Modeling the Respondents' Profile in a Web Survey on Firms in Italy

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Abstract

The main factors influencing the cooperation in surveys over Internet, as suggested from empirical studies (Batagelj et al., 1998; Dillman et al., 1998), could be grouped into:
- factors influencing the contact with the respondent (e.g., awareness of the survey, e-mail solicitation plan);
- individual factors (e.g., socioeconomic characteristics, knowledge of the subject, experience with Web surveys) that shape the decision to participate as the result of the interaction of the individual characteristics of the respondent with the invitation of the survey designer.

When the survey is directed toward a specific target population with access to Web, often identified by an administrative file, there are many auxiliary variables available to understand the respondent behavior. In the case of the population of firms the list of the Chamber of Commerce is completed by the individual characteristics of the firm, such as the legal form, the number of employees, and the class of economic activity.

The e-mail list does not represent the whole population of firms, it represents a segment with access to Internet that choose to publish the e-mail address. Due to the development of the e-commerce, this segment in some sectors of economic activity covers a large part of the population and many firms in several sectors of economic activity are now joining the net to gain visibility. The diffusion of Internet has been growing in the small medium size enterprises, too. Although no complete coverage of the list is supposed, we work under the hypothesis that the list is our target population.

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1   Introduction

A complex set of questions should be answered before promoting the use of Internet in the surveys on firms. The most frequent questions arise about the factors that influence co-operation of the firms at the different stages of the survey process. During the survey period, decisions have to be made both to contact the eligible firms and to solicit the compilation of the electronic questionnaire. The interaction of the characteristics of the firm with the decisions of the survey designer influences the response rate and the success of the survey.

The outline of the respondent profile is then crucial in order to set up specific Internet survey methodologies and inference rules. In the paper the profile is described and modeled focusing on the self-selection process leading to the self-interview and on the individual behavior during the survey period.

Empirical studies (Batagelj et al., 1998; Dillman et al., 1998) suggest that the main factors affecting the co-operation in surveys via Internet can be grouped into:

- factors related to the contact with the respondent and often under the control of the survey designer (e.g., e-mail solicitation plan, survey awareness);
- individual factors that shape the decision to participate as the result of the interaction of the individual characteristics of the respondent with the invitation of the survey designer (e.g., social and economic characteristics, knowledge of the subject, experience with Web surveys). These factors are out of the control of the survey designer.

In order to model the firm's co-operation process in Web survey, we propose an approach that is based both on the factors that influence the contact and on the individual characteristics of the firm (Section 2). The attention is limited to list based Internet surveys. In other words, we restrict the analysis to a group of firms whose e-mail address is known from administrative sources. This implies that, in the economy of this work, the e-mail list of firms is the target population. In our project, the Web survey on "Technological communication and links among enterprises" has been carried out in five provinces of the Lombardy region in Italy (Section 3). The results are illustrated and discussed with reference to the contact and response process both at general and at individual level (Sections 4 and 5).

2   Modeling the respondents' profile

The respondents' profile is studied under two different and complementary perspectives:

a) The self-selection process that produces the set of respondent firms from the set of contacted firms.
b) The individual behavior of the respondent during the period from the e-mail of invitation to the self-interview.

There are individual factors, which encourage response and other factors that make it problematic. For instance, it could be assumed that it is easier to contact via e-mail the leader of a small firm rather than the director of a big company. Moreover, some limited technological knowledge could affect the ability to co-operate with the survey organization. Technological skills could be correlated with the intensity of the use of Internet during the current activity of the firm (e-commerce, distributive network features).

The behavior of the respondent after the e-mail of invitation opens new perspectives in the definition of the survey period. The whole survey period is the period between the first e-mail message and the last self-interview. The individual length of the survey period depends on many factors and its length is also the results of the firms' reactivity to the solicitation plan.

In Web surveys we can distinguish three types of auxiliary information useful to explore the respondents' profile:

- Information available before the survey: we refer to the auxiliary variables often available in the file from which the e-mail list is obtained, e.g., denomination, size, legal form, economic activity of the firm (*a priori* variables);
- Information available during the survey: they are production process variables automatically collected by the CAWI (Computer Assisted Web Interviewing) system, e.g., number of return receipts, number and time/data of the accesses to the server where the form is resident, data and time of each e-mail message (invitation and soliciting messages) (*Web process* variables);
- Information available after the survey: we refer to other characteristics of the firm collected with the self-interview, e.g., familiarity with the Web, use of e-commerce of the firm (*a posteriori* variables).

