The Effect of Business Networks on Computer Adoption

by

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Declaration

I certify that all material in this thesis which is not my own work has been identified, and that no material has previously been submitted and approved for the award of a degree by this or any other University.

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Abstract

This paper looks at the effect of business networks on the computer adoption decision of Small and Medium Enterprises in Pakistan. I design a survey questionnaire that will help capture the information network of a firm within these business networks. Using the survey data, I find that the effect of the number of computer users known is strong and significant in each of the networks defined: those of clients and suppliers, competitors and family members. Comparing differences in the results between the three networks provides insight into the information and usage externalities that arise differently from each network.

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1. Introduction

In this paper, I investigate the diffusion of computers amongst Pakistani firms. Specifically, I am interested in how business networks influence computer adoption, both via information dissemination and by increasing the usefulness of the computer to the firm.

The motivation to study how business networks influence computer adoption comes from empirical evidence which suggests that the flow of information within social networks can be an important determinant of adoption in a variety of economic and social decisions. The aim of this paper is to examine the extent to which business networks provide such information flows, and what influence this would have on business decisions. Given that computers also exhibit network effects in usage, it will be important for policy makers to use the results both to conduct correct cost-benefit exercises, and to leverage this network effect to achieve the desired level of diffusion of such technologies.

The data I analyze come from a survey of 226 Small and Medium Enterprises in Pakistan. I use a survey questionnaire that I designed specifically for this paper. It explores in detail the nature of information interactions and computer use, both within the firm and amongst the business network. The questions are structured in a way that helps resolve some of the key empirical problems that have been encountered in similar work previously.

I find that the decisions of the CEOs to adopt a computer are positively correlated with the decisions of their clients/suppliers, competitors and families, with evidence of information and usage externalities. Intuitively, we can expect different magnitudes of effects for each of the networks defined: the network of clients and suppliers is a source of both information and usage externalities, while only the information effect is present for the network of competitors. Amongst the three networks, the family network is the least relevant for the office computer purchase decision. This suggests that the network effect should be highest for the network of clients and suppliers, followed by the network of competitors, and finally it should be lowest for the family network. The data give exactly this result. The effect appears to be strongest for the network of clients and suppliers. The effect of competitors is weaker, but also significant, and appears to be higher for smaller firms, suggesting that smaller firms might be taking the lead from competitors. The family network effect is the weakest of the three for the adoption of computers at work, but very strong and significant for the adoption of home computers.

The next section sets out the conceptual framework. Section 3 discusses the related empirical research. Section 4 presents the background and the data used. Section 5 sets out the empirical framework, and Section 6, the results. Section 7 looks at specification checks and Section 8 concludes.

2. Conceptual Framework: Usage and Information Externalities

For the purposes of this paper, I distinguish between two types of network effects: the usage externality and the information externality.

2.1. Usage Externalities

A usage externality arises when the value of adoption depends on the number of adopters. A simple example is a fax machine, where the usefulness of the machine to an individual user increases as the number of users increases. In the context of computers, and for the Internet especially, the returns to activities such as Email and putting information on the Web are proportional to the number of people who have access to Email/Internet. The relevant network of users here is better defined as the firms or individuals that are linked together in the business chain. For example, a leather goods manufacturer would benefit more from Email and managing orders and suppliers electronically if his suppliers and retailers were also doing the same.

Another advantage of having an established network of users is that it is important for the provision of adequate support services. Clusters of users are better able to lobby for government infrastructure, and are also more attractive for private service providers. In the example of computers, local Internet Service Providers, web–design and computer support firms and are likely to spring up once a user-base has been established, making it easier and more productive to use the computer to its full potential. The establishment of such services, therefore, plays back into the adoption decision of those who have not yet bought a computer.

For both the reasons outlined above, the successful diffusion of technology depends on mobilising sufficient numbers of initial users, after which the market could develop without further intervention.

2.2. Information Externalities

An information externality arises when the adoption of the technology by someone leads to increased awareness of the technology for others, increased information about its profitability, and/or on how to solve problems.

In looking at technology adoption in businesses, the learning that arises from the adoption decisions of others is important because it may be too expensive for small firms to invest in market research or formal IT investment evaluations independently. There may also be psychological barriers to trying a completely unfamiliar technology. As the number of users known increases, the familiarity with the technology increases which makes the decision to adopt less formidable. I expect, therefore, that at least some part of important business-changing actions is deferred till there is an opportunity to observe the decisions and more importantly, to discuss the experiences of others. As discussed earlier, this may prolong the diffusion process of a profitable technology, or in the extreme, halt it altogether.

Information spill-overs can be from observed actions of others, as in, for instance, the herding and information cascades models,[1] or from direct discussion, for instance in the word-of-mouth learning models of Ellison and Fudenberg (1995) and Cao and Hirshleifer (2000), where communication about outcomes plays a direct role in aggregating the information of individual agents.

