telephone calls by examining the two extreme categories of calls with web portal usage.

For the first category of calls, the web portal provides simple tools to customers to easily retrieve the relevant information unambiguously. The firm's web portal provides three such functionalities, (1) customer can click the provided button on portal that automatically sends an ID card request to the firm and customer can also track the status of this request (2) customer can fill in her zip code and the type (specialty) of health care required and the web portal gives details of all participating health care providers in the vicinity with their quality scores (3) customer can easily download all insurance forms (organized in an alphabetical order) from the web portal. As these functionalities on web portal provide unambiguous information with minimal effort and information search on customer's part, we expect that customers would get desired answers in these cases from web portal. So the web portal should substitute the calls in these cases.

For the second category of calls, the related information is provided in comprehensive fashion with little interactive tools. We identify two such areas on web portal: (i) The product related information is given in a 70-80 page product benefit booklet on web portal with no interactive search tools / features – the firm classifies and records the calls related to coverage of plan & drugs as product coverage related calls, (ii) The claims related information on web portal includes customers medical and pharmacy claims, previous health spending, and a comprehensive booklet on health care procedure prices and health care costs – the firm similarly records these calls as claims related calls. In both of these categories, a customer has to sift through voluminous document to search the relevant information. Based on listening to hundreds of live

calls, examples of some such calls are "*My doctor has prescribed ----- but I see four different types of coverage on my benefits pages on web/ I cannot locate or understand my coverage on my benefit page on web --- Please tell me whether it is covered under my plan?"; "I thought my plan allowed for --- specialist visits but I see three different conditions for it on my benefits page – please clarify?"; "I need ---- procedure for my treatment -------- I am confused about the cost of this procedure as appearing in health care / procedure cost page on portal?";" What are my generic drug coinsurance rate / co-pay?"*. We would expect that such calls should increase with web portal usage.

We test this intuition on our data. The mean values for these categories of calls for the 2006 web registered and non-web registered customers are given in Table 8.

Table 8 – Summary statistics for specific categories of calls

Telephone calls	Observations	Period 05		Period 07	
		Mean	Std. Dev.	Mean	Std. Dev.
2006 regd. Customers					
Product benefits and claims related calls	2715	0.373	0.989	0.811	1.627
(Provider participation, ID card and form related calls)	2715	0.055	0.26	0.029	0.19
Non-web registered customers					
Product benefits and claims related calls	48631	0.239	0.842	0.427	1.297
Provider participation, ID card and form related calls	48631	0.041	0.232	0.03	0.198

We see a reduction in the mean value for the first category of calls from period 05 to period 07 for both the web registered and non-web registered groups , but this reduction is much higher for web registered group. We also see an increase in the second category of calls from period 05 to period 07 for both groups, but the increase is much higher in web registered customers. These trends in mean value support our intuition but we now test it more rigorously via the regression specification (A).

We estimate specification (A) with 2006 web registered customers as treatment group and non-web registered customers as control group. The only difference being that we use the two categories of calls as discussed above as dependent variable. The results are given in Table 9.

Table 9 –Impact of Web Portal use on type of calls

Dependent variable: Telephone calls	Calls for unambiguous information	Calls for ambiguous information
post dummy	-0.011*** (0.0001)	0.17*** (0.006)
***reg.post* dummy**	**-0.016** (0.01)**	**0.246*** (0.03)**
Customer liability (in 1000 $)	0.0001 (0.0001)	-0.007 (0.01)
Negotiated charges (in 10000$)	-0.002 (0.001)	0.008 (0.01)
Number of claims	0.0003*** (0.00)	0.007*** (0.001)
Constant	0.036*** (0.001)	0.104*** (0.07)
N	51346	51346
R-sq (adj R-sq)	0.50 (0.19)	0.63 (0.25)

Note - ***, **, * = statistically significant at the 1%, 5% and 10% levels (two-sided test) respectively (Standard errors in parenthesis).

We find a negative and significant coefficient estimate for the *reg.post* dummy for the first category of calls and a positive and significant coefficient for the second category of calls. The coefficient estimate value -0.016 for the first category of calls signifies 29% decrease in such calls due to web registration for the web registered group. Likewise an estimated value of +0.246 for the second category calls signifies 66% increase in such calls due to the web registration. These results clearly indicate that the web portal is useful in reducing calls where it provides tools to customers to readily retrieve relevant information unambiguously. But at the same time, it could lead to substantial increase in calls if the information is provided in comprehensive fashion with no adequate interactive tools.