These sets of variables are candidates to correlate with the individual contact and response; particularly, the Web process variables are candidate to explain the response process and/or the respondent's behavior during the survey period.

As regards the self-selection process, the question is about the characteristics of the respondents that correlate with the probability of self-interview p_i. If the set of contacted firms is composed by c firms and R_i is the indicator of the event of interest (i.e. $R_i = 1$ when the firm close the self-interview, 0 otherwise), the probability p_i can be estimated assuming that $\text{logit}(p_i) = x_i'\alpha$, where the vector x_i contains the covariates of the probability of response of the firm i.

The e-mail list covers many types of firms, differing by economic activity, number of employees, legal form. There are *a priori* variables that identify the structure of the firm and that can be used to outline the respondent profile. Given the response, the respondents can be identified also by the set of variables that we have called *a posteriori* variables. These are the variables whose values are collected during the self-interview. In our survey, a set of items in the questionnaire regarded the familiarity of the firm with Internet. The items were introduced to have an insight of the behavior of the respondent as Internet user. The attention was on the use of Internet during the current activity of the firm.

Given the response of the firm, the attention is on how long is the period T_i between the e-mail of invitation and the self-interview. The firms who participate in the survey can complete the form in a few days from the first e-mail of invitation or can complete the form after some solicitation messages at the end of the survey period.

This behavior can be explored, modeling the probability of closing the self-

$$\text{logit}\big(P(T_i = t_j \mid T_i \geq t_j)\big) = \beta_{t_j} + y_i'\beta$$

interview in time t_j given that it has not yet completed before ($T_i \geq t_j$). The survival model for the time from the first e-mail to the self-interview can model the probability of closing the self-interview in time t_j describing the evolution in time of the probability of response β_{t_j} and expressing it as a function of the individual covariates y_i'.

In this context, it is important to explore the reactivity of the respondents to the messages sent by the survey organization: the communication with the firm is on-line and it is possible to send many soliciting messages (stimuli) to encourage the participation in the survey.

The attention is on the probability of prompt reaction to the stimuli s_i and the Web process variables are useful to define a set of indicators to explore the reactivity to the messages: number of days before the response, connection date and time, duration of each connection. If S_i is the indicator of the event of interest (i.e. $S_i = 1$ when the firm reacts to the e-mail in two working days, 0 otherwise) the probability s_i can be estimated assuming that $\text{logit}(s_i) = z_i'\gamma$, where the vector z_i' contains the covariates of the reactivity of the firm *i*.

3   The CAWI data collection process

The whole interviewing project has been directed toward about 2500 firms of the provinces of Bergamo (used as pilot province), Brescia, Lecco, Varese, and Mantova (each province is in the Lombardy region) in the manufacturing and

building sector. E-mail addresses have been identified from a list of the Chamber of Commerce for the Bergamo province and from a Unioncamere database for the other provinces. The database of the a priori variables has been obtained From the administrative records of the same institutions [2].

The survey is on "Technological communication and links between enterprises", the questionnaire has been kept simple and based mainly on qualitative answers and some percentage data. The interviewed firms have been asked about the use of e-commerce, the collaboration with other enterprises and/or the belonging to groups, the markets, and the employment. The questionnaire consists of 8 pages (6 pages of 40 substantial items, 1 welcome page and 1 final page).

The data collection has been carried out according to the following steps:

- The first invitation to participate in the survey is an e-mail sent (survey presentation letter) to each firm of the e-mail list at the beginning of the survey period. In order to encourage the participation incentives have been offered (survey report and other connected advantages). The discussion on the opportunity of promotion and incentives to co-operation in the first e-mail in order to reduce the nonresponse rate has been the topic of many contributions. Batagelj et al. (1998) has studied the effects of incentives on responses.

- The access procedure to the questionnaire compilation is simple. Each firm receives its own address for compilation; no identification code (id) and no password are required. Day, hour and duration of each access to the questionnaire are recorded.

- During the survey period three soliciting e-mail messages have been sent. Soliciting e-mail messages have been sent weekly. The first soliciting message was sent 14 days after the survey follow up.

- A fourth soliciting e-mail was sent (excluding the pilot province) after the end of the survey period (3 months after the first e-mail message). This last soliciting message encouraged the firm to fill the questionnaire or to a react in order to interrupt to surveying process. The primary objective of the last soliciting e-mail was the investigation of the characteristics of the firms, which had no reaction to the first e-mail (i.e. no questionnaire compilation, no explicit refusal, and no effectively detected wrong e-mail address).