Both kinds of learning can take place between firms depending on which business network is in question. Amongst competitors, it is likely that the more superficial observation-type learning is taking place, while discussion might be the more important mechanism for the transmission of information with clients. Later, this difference will be important in interpreting the results.

[1] Information cascades feature in Banerjee (1992), Dasgupta (2001), Caplin and Leahy (1998) and Chamley and Gale (1994). Bikhichandi et al (1998) provide a comprehensive review of the literature.

3. Review of Empirical Literature

There has been a proliferation of empirical work on social network effects, much of which focuses entirely on information externalities. The literature spans a variety of subject-matter, such as agricultural technology and educational attainment. I organise the literature by subject-matter categories below.

3.1. Network Effects in the Adoption of Information Technology

One of the papers closest to mine in subject matter is Goolsbee and Klenow's study (2002) of the diffusion of home computers in the US. The network that they look at is defined as neighbourhoods, i.e. geographical proximity. They find that people who live in areas where a higher fraction of households own computers are more likely to own a computer, with the spill-overs arising from experienced and intensive computer users rather than newer or less sophisticated users, suggesting information externalities. They also find that the network effects are linked to the use of Email or the Internet, suggesting usage externalities.

I am able to improve upon the methodology of the paper by using the actual network rather than a geographically defined one. Geographical proximity might not be an appropriate network to use because it defines a theoretical network rather than the actual network of interest. Particularly in the urban context, the widespread use of telephones and cars means that the actual information network is not restricted by geographical proximity. In their paper on learning about agricultural technologies, Conley and Udry (2001) find evidence that information links are not necessarily related to geographical proximity. Firstly, even people living within close vicinity may only have limited information flows amongst themselves. They find that farmers matched at random with 10 people from the same village only had a communication link regarding farming decisions in 7% of the matches, and even in these cases, precise quantitative information was rare. Secondly, there may be strong information links outside the physical boundary defined by the researcher. This finding is true for the small villages that they review - for larger cities with well-developed transport and communication systems, this result is likely to be even stronger.

Furthermore, when there are usage externalities, geographical proximity does not define the correct network because the usage effect will be stronger precisely where electronic sharing and Internet communication is cheaper and easier as compared to physical sharing. And this is the case for larger physical distances where it is slower to use physical mail and more expensive to use telephones.

A final problem with defining network variables in terms of geographical averages is that geographical fixed effects cannot be controlled for. There may be important differences between cities and neighbourhoods that influence the computer adoption of all residents, without necessarily implying any learning effects. This is further compounded by the issue of location choice: individuals choose where to live and are likely to seek out those areas where they find a particular match. This means that the location choice is endogenously determined, and standard OLS results will be biased.

I have an important advantage as compared to Goolsbee and Klenow (2002) in that I have specific data on the information networks and do not have to use geographical averages. This means that I can improve upon the concerns discussed above by identifying specific information networks and controlling separately for geographical fixed effects.

3.2. Network Affects in the Adoption of Agricultural Technologies

Technology adoption and learning effects have also attracted substantial interest in understanding the diffusion of agricultural technologies. Rural sociologists have long recognised the importance of learning in agricultural technology[2], and economists are now formalising and modelling the learning process. For example, Munshi (2004) looks at the diffusion of High Yielding Variety (HYV) rice and wheat in India, defining the information network as neighbours, i.e. geographical proximity. He finds

[2] for a discussion, see Everett Rogers (1983)

greater network effects amongst homogenous populations and technologies that are not highly sensitive to individual characteristics. The presence of information diffusion and learning would predict effects in exactly this direction. The experiences of neighbours are more valuable when the differences in individual and plot level variables can be held constant, or when they are unimportant.

Other recent examples of work that focuses on learning in agriculture include Conley and Udry (2005) and Bandiera and Rasul (2005). In general, they find evidence that suggests that information does spill-over from the decisions and outcomes of adopting farmers towards others in their reference group. Both papers improve on earlier research by using data with details on the information interactions of individuals. Conley and Udry (2005) define the information network by asking specifically about the agents that the respondent turns to for information. They find that the input decisions of farmers are influenced by successful experiments in their information neighbourhood, suggesting information externalities. Bandiera and Rasul (2005) define the information network as that of family and friends. This potentially excludes information obtained from people in information networks that are not limited by family and friends, but is supplemented by including separate networks on geographical or religious basis. They also compare the results from networks demarcated along religious and geographical boundaries, and those defined as friends and family, and find that both are independent sources of information.

3.3. Network Effects in Other Fields

Finally, peer-group effects have been shown to matter in many kinds of social and personal decision-making. Several social networks based models have used information sharing as the main cause of the correlation in group decisions. Bertrand et al (2000), for example, suggest that upward mobility can be restricted when the disadvantaged interact with each other, by spreading information on welfare eligibility rather than job opportunities, or by negative peer pressure. Glaeser et al (1996) look at spatial correlations in crime rates, and while they recognise that global interactions such as labour market conditions would also play a part, the focus of their study is local influences, i.e. meetings between agents that give rise to information flows about crime techniques and pay-offs.