We examined the effect of web usage on telephone calls in customers of different age segments. For this, we divided the entire population of customers in four age segments <40 years, 40-50 yrs, 50-70 years and >70 years. We ran specification A for the same treatment group and control group for these segments of customers separately. The results are given in Table 10. We find that younger customers (age <40 years) and very old customers (age>70 years) increase their calls the most. In comparison the customers in age group 40-50 years show the minimum increase in their telephone calls. The increase in calls with web

usage for older customers was expected but it is surprising to see higher increase in calls for younger customers as well. One possible explanation for it is that even though younger customers are web savvy (higher probability of getting relevant information) but they also tend to go to web portal more often (low web access cost) for low severity health event or for no specific reason. In some of such web browsing they are more likely to get ambiguous information leading them to call.

Table 10 – Estimates for customers of different age

Dependent variable: Telephone calls	For age <40 years	For age 40-50 years	For age 50-70 years	For age >70 years
post dummy	-0.012 (0.02)	-0.038* (0.02)	-0.002 (0.02)	-0.02 (0.02)
***reg.post* dummy**	**0.179*** (0.05)**	**0.149** (0.05)**	**0.173*** (0.05)**	**0.204*** (0.05)**
Customer liability (in 1000 $)	0.032*** (0.01)	0.015*** (0.001)	0.0005 (0.002)	0.008*** (0.002)
Negotiated charges (in 10000 $)	0.003 (0.02)	0.013 (0.02)	0.015 (0.01)	-0.017 (0.02)
Number of claims	0.024*** (0.001)	0.022*** (0.001)	0.021*** (0.001)	0.015*** (0.001)
Constant	0.67***(0.02)	0.50*** (0.02)	0.61*** (0.03)	0.78*** (0.02)
N	10715	11286	21519	15121
R-sq (adj. R-sq)	0.67 (0.36)	0.68 (0.38)	0.69 (0.38)	0.76 (0.42)

Note - ***, **, * = statistically significant at the 1%, 5% and 10% levels (two-sided test) respectively (Standard errors are in parenthesis).

4.5 Additional Robustness Checks

We have shown the increase in aggregated telephone calls from a 10 month period 05 to another 10 month period 07. If web portal usage actually causes the telephone calls, such calls should happen within a reasonable period immediately after the web portal usage. We now show evidence of this. We ran three separate specification (A) with the dependent variables as (1) total calls minus total calls made within 5 days of web portal visit, (2) calls of category one (where related information is clear on web) minus calls of this category made within 5 days of web portal visit, and (3) calls of category two (where related information is ambiguous on web) minus calls of this category made within 5 days of web portal visit. We expect that if the web causes aggravation then typically the calls are made immediately after the web portal visit. Therefore, once calls made immediately after web visits are removed, we expect that result of

call increase would go away for the total calls and category two calls. Since, web helps in resolving category one calls, we should not see many such calls made immediately after the web visits and thus the result of decrease in calls due to web usage for category one calls should remain unchanged. The estimated coefficients for *reg.post* dummy in specification (A) are given in Table 11. For brevity we suppress the estimate of all other control variables (health severity variables). We also provide the corresponding coefficient estimates when the calls made within 5 days of web visit are not removed in Table 11 for quick comparison.

Table 11 –Estimates with calls made immediately after web visit removed

Coefficient estimate for *reg.post* dummy	Total calls	Calls for ambiguous information	Calls for unambiguous information
With all calls	0.180*** (0.05)	0.246*** (0.03)	-0.016** (0.01)
With calls within 5 days from web portal visit removed	0.02 (0.05)	0.083 (0.63)	-0.019*** (0.006)

Note - ***, **, * = statistically significant at the 1%, 5% and 10% levels (two-sided test) respectively (Standard errors in parenthesis).

Note that the coefficient estimates for *reg.post* dummy are exactly as per our intuition (discussed above) and thus supports our claim of causal increase of telephone calls with web usage where web provides ambiguous information and decrease in calls where web provides clear information.