A pilot survey was carried out on 400 manufacturing firms of the Bergamo province. This pilot survey, whose results are described in Biffignandi, Pratesi (2000) achieved a high response rate given the contact (45%) and confirmed that:

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[2] We thank the Ufficio Studi of the Bergamo Chamber of Commerce and the Ufficio Studi of Unioncamere for the assistance in the definition of the a priori variables. The Web process variables were recorded by the EZSurvey CAWI system by Raosoft inc.

a) the questionnaire was enough simple and straightforward so that we can assume that the questionnaire effect is removed from the factors affecting the compilation and collaboration process;

b) the technical difficulty in understanding the procedure for compiling the questionnaire was fully acceptable and intelligible under a basic Web knowledge. This obviously did not avoid that during the survey process the interviewed firms faced some technical difficulties in filling the questionnaire. Actually, these difficulties were mainly due to the variability in technical knowledge of the Web user and to the amount of attention paid to the technical instructions.

4 Contact, response and reactivity in the CAWI survey

The Web survey, undertaken in the Brescia, Lecco, Mantova and Varese provinces, has been initially based on an e-mail list with 2047 firms. The number of firms has been reduced soon to 1790 due to the verified no contact possibility connected to the quality of the list (12% of explicitly wrong e-mail addresses).

By carrying out the complete survey procedure on the 1790 firms, we have been able to get confirmation of the success in getting the contact in 559 cases (see Table 1). Concerning the remaining 884 no sure evidence of contact has been provided during the survey period[3]. Some evidence of contact can be detected by analyzing the log file of the accesses to the questionnaire from firms, which have not participated at the self-interview. A provisional estimated of the number of firms, which were visiting the questionnaire is shown in Table 1. No visiting the questionnaire has been assumed as no reaction, i.e. a rough indicator of any contact.

Table 1: Outcome of the Web survey.

CONTACT		NO CONTACT	
Completed self-interview (CI)	442	Wrong e-mail (WE)	247
Explicit refusals (ER)	117	No reaction (Nor)	323*
Visits to the forms (OE)	561*		
Total	1120*	total	670*

*Provisional estimate

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[3] For instance, some firms could not have been reached since the e-mail is not a currently used one or some firms could have ceased their activity. The fourth solicitation e-mail, as stated in par. 3, has been devoted to collect more information in this group of firms from which we got no reaction at all.

In our Web survey we obtained 442 completed interviews (CI) and 117 explicit refusals (ER). By calculating the contact and response rates according the criteria proposed in Biffignandi, Pratesi (2000) the results are[4]: gross contact rate = 54,7%; net contact rate: 56,8%; response rate given the contact 39,5%, overall response rate=21,9%.

4.1   The response rates by groups of firms

The overall response rate is 21,9% (442/2047). The result is concordant with results of analogous surveys and can be discussed in relation to the characteristics of the respondents.

The e-mail list identified a population of medium sized firms operating mostly in manufacturing sector. The response rates classified by size of the firm, legal form and economic activity are shown in Tables 2-4.

The response rates grouped by size of the firms suggest that small firms (less than 20 employees) have a different propensity to response than medium (from 20 to 249 employees) and medium-large firms (250 and more than 250) (see Table 2). The response rates in the classes are homogeneous with the overall response rate when grouping the data by legal form (see Table 3)

Economic activity has been classified in three categories: class 1 contains the mechanics, the metal products and the traditional sectors (wood, paper, rubber and plastic products), class 2 contains firms that produce equipment and other manufacturing firms, then class 3 refers to firms active in the building sector. Classes 1 and 2 cover the whole manufacturing sector. Response rate is higher in class 2: the rate is 26,1% versus the overall rate equal to 21,9%.

Table 2: Overall response rate by number of employees.

Response	Number of employees						Total	
	<20		20-249		>249			
No	593	75,7	881	79,7	51	81,0	1524	78,1
Yes	190	24,3	224	20,3	12	19,1	427	21,9
Total	783	100,0	1105	100,0	63	100,0	1951	100,0

Table 3: Overall response rate by legal form.

Response	Self-employers		Society		Others		Total	
No	178	79,8	1249	77,9	97	78,2	1524	78,1
Yes	45	20,2	355	22,1	27	21,8	427	21,9
Total	223	100,0	1604	100,0	124	100,0	1951	100,0

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[4] These rates are affected from the provisional data quoted in Table 1; when the results of the fourth soliciting e-mail quoted in par. 3 are available definitive rates will be computed.