The effects of information networks on firm-level outcomes feature in two other papers that I am aware of: Barr (2000) examines how entrepreneurial social capital (defined in terms of contacts known) impacts firm performance via knowledge flows between enterprises. She estimates a Cobb-Douglas production function, which uses the number and diversity of contacts that the farmer has in various categories as an input and finds that entrepreneurs with a larger and more diverse set of contacts have more productive enterprises, with some evidence that these networks facilitate information flows.

Gowrisankaran and Stavins (2004) also find network externalities amongst banks in the adoption of a specific electronic technology, separating out peer-group effects from other standard market-based effects, such as economies of scale. Both papers suggest that firm-level decision making is influenced by information sharing and learning effects from other firms.

4. Data and Background

4.1. Data[3]

The data I use come from a survey that I designed for the purpose of this paper. It is a cross-sectional survey of 226 firms which asks the CEOs for detailed information on their computer usage and business information networks. This is attached to a larger data-set that covers a broad range of firm-specific variables. I describe both data-sets below.

The larger data-set is a survey of 651 Small and Medium Enterprises (SMEs)[4] in Pakistan which collected detailed data on a broad range of variables, such as: inputs and outputs, human resources, finance, use of technology, and perceptions of the environment that the firms operate in. This survey was commissioned by the Lahore University of Management Sciences' Small and Medium Enterprise Centre, and was carried out in June 2003 by ACNeilsen, an international market research organisation. The objectives of this survey are to assess the economic environment faced by SMEs, and to appraise the constraints and issues faced by the companies. The survey samples manufacturing firms in 10 cities. In each city, the firms are chosen randomly from the list of all registered manufacturing firms and are in proportion to the total number of registered firms in that city. The data was collected by personal interviews with the CEO or the owner of the company.[5]

To collect detailed information on computer usage and information networks, I then formulated a more detailed questionnaire, using the larger data-set as a pilot round. I designed the questions in a way that would help me address the identification problems that arise in estimating network effects.

I enquired about three separate groups from which information and usage externalities might arise: clients/suppliers, competitors and family. Within each group, I asked

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[3] I am grateful to Dr. Arif Rana and the Lahore University of Management Sciences for allowing access to their data-set, and for their assistance in co-ordinating and conducting the independent survey.

[4] SMEs in Pakistan are defined as those firms that employ fewer than 100 people and have productive assets of less that Rs. 40 million (approximately £400,000).

[5] The questionnaire is lengthy and the majority of it was not used for this paper. Therefore, it is not attached to this paper but is available on request.

specifically how many people the respondent met with regularly, and out of those, how many had computers, and how many of those had bought the computer before/with/after the respondent. I also asked how many of their networks members do not have a computer *for sure*. Table 1 describes the data for each of the network categories with the specific question that each category is derived from. The questionnaire used for the data on information networks and computer use is translated into English in Appendix 1.

Asking these questions in this way gives this paper three important advantages over previous literature:

Firstly, it allows respondents to define for themselves the correct information network, rather than requiring the researcher to have to proxy it with neighbourhood or other averages, which define the potential network. This also allows me to control separately for geographical fixed effects.

Secondly, being able to separate the number of people that the respondent meets with regularly from the number of people within these people who have a computer means that I am able to control explicitly for the size of the network. This is an important control variable which differentiates this paper from others that also use observational data. It ensures that the effect that I pick up from the regressions does not come from knowing more people, i.e. having a larger network, but specifically from knowing having more computer owners within this network.

Thirdly, the data allows me to control explicitly for people who do not know about computer ownership in their network. I use the respondents who knew for sure that none of their network members have a computer as a reference category to compare against people who knew for sure that '*x*' of their network members have a computer, rather than rely on people who might not know, or did not respond.

Questionnaires used in earlier work have phrased the question as: "*How many people do you know who are planting a certain type of seed?*" If the results of such a question are used, we would be comparing people who know a positive number of computer users with people who either know none, or who do not know, without being able to distinguish between the two. The correct comparison for people who know computer users is with those who know none.

A final important strength of the paper is that I have detailed information on what each firm manufactures. Since business networks might simply be picking up the effect of similarities in the industry that a firm operates in, being able to control for product fixed effects plays a key part in alleviating the identification problem.

This questionnaire was then presented to a sub-sample of the firms that participated in the June 2003 survey as a telephone supplement. This supplementary survey was conducted in August the same year, approximately 6 weeks after the first survey. Moreover, it was conducted by the firm that was responsible for the first survey, and they were able to ensure that the respondent would also be the same within each firm. The sub-sample was composed of all the firms in the 4 major industrial cities: Karachi, Lahore, Gujranwala and Sialkot. 226 responses were received and matched by respondent ID to the larger data-set.