From Figure 3 on page 12, we observe that the customer calls increase sharply with web registration but then decline and stabilize at a higher level. We excluded the year of registration from our analysis to avoid picking up any transient aggravation and/or learning effect of web on calls during this period. It may be possible that customers learn to use web portal with time and thus their increase in calls with web usage may decrease with time. We conduct additional analysis to reassure our reader that learning on web with time does not alter our result qualitatively. We divide the 2006 registered customers into two cohorts, old registered customers (registered on web portal between March– July06) and new registered customers (registered on web portal between August–Dec06). We find 1317 old registered customers

(48.5%) and 1398 new registered customers (51.5%) in our sample of 2006 registered customers. Now we run revised specification (A) with these old and new registered customers as two treatment groups and the non-web registered customers as control group.

$$tel_{it} = \beta_i + \beta_1 X_{it} + \beta_2\, regnew_i + \beta_3\, regold_i + \beta_4\, post_t + \beta_5\, regnew.post_{it} + \beta_6\, regold.post_{it} + \varepsilon_{it}$$

Where, $regnew_i$ = 1 if the customer i is registered on web portal btw August–Dec06 and 0 otherwise

$regold_i$ = 1 if the customer i is registered on web portal btw March– July06 and 0 otherwise

Other terms have similar meaning as in specification (A). The coefficient estimate for β_5 and β_6 indicates the treatment effect of web usage for the new and old web portal registered customers respectively. We show the estimated coefficient in Table-12.

Table 12 –Estimates investigating learning in 2006 registered customers

Dependent variable: Telephone calls	Coefficient estimates (Standard errors in parentheses)
post dummy	-0.02* (0.01)
***regnew.post* dummy**	**0.20*** (0.06)**
***regold.post* dummy**	**0.15** (0.07)**
Customer liability (in 1000 $)	0.006*** (0.001)
Negotiated charges (in 10000 $)	0.025** (0.008)
Number of claims	0.017*** (0.000)
Constant	0.7*** (0.01)
N	51346
R-sq (adj. R-sq)	0.69 (0.39)

Note - ***, **, * = statistically significant at the 1%, 5% and 10% levels (two-sided test) respectively

We find a positive significant and similar treatment coefficient estimate for the old registered customers and the new registered customers. The estimate for the old customer cohort is a bit smaller but statistically indistinguishable from the estimate for the new customers. So, overall our results show similar magnitude of call increase for the old web registered customers and new web registered customers.

However, in the year of registration, we see a large increase in call volume and then some decline. It may be due learning to use the web. We intend to aspect in finer details in our future work.

5. Conclusions, Managerial Implications and Limitations

We conduct a field study at a large US health insurance firm and examine how the availability of web portal affects the demand for telephony based assisted call center services. We first provide a model for customers call generation process that indicates the possibility of both the substitution effect and the aggravation effect of web portal usage on the telephone calls. We estimate the net effect of web portal usage on the telephone calls in our field study setup through a diff-in-diff regression design. We find that web based self-service usage leads to 14% increase in telephone calls to the call center. A deeper inspection shows that calls go down when the information sought by the users on the web is unambiguous. However the aggravation effect is very large, as expected, when the information is ambiguous and likely to cause more questions leading to more telephone calls. We run several falsification and specification tests to ensure that our results are robust to any potential selection of customers in web portal treatment in our sample. This result is quite contrary to the prevalent rationale of cost savings for investments in SSTs. Our result has large managerial implications for the new generation contact center operations where number of different channels of customer services like telephony, internet chat, web portal based self-service, interactive voice response unit, email and SMS are offered simultaneously.

Our results give several broad prescriptions to practicing managers. First, in a multi-channel service set up, a channel or a group of channels cannot be managed in isolation. Understanding how customers choose among the available channels and how usage of one channel impacts the usage of other available service channels is essential for designing, deploying and effectively managing multi-channel service setup. Second, self-service channel should not be seen only as a means of reducing operational cost. Firms often differentiate by offering multiple channels (wider options) to its customers to choose the one which they find most convenient. Prior research indicates that this may lead to higher customer

satisfaction, retention and loyalty (Wallace et.al. 2004, Danaher et.al. 2003). In our field setting, we note that the customers who call more after web portal usage also go more often to the web portal. This suggests that the customers see value in web portal usage. Third, self-service channel, often times, does not resolve customer query completely and thus should be provided with options to escalate the query to the other possible assisted channels like email, web chat, telephony etc (Bonde 2006). Management practitioners caution that without such escalation options, the customer may feel frustrated and could churn. Moreover, the escalation option also addresses the lack of human contact issue in self-services, which is found to be detrimental for customer loyalty (Areily et.al. 2002). Finally, low-value high-volume standard transactions which require least customer effort and knowledge are the ones most suitable for self-services (Roth 2001, Roth et.al. 2002). Customers use self-service options for standardized services and thus impose lesser demand to the other available alternative channels. However, for web based self-services options where customers have to first search for relevant information from a comprehensive but passive information source and then process it to find desired answers, the complete resolution of customer query through self-service channel alone and thus cost savings does not seem so straightforward. The potential aggravation effect of such web usage can be mitigated by possibly incorporating interactive query resolution tools in web portal design.