Table 4: Overall response rate by economic activity.

Response	Class 1		Class 2		Class 3		Total	
No	1036	78,7	278	73,9	210	81,1	1524	78,1
Yes	280	21,3	98	26,1	49	18,9	427	21,9
Total	1316	100,0	376	100,0	259	100,0	1951	100,0

4.2   The role of the solicitation plan

First of all we look at the timing and reactivity observed in the compilation process.

The 28,5% of the respondents were reached with an easy contact, since they didn't need a solicitation message. The solicitation process anyway has played an important role in the success of the survey (71,5% of the respondents received at least one solicitation), although with a decreasing impact (see Table 2).

One of the major advantages of Web surveys is the speed of the data collection process. If every firm of the e-mail list would react immediately to the invitation message the Web survey could be concluded in few days. In many practical situations the Web survey period is longer than a couple of days, but the effort should be towards the obtaining of a short period for the data collection.

The distribution of the self-interviews by distance from the first e-mail message is shown in Table 2. More than the 50% of the firms responded in two weeks. Very few firms responded after 3 weeks from the first e-mail.

The distribution of self-interviews by week shows that the compilation process achieves the 61% of the collaborations within two weeks from the start of the survey period. A high increase in the collaboration process is registered in the second week (36,2% of the completed interviews).

Table 5: Self-interviews by distance from the first e-mail.

Days from the first message	Self-interviews	%
7	108	24.4
8-14	27	6.1
15-21	133	30.1
21-28	121	27.4
> 28	97	22.0
Total	442	100

The variables on reactivity highlight the importance of the contact message in the Web surveys and the high impact of that in the short time. In fact, the 83,5% of

the self-interviews have been completed within to days from a contact stimulus (Table 3).

Table 6: Self-interviews by number of soliciting messages.

Number of soliciting messages	Frequency	%	Cumulative frequency
0	126	28,5	28,5
Only 1	128	29,0	57,6
Only 2	99	22,4	79,9
3	89	20,1	100,0
Total	442	100,0	

A high percentage of self-interviews are closed in two days from an e-mail message (89%). More than 50% of the self-interviews completed after the invitation letter (zero soliciting messages) is in the first two days after the sending of the email of invitation. The percentage is still high for the soliciting messages (see column (b) in Table 4).

Table 7: Self-interviews by number of soliciting messages and reactivity.

Number of soliciting messages	Period before the self-interview			
	≤ 2 days		> 2 days	
	Respondents	(b) %	Respondents	(c)%
0	86	68	40	34
Only 1	115	89	13	11
Only 2	91	92	8	8
3	77	86	12	14
Total	369	83.4	73	16.6

The reaction within 2 days from the solicitation message is relevant for each solicitation message as shown in the distributions of Table 4. In addition, Figure 1 reports the cumulative percentage of self-interviews during the whole survey period. It is evident the effect of the solicitations and the exponential patterns of the responses starting from each solicitation.

5   The logistic analysis of the respondents' profile

The respondent profile has been studied through a set of auxiliary variable available in the list of email provided by the administrative office. Given the response, the behavior of the respondent during the survey period has been studied processing a set of *Web process* variables collected by the CAWI (Computer Assisted Web Interviewing) system. Also some variables collected in the self-interview have been used in the explanation of the respondent behavior. A section of the Web questionnaire was devoted to the identification of the frequency and