4.2. Background

Pakistan is a developing country with a GNI per capita of US$690 in 2005.[6] ICT infrastructure is not well established: In 2004, there were 32 telephone mainlines per 1000 people. With 5 personal computers and 13 Internet users per 1000 people, the diffusion of ICT is not high, even compared with the average for low income countries.[7] The adult literacy rate, as a fraction of the population over the age of 15, was 47% in 2005, which diminishes the relevance of computers for a large portion of the population. The focus of my sample is Small and Medium Enterprises, where the issue of computers and ICTs should be more pertinent. I also expect fewer obstacles to the adoption of computers amongst my sample: literacy and financial constraints should be of less immediate concern, making it a more feasible option to buy a computer.

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[6] Source: World Bank "At a Glance" tables for Pakistan

[7] The average figures for all "low income countries" for the same years are:
33 mainline telephones per 1000 people
20 Internet users per 1000 people
8 personal computers per 1000 people
(All figures are from World Bank "at a glance" tables for Pakistan)

Small and Medium Enterprises are an important part of Pakistan's economy, constituting approximately 90% of all businesses. They employ 80% of industrial labour, and contribute 40% to GDP and 25% to export earnings.[8]

However, the incomplete formal infrastructure available means that these firms face a difficult environment: credit, skilled labour, regulation and bureaucratic procedures, poor utility supply, and access to technology and raw material remain important constraints that hold these firms back. Recognising the importance of these firms, the government has created provincial organizations and banks to assist them. To deal specifically with Information Technology, the government set up an IT and Telecommunications Division under the Ministry of Science and Technology in April 2000, and declared IT to be one of the four major drivers of growth. The new IT Policy and Action Plan has identified 11 areas to focus on. The guiding principle is for the government to be a "*facilitator and enabler to encourage the Private Sector to drive the development of IT and Telecommunications*". Further to this cause, the State Bank of Pakistan allowed banks to open Internet Merchant Accounts to facilitate e-Commerce in June 2002. There are also tax incentives, such as a 15-year tax holiday for IT companies, and no import duties on computers and computer parts.[9]

However, despite these efforts, there is poor diffusion of IT. Table 2 shows some summary statistics. Of the sample of CEOs that were interviewed in the 4 major industrial cities, just 31% used a computer at work. The diffusion of computers for the larger set of 10 cities is much lower than that, at 16%. This is also particularly low as compared to recent data for the OECD countries, which shows that nearly all firms with 10 employees or more have not only a computer but also a connection to the Internet.[10]

Table 3 explores some differences between computer users and non-users. As expected, computer users are significantly more educated and experienced and head larger sized firms. Table 4 further illustrates that computer users know more clients,

[8] Source: Small and Medium Enterprise Development Authority, Pakistan http://www.smeda.org.pk/
[9] Government of Pakistan (2000)
[10] OECD (2004)

competitors and family members who have computers. This gives a first indication that there is a significant relationship between the two. Of the reasons discussed earlier, that may give rise to network effects in this context, are usage and information externalities. The next two tables summarise some evidence from the data that sheds light on these effects.

Table 5 looks at the importance of various factors in deterring the purchase of a computer. When asked what the most important reason for not using a computer was, 45% of the respondents identified lack of information, both on how to use a computer and on the profitability of the computer, as the most important reason for not using it. This suggests that information is an important constraint in the decision to buy a computer. It is also worth highlighting that only 7% of the firms claimed that financial constraints were important. This suggests that computers are available at prices that are affordable to the average firm. These constraints are much simpler than those observed for OECD countries, which focus more on security problems, and slow or unstable data communications which make delivery or guarantees problematic and, therefore, hamper the ability of the firms to conduct business online.[11] This probably reflects the more basic use that a computer is put to in the average Pakistani firm, as compared to the OECD sample, and the more initial stage that the average Pakistani small firm is in evaluating the purchase of a computer.

One of the other reasons that networks can be important in the decision to buy a computer is that they give rise to a usage externality. Table 6 summarises the activities performed on the computer. Email and Internet can clearly give rise to usage externalities, and together they constitute 20% of responses for the most important activity performed on the computer. Email and Internet also feature in the secondary uses of the computer, which would further increase the importance of usage externalities. In fact, two-thirds of the sample said that they used the computer to exchange material with another computer user. So although there are important independent uses of the computer, there appears to be a significant network externality in the usefulness of the computer to the firm.

[11] OECD (2004)

5. Empirical Framework

I estimate the effect of the computer adoption decisions of a firm's network members on the firm's adoption of a computer. Let the net gains from adopting a computer be captured by an unobserved latent variable a^*, which includes the benefit of both information and usage externalities. When this net gain is positive, we expect the firm to purchase a computer. I define a_{icp} as the observed computer adoption decision of firm i in city c producing product p. If the net gain is positive, $a_{icp} = 1$, if the net gain is negative, $a_{icp} = 0$.