Present work has several limitations which also offer opportunity for extensions in future. One limitation is that we don't have data on call durations and thus we cannot rule out the possibility that calls made after the web self-service may be shorter and thus less costly. We interviewed several managers and CSRs and they did not feel that calls followed by web usage are shorter. Moreover, total call handling time for CSR is comprised of actual talking time with customer and the time taken in wrap up activity. Normally, the wrap up activity takes around 20-30% of the total time. So even if the talking time is reduced in calls after web self service, the wrap up activity still takes the same time and thus the net effect on total call handling time may not be much. Moreover, we have only estimated the mean impact of web portal registration on telephone calls for the population of customers. It will be of great value for the firms to

segregate customers who use web self service efficiently from those who don't. A random coefficient model / Hierarchical Bayesian model on panel data with multiple realizations for individual customers would allow estimation of individual level parameter and thus distribution of the parameter estimates. This could be an interesting future extension of the present work. We also find some evidence of customer learning to use web with time. An extended dataset with more time period will allow us to explore and estimate the impact of such learning on customer calls.

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Appendix - A

Instrumental Variable Approach

We use Age and its polynomials as instrument for web registration. We expect younger users are more likely to use web. We also expect that while age may be correlated with calls, it is unlikely to be correlated with difference in calls which is our dependent variable.

We find a strong non-linear relationship between the variable web portal registration and age – age, square of age and cube of age (herein after referred to as age variables) bears strong correlation with variable reg. The F statistics for exclusion of age variables in the regression is 416. Thus the age variables satisfy the basic requirement of relevance of instrumental variable (Bound et.al.1995)[8].

We test this by regressing the change in telephone calls (outcome variables) on age variables and other control variables for a subsample of customers', who don't get the treatment of web registration. If age variables are valid IV, we should see insignificant coefficient estimate for age variables in this regression. We find insignificant coefficients for all age related variables for such subsample of customers in our data. This indicates that age variable satisfy the exogeneity requirement of instrumental variable in our setup (Angrist et.al. 1991)[9].

We propose IV regression specification (B) with age variables as IV for endogenous variable *reg*

$$\Delta tel_i = \beta_0 + \beta_1 \Delta X_i + \beta_2 \, reg_i + \varepsilon_i$$

$$reg_i = \alpha_0 + \alpha_1 \Delta X_i + \alpha_2 \, age_i + \zeta_i \qquad \text{---------- (Specification B)}$$

Where $E(\varepsilon / \Delta X, reg) = 0$ & $E(\zeta / \Delta X, age) = 0$. Note that age in the above specification signifies all age variables i.e. age, square of age and cube of age.

[8] Bound et.al. 1995 indicated that the partial R sq and the F statistic for exclusion of the identifying instruments in first stage regression are useful indicators of the quality of the IV

[9] Angrist et.al. 1991 similarly showed that their instrumental variable quarter of birth did not have any significant relationship with earnings (dependant variable) for the subsample of college graduates who were not affected by compulsory schooling laws (treatment).

The results of specification B with age variables are given in Table 6. We see that web portal registration (*reg*) bears a strong partial correlation with age variables and the dummy variables for age bands. The 2SLS regression with instrumental variables show a positive and significant estimate for coefficient of variable *reg* indicating that web portal registration leads to increase in telephone calls. Note that these estimates are higher than the one we obtained with the simple OLS in specification (A).

Table 12 – Estimates for IV specification (B)

	2SLS coefficient estimates	First stage coefficient estimates
Change in customer liability	0.006**	-0.000
	(0.003)	(0.000)
Change in provider charges	0.02	0.001
	(0.01)	(0.001)
Change in number of claims	0.018***	0.0000
	(0.001)	(0.0000)
Web portal registration dummy	**0.670****	
	(0.309)	
Age		0.013***
		(0.00)
Square of age		-0.0002***
		(0.00)
Cube of age		0.0000043***
		(0.000)
Constant	-0.046**	-0.098***
	(0.02)	(0.01)
N	51346	51346
adj. R-sq	0.043	0.020

Note - ***, **, * = statistically significant at the 1%, 5% and 10% levels (two-sided test) respectively (Standard errors in parenthesis)