the reasons of using Internet in the current activity of the firm (*a posteriori* variables).
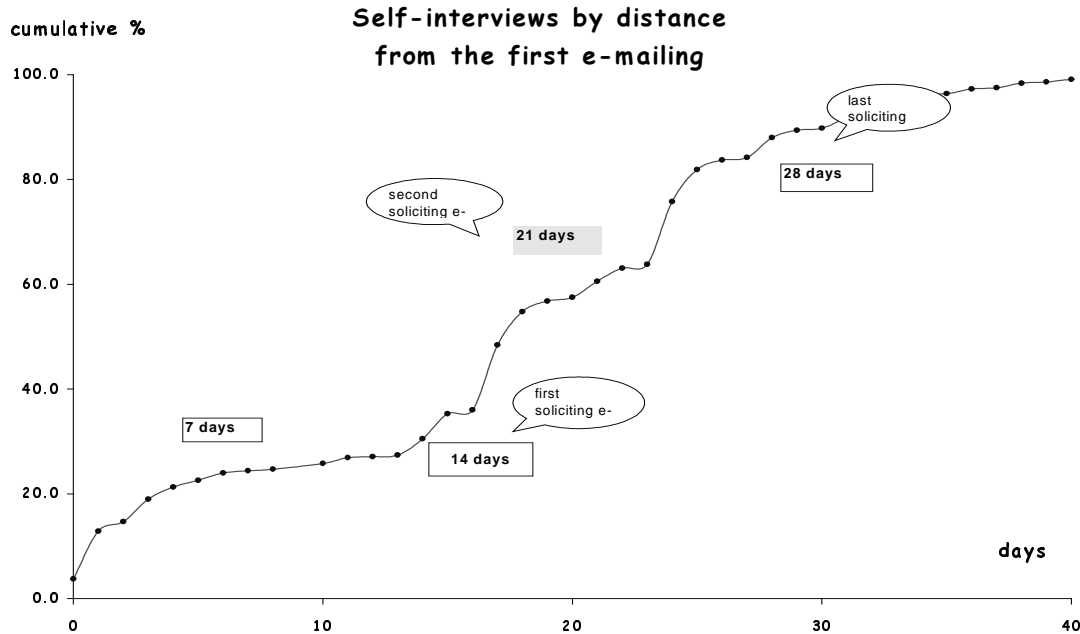

Figure 1: The cumulative percentage of self-interviews during the whole survey period.

Each explanatory variable has been entered in the model. The variables and the interactions have been maintained only if the significance level has been higher than 0.05 (backward elimination procedure). The results are shown also for not significant explanatory variables when they help in the discussion of the results. All the models have been adapted with the logistic procedure of the SAS package. The covariate effect on the likelihood of the model have been tested with the likelihood ratio test; the fitted models have been evaluated doing a comparison of the models with standard tests (likelihood ratio test for nested models and Akaike Information Criterium for not nested models).

5.1   The self-selection process of the respondents

At individual level the propensity to complete the self-interview, indicated by p_i, has been studied considering the *a priori* variables as explanatory variables in a logistic regression model for the response indicator R_i ($R_i = 1$ when the firm close the self-interview, 0 otherwise).

The probability of non response $1 - p_i$ is lower for firms with less than 20 employees (Table 8: odds ratio=0.792) with respect to the medium and medium-

large sized firms together. The result does not change even if we correct by legal form (Legal Form 1: limited liability companies, Legal Form 2: general partnership companies, Legal Form 3: limited company, joint stock companies) and economic activity. The role of these two explanatory variables seems to be different: the legal form of the firm has no significant effect on the probability of response, while the economic activity has an influence on the probability of non response.

Table 8: Logistic regression for the probability of nonresponse.

Variable	Estimate	Std Err	p-value	Odds Ratio
Intercept	1.644	0.1721	0.0001	
Firms < 20	-0.291	0.1294	0.0245	0.748
Class 2	-0.273	0.1338	0.0410	0.761
Legal Form 1	-0.159	0.1702	0.3496	0.853
Legal Form 2	-0.370	0.2160	0.0861	0.690
Legal Form 3	-0.280	0.1741	0.1070	0.755
-2 LOG L null model=2050.361 estimated model=2038.006 LRT=12.354 with 5 DF (p=0.0302)				

The probability of participation is higher for firms of class 2. They are likely to be familiar with Internet because of their production process, they mostly operate in the production of mechanical and electrical equipment, and this seem to decrease their probability of non participating in the survey.

The evidence seems to suggest that the internal organization of the firm more than its formal entity (legal form) has an effect on the response rate. Both the size of the firm in term of number of employees and the class of economic activity can be considered a proxy of the internal organization.

5.2 The individual behavior in the survey period

The results of the survival model for the time between the first e-mail and the self-interview are shown in Table 9. We model the probability of self-interview in the week t_j from the first e-mail conditional on not having completed before. The reference category is the first week. In the second week the conditional probability decreases (the coefficient β_{w2} is lower than zero) then increases in the third week ($\beta_{w3} > 0$) and continues to increase till all the firms complete the self-interview (after six weeks from the first e-mail). The decrease in the second week gives reason of the first soliciting message that, we remind, has been sent after 14 days from the first e-mail of invitation to participate in the survey (see also Figure 1).

The level of the conditional probability is lower in July and in August: in these months many firms allow the employees to have vacancy from work and this could have influenced the probability of response. Again the size of the firm is a significant factor: the level of the probability is higher for the small firms which confirm their higher propensity in participating in the survey.