To explore the impact of business networks on the computer adoption decision, the following equation can be estimated:

$$Prob\ (a_{icp} = 1) = \beta A_{n(i)} + \gamma X_i + \partial Z_c + \lambda Z_p + u_{icp}$$

Specifically, a_{icp} is derived from the answer to the question "*Is a computer used for business purposes at your firm?*" The independent variable of interest, $A_{n(i)}$ is the number of people you interact with regularly who have a computer. Z_c and Z_p are the city and product fixed effects respectively. The city fixed effects capture any geographical correlations that may arise due to, for example, a higher concentration of support services in a particular location. In addition, this would allow me to control for correlations that arise from common characteristics that lead individuals to choose where they live.

Product fixed effects are also important because they allow me to control for correlations between business networks that are determined by common industry characteristics. This is crucial because the business networks are defined in terms of competitors and clients, and there may be important industry-level factors that influence the propensity to adopt computers. This would affect both clients and competitors and it would lead to correlations in the behaviour even if there was no learning or usage effect.

X_i are the firm's observable characteristics, and u_{icp} captures the idiosyncratic individual unobservables.

I first estimate a linear probability model (LPM). This model gives estimates of the partial effects of the explanatory variables on the response probability, and is a realistic choice for binary response models with fixed effects. Logit and probit models with a large number of categorical variables and a small sample size become problematic as observations are dropped because a particular category predicts success or failure perfectly. For this reason, although I report logit estimates as well, I give preference to the OLS regressions.

An OLS model used on binary response data also has some potential weaknesses which I identify below, with a note on why I feel that the problems are not severe in this case.

Firstly, the predicted probability can lie outside the 0-1 range, which makes it awkward for interpretation, and may indicate that this is not the appropriate model to use. Predicted values outside the unit interval are likely to be a problem particularly when the mean of the dependent variable is close to 0 or 1. In this data, the mean of the dependent variable is 0.26, which does not, at the outset, flag this up as a serious problem. Still, to ensure that the results are not biased because of this, I report the percentage of predicted values that lie outside the 0-1 range for each linear probability model estimated.

Secondly, LPMs imply that a unit change in the explanatory variables always changes the response probability by a fixed amount, regardless of the initial value of the explanatory variable. This is problematic again at the extreme ends of the 0-1 probability range. Nevertheless, the linear probability model can give reasonable estimates near the centre of the distribution of the explanatory variables, and for averaged-out partial effects. The percentages of predicted values that lie outside the 0-1 interval can again be useful here, and it is reassuring that this percentage is not high for any of the regressions I use.

In addition, I correct for the heteroskedasticity that arises since an OLS regression is fitted to a binary response model by using Huber-White robust standard errors.

6. Results

6.1. Determinants of Adoption

6.1.1. Non-Network Variables

In deciding which factors to include as explanatory variables, I was guided by existing research on the diffusion of IT, particularly OECD (2004) and Karshenas and Stoneman (1995). The OECD report identifies three sets of factors that influence the adoption of computers. The first comprises the anticipated benefits of adoption, particularly improved customer-orientation and advantages related to costs. The second set comprises the costs of adoption, which includes not just the cost of the direct investment, but also restrictions on finance and deficiencies in knowledge. The final set includes the information spill-overs and learning effects, competition and size. In addition, it points to organizational features that facilitate the adoption of new technologies. I try to include as many variables that measure these factors as possible.

The first column of Table 7 looks at the non-network factors that may influence the decision to get a computer.

Education is represented by the years of schooling, which has been computed from the seven broad categories of educational achievements reported in the data. An additional year of schooling adds 0.035 to the probability of using a computer at work.

The next variable measures if the firm trades internationally. Such firms can be expected to gain more from digital technologies, such as Email, because it provides a larger relative advantage as compared to traditional means of communication. Furthermore, foreign firms may have a higher rate of computer adoption, making it more useful to share information digitally. The export dummy is 1 if the firm exports any of its products, and 0 otherwise. All the exporters in the sample use a computer, and thus this has a strong effect on the probability of using a computer, increasing the probability of adopting a computer by almost 0.6.

The next two variables were computed from a question regarding their firm's growth in the last 5 years. The omitted category is if they increased their production in the last 5 years - this was the largest category, with just over 40% of the sample and, therefore, is efficient to use as the reference category. As expected, decreasing production, or even keeping it constant, reduces the probability of owning a computer as compared to firms that increased their production recently. Decreasing production, for example, takes 0.14 off the probability of adopting a computer, as compared to increasing production in the last 5 years.

Another factor that might influence the computer adoption decision is exposure to media. The TV dummy equals 1 if the respondent watches TV at least 2 days a week. I have similar data for newspaper readership. However, since the news dummy is correlated with the TV dummy and with education, it was dropped in the interest of parsimony.

Another factor that could be important is how many years the respondent has been in the same line of business. This could work in two opposite ways: by making him more aware of his business needs and better established, and therefore more likely to buy a computer; or, by making him more entrenched in traditional ways of doing business and unwilling to experiment. The coefficient is positive and marginally significant, adding 0.007 to the probability of adopting a computer for each additional year of experience, indicating that experience works towards computer adoption, but not strongly. The effect of 20 years of experience would be to add 0.14 to the probability of adopting a computer.

In addition, I include a dummy derived from how many generations the family has been in the business. The dummy takes a value of 0 if this generation is the first one, and 1 if the business is inherited. Like experience, this variable can also work in two opposite directions. There is a complex set of factors that come into play in family businesses and it is not within the remit of this paper to investigate them fully. I will, however, lay out some features briefly in order to explain the inclusion of this variable.

On the one hand, someone who inherits the business will have strong established links and will have imbibed business values from a young age. It is common in Pakistan for businessmen to take their young sons to work in school holidays, and to start them off full-time at the family business early rather than send them to university. This seems to come from a belief that the hands-on experience they will acquire is far more valuable than further education. If the belief is true, and people who inherit the business are, in fact, keener and more entrepreneurial, then this may give them more confidence to experiment with new technologies.

On the other hand, people who inherit the business may lack motivation and be complacent. Most may not have had any choice in entering the business. The head of the household too, may not have any effective choice, being unable to fire his son even following bad performance. In addition, if the business is not very profitable, the sons who are intelligent and hard-working may take up options outside of the business, leaving the less able behind with no option but to work in the family business.

This variable proves not to be significant, and I surmise that this is because it captures both a positive and a negative effect and the two cancel out.

Whether the firm has ever taken credit is insignificant, which could indicate that financial constraints are not restraining the businessmen from investing in computers. This is also supported by their direct responses when asked what the key reasons were for not using a computer. As described in Table 4, only 7% of the firms felt that financial reasons were constraining their decision to purchase a computer.[12]

To proxy for the size of the firm, I use the total number of employees, which has a small but significant impact on the computer use decision. Having 10 more employees adds 0.04 to the probability of adopting a computer. A host of other variables including the number of years the firm has been trading, father's education, various

[12] There is a possibility that the results are insignificant because the reference category includes not only those who do not have sufficient funds and are unable to get loans through a formal channel, but also those who do not need credit because they have sufficient funds to self-finance. Formal financing is not common amongst the sample: just 14 of the firms in the sample had ever taken a loan, and 20% had no idea what interest rate they might be charged.

measures of firm size, and attitude towards risk were also tried and found to be insignificant, and did not impact the results for the number of computer users known. I report the streamlined regression only and drop any additional variables that are correlated with each other.

6.1.2. Network Variables

In the second column of Table 7, I add an aggregate measure of the number of computer users known amongst the clients/suppliers, competitors and family members that the CEOs of the firms interact with regularly. This is computed from the variables described in Table 1 earlier, adding together the computer users known in each of the three categories. There is some loss of detail in including the network variables in this way, but it gives a good first indication of how significant network effects are likely to be. The effect of the number of people known is positive and significant - knowing about 5 more computer users increases the probability of computer adoption by 0.035 - the same impact on the probability of using a computer at work as an additional year of schooling.

In column 3, I add city fixed effects, which captures any variables that operate at the city level, such as availability of services and infrastructure. Column 4 includes product fixed effects. As described in the data section, this is an important control variable because it ensures that the correlation we observe between the decisions of the firm and those of its clients and competitors are not because of common characteristics of the industry that they operate in. There are several levels of detail available for the main product manufactured by the firm. The broadest classification is the 3-Digit ISIC code.[13]

By that classification, there are 22 product categories in the sample. However, for many products, each category holds just a handful of companies, and including so many fixed effects comes with the loss of too many degrees of freedom. For this reason, I draw up 8 broader categories, such as 'metal and minerals' which encompasses `non-metallic minerals', `iron and steel basic industry' and `non-ferrous metal based industry', and use these to control for product fixed effects. The

[13] International Standard Industrial Classification of All Economic Activities (ISIC Rev.2)

aggregation details are described in Appendix 2. Using the complete set of 22 product categories gives the same result as in this table. However, in later regressions with more categorical variables, it becomes problematic to compute test statistics.

Finally, in column 5, I add the caste of the respondent. The reason that caste might be important is that several of the businesses are dominated by specific castes. For instance, Memons have a strong presence in textiles. They are also able to solve many business problems by trading internally and consulting with each other. In this way their decisions may be correlated with each others, or taken jointly. As with the product fixed effects, there are details for 40 castes, with just 5 categories that received more than 20 responses each. For ease of analysis, I aggregate the data into these five categories, with a sixth category for all others. The aggregation details are described in Appendix 3. The results remain robust to the inclusion of these 3 types of fixed effects.