The time from the first e-mail to the self-interview ranges from one week to six weeks and this is an evidence that the firms has different reactivity to the e-mail messages. The reactivity to the e-mailing is a relevant factor in keeping short the survey period and it is important to understand the causes of the slow reaction of the firms which need a long time to complete the self-interview.

Table 9: Survival model for the time of response.

Variable	Estimate	Std Err	p-value	Odds Ratio
Intercept	-0.461	0.146	0.0015	
Week2	-1.048	0.245	0.0001	0.351
Week3	1.448	0.192	0.0001	4.252
Week4	2.822	0.240	0.0001	16.806
Week5	3.438	0.386	0.0001	31.120
Week6[5]	6.081	1.218	0.0001	437.600
July	-1.876	0.174	0.0001	0.153
August	-5.681	1.067	0.0001	0.003
Firms < 20	0.294	0.147	0.046	1.342
-2 LOG L Null model=1631.368 Estimated model=1176.116				
LRT=455.252 with 8 DF (p=0.00001)				

The logistic analysis of the reactivity to the e-mail in two working days indicated that the probability of reaction s_i is function of the familiarity with Internet, of the order and the number of the e-mail message, of the time of sending of the e-mail (July and August), and of the size of the firm.

The other a posteriori variables, the practice of e-commerce and of sub-contracting, have been removed from the model because they are not significant.

The probability to react in two days is higher for the firms which use Internet every day during the current commercial activity (odds ratio=1.994) and for the firms who have been solicited three times. These are the firms more difficult to be contacted (odds ratio=3.480) but it seems that when they decide to participate they have a prompt reaction.

Reactivity is lower in July when many firms allow the employees to have vacancy from work: this could have delayed the response. We have left August in

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[5] After six weeks all the respondents have completed the self-interview. This is the reason why the odds ratio is very high for this category.

the model just to witness that August is the end of the survey period: we collected few self-interview after the end of July.

Table 10: Logistic regression for the probability of reaction.

Variable	Estimate	Std Error	p-value	Odds Ratio
Intercept	1.510	0.289	0.0001	
Familiarity	0.690	0.287	0.0162	1.994
3 solicitations	1.247	0.498	0.0122	3.480
July	-0.432	0.295	0.1426	0.649
August[6]	-17.529	708.500	0.9803	0.000
Firms < 20	-0.226	0.288	0.4324	0.798
2 LOG L Null model=351.037 Estimated model=320.654 LRT=30.382 with 5 DF (p=0.0001)				

Reactivity is also function of the size of the firm. Small firms do not have a prompt reaction in comparison with the other firms (odds ratio=0.798); beside that, they show a higher probability in participating in the survey (see Table 8).

6   Concluding remarks

The respondent's profile can be outlined composing the main empirical findings on the self-selection process leading to the self-interview and on the individual behavior of the respondents during the survey period.

The internal organization of the firm (size of the firm and economic activity) is crucial in the self-selection of the set of the respondents. Then, their behavior during the survey period is still influenced by the size of the firm. Small firms are more likely to participate in the survey, but they have a longer time of reaction (more than two working days) to the stimuli of the survey organization.

In small firms, where the internal organization is flexible and simple, it is easier to contact by e-mail the leader who can directly decide to participate or not participate in the survey. This fact tends to increase the response rates of small firms. In firms where the internal organization is more complex, often the employee who receives the e-mail message is not on duty to reply to it and the message need to be forwarded to the management. So the division of work can cause a sequence of redirections of the original message that often ends with the missed participation of the firm.

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[6] The 44.96% of the respondents completed in June, the 53.63% completed in July, only the 1.41% completed in August.

When we limit the analysis to the behavior of the respondents, the big firms that participate in the survey - those firms where the initial e-mail message has suffered only a short chain of redirections - show a more prompt reaction to the stimuli: their participation is obtained in less than two days from the stimulus or never. In fact, it reasonable that the access to the Web plays a different role in firms of different size classes and that it is more or less straightforward managed by the staff that should be devoted to the survey compilation.

These results are likely to be extended to other populations of firms. In any case, there is the need to produce other empirical findings that support the definition of the key factors in the respondent's profile. More results on firms operating in other sectors of economic activities in other countries would be of extreme help in the outline of general criteria for the optimal management of the contact/response process in Internet surveys on firms.

Acknowledgements

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