One of the main problems with these regressions is that the sample size drops to less than half if I include the number of computer users known as an aggregate of clients, competitors and family members. As described in the data section, in order to ensure accuracy, the questions were asked in this order:

- How many of your clients do you interact with at least once a month?
- Out of these, for how many are you *sure* that: they have a computer, OR, they do not have a computer

Because they were asked to respond only if they were sure, there were several missing values for this question. If we aggregate the responses for clients, competitors and family, the final response is missing even if the respondent was unsure about just one category. Therefore, in the following tables, I try to use each category separately, both in order to maximise the number of firms included in the analysis, and also to investigate if each network works differently from the others.

6.2. Networks of Clients/Suppliers

Table 8 looks specifically at the network of clients and suppliers. The first column is a basic linear regression with all the variables discussed in the last table, including all the fixed effects. In addition, I control for the number of clients/suppliers with whom the respondent interacts regularly, i.e. the size of the network. This is an important control variable which differentiates this paper from others that also use observational data. If I had asked how many people the respondent knows who own a computer, respondents who are more social or open, or whose business involves more face-to-face contact with clients, would know more people who own a computer because they meet with more people regularly than others. Controlling for the number of clients that the respondent meets with regularly, regardless of computer ownership of either party, ensures that underlying business or personal characteristics that drive how many clients they meet are not influencing the results. The results are robust to the inclusion of this variable. The first column looks at the effect of the number of clients/suppliers who have a computer - knowing an additional client/supplier computer user increases the probability of adoption by 0.015, a positive and significant result.

In the remaining columns, I look for possible non-linearities. Column 2 supports the idea - the regression results indicate that the probability of buying a computer increases with the number of clients user known, but at a decreasing rate. The probability of adopting starts to fall between 16-17 users known.[14]

An important feature of the observations used in these regressions is that this sample comprises people who know about the computer ownership of their clients/suppliers. It compares people who have computer-owning clients/suppliers with people who know that their clients/suppliers do not have computers. This distinction is important because it removes the people who do not know from the analysis, since they could be systematically different from the people who know, and we could be picking up the effect of their knowledge about computer ownership rather than looking at the effect of knowing computer owners versus not knowing computer owners. Another related

not quite right "who don't know" "who know many" who know few

[14] The range of client users known in this sample is between 0 and 50, with 39% of the sample saying that they know that none of their clients have a computer. Almost 86% of the respondents know 10 or fewer clients with computers, so that range is likely to be more precisely estimated.

problem is that people who do have a computer might be more likely to know either way about the computer ownership of others, so the sample of people who know are likely to have a higher proportion of computer owners than the base sample. For example, the act of having recently bought an important new item of equipment would mean that they are more likely to bring it up in conversation, thereby generating a discussion on computers that reveals the computer ownership of your client. Or, having bought a computer, they might explicitly ask their clients or suppliers if they have access to Email as a means of further communication regarding orders. Although the data does show a difference between the two samples, the difference is small and not significant.[15]

Average computer ownership amongst the sample of people who know about the computer ownership of their clients/suppliers is 0.32, with a standard deviation of 0.47. In comparison, average computer ownership amongst people who do not know about the computer ownership of their clients/suppliers is 0.25, with a standard deviation of 0.44.

To account for the people who do not know and to include more of the observations in the analysis, I use the following regressions to include them as a separate category.

Columns 3 and 4 estimate spline functions to examine non-linear effects. I disaggregate the number of clients known into categories, including a category of respondents who `don't know' about the computer ownership of their clients and suppliers. The omitted category is that the respondent is sure that none of his clients and suppliers has a computer.[16]

In this specification, it becomes clear that knowing at least one computer user increases the probability of owning a computer by 0.2, which is a large and significant result - the equivalent effect of an additional seven more years of education, or employing 67 additional people. In the next column, I break up the number of client/supplier users known further. The effect of knowing more than 4

[15] $P < t = 0.21$

[16] In most cases, this was the largest category and so is efficient to use as the reference category.

clients/suppliers with computers is very strong and significant, and the effect of knowing more than 10 clients/suppliers is even stronger.[17]

The results in column 2 and 4 are compatible: The effect of clients increases, or is fairly steady until 10-12 users, and does not start to decline until later.

Both increasing and decreasing returns are consistent with theory. In terms of information spill-overs, there may be decreasing returns to the information that an additional client can add. Yet there are clearly increasing returns to the usefulness of the computer as the network of people you can exchange information with increases.

6.3. Networks of Competitors

I repeat this series of regressions for the network of competitors, reported in Table 9. Computer owning competitors have a significant impact on the probability of using a computer at work, although the effect is smaller than that of clients. Once again, I control for the number of competitors the respondent meets with regularly. The effect of meeting with more competitors is actually negative, although very small, which is a surprising result. The information story would predict that membership of trade groups and such opportunities to meet with people in the same industry increases the pool of information available, and should increase the probability of using a computer. However, it could be that because most people do not use a computer, the prevailing default opinion is that they are not useful. This would mean that the more people the respondents meet in the industry, the more convinced they are likely to be that they should not buy a computer. However, meeting with competitors who have a computer changes this scenario, as the competitors are more likely to encourage them to buy a computer. Column 2 indicates that the number of competitors they meet with regularly who have a computer increases their probability of using a computer by 0.1, while meeting with more competitors in general reduces this probability by 0.002.

The discussion of people who know about the computer ownership of their clients versus those who do not know applies here as well, and I employ the same strategies

[17] The F-test for equality of the coefficient for 4-9 clients with the coefficient for 10+ clients is 1.21 ($p > F = 0.27$), indicating that the difference between knowing 4-9 client, and knowing 10+ clients is not statistically significant.

to deal with it. The average computer ownership amongst people who did know about the computer ownership of competitors was actually lower this time at 0.29, with a standard deviation of 0.46, than the people who did not know about computer ownership of their competitors - an average of 0.36 with a standard deviation of 0.49. However, this difference is not statistically significant.[18]

Columns 4 and 5 explore non-linear effects. The omitted category is the people who know for sure that none of their competitors have a computer. As compared to this group, knowing 4-9 competitors who own a computer increases the probability of adoption by 0.17, and knowing more than 9 computer owning competitors increases it by 0.32. Both results are strong and significant.

The differences in the results shown in Table 8 and 9 are important: information and usage externalities are both present within the network of clients, yet for the network of competitors, the information externality may be the only one. Furthermore, the fact that the nature of the relationship is competitive in Table 8 and complementary in Table 7 means that the nature of the information transfer differs in important respects. The information gathered from clients and suppliers might be more valuable because exchanging accurate information serves both parties. In a competitive environment, members may be less interested in sharing their information on how to use a computer if they want to maintain their competitive edge. Therefore, information may flow less freely amongst competitors. Furthermore, a lack of trust may mean that the incumbent places less value on direct information from his competitors, as he is unsure of the genuineness of the advice. This could also be the reason that we do not observe decreasing returns in these tables, despite the fact that this table should account for the information externality alone. If the incumbent is wary about individual pieces of information, the larger the pool of competitors he can draw information from, the more certain he can be about the conclusions he can draw from the signals he receives. Each additional computer owning competitor therefore provides not just extra information, but also lends credibility to the conclusions that he can draw from the information that the earlier stock of computer owning competitors had provided.

[18] $P < t = 0.74$

For these reasons, I think it is reasonable to view the results on competitors as a lower bound on the information externality that arises from the networks an individual is part of.

6.4. Family Networks

In Table 10-A, I look at network of family members in more detail. This network is not strictly speaking part of the business network, but serves as an additional check on the conclusions drawn, as family can still be an important source of information.

Here again, the effect of knowing family members who have a computer is strong and significant, even after controlling for the number of family members you meet with regularly. The effect of knowing an additional family member, 0.018 in column 1, is as strong as an additional year and a half of formal education. Columns 3 and 4 demonstrate that this effect arises from knowing more than 10 family members, which increases the probability of owning a computer by 0.22.

The results in Table 10-A are weaker than those for competitors and clients. Clearly, the information and usage externality both apply here, as they do amongst the network of clients, but the results suggest that the usage externality differs between clients and family. For an office computer, which is used largely for business purposes, the usage externality is probably greater amongst clients than it is amongst family - which leads to the stronger results for clients. As a check on this, I use information on the respondent's home computer purchase decision to see if the effect is stronger for the network of family members there as compared to the effect on the work computer purchase decision. Table 10-B presents the results. Column 1 shows that an additional family member increases the probability of owning a home computer by 0.041, as compared to the effect on the probability of having a computer at work of 0.018. Column 2, which can be compared with Column 4 in Table 10-A, shows similarly that the effects of family members are much stronger for home computer use.

A comparison of Tables 10-A and Table 10-B lends support to the idea that family members exert a stronger influence on home computer purchase decision than they do on the office computer purchase decision. And as predicted, Table 10-C confirms that clients do not exert an influence on the home computer purchase decision. However, these results are not conclusive, since there could be important differences in families which make their computer adoption decisions correlated and I am not able to control for those effects.

6.5. Further Results

The data shows some interesting interaction effects as well: Table 11 shows the results from interacting the size of the firm with competitors known who have a computer. The size of the firm is proxied with a dummy which takes a value of 1 if the firm employs more than 10 employees and 0 if it employs 10 or fewer employees, a split of the sample at the median size. The results show that smaller firms have larger competitor effects as compared to firms with more than 10 employees. This supports a view that smaller firms may be market followers rather than market leaders.

6.6. Summary

The results described above show significant positive effects arising from each of the three networks defined. In all three networks, the effects appear to become stronger as the number of computer users known increases. There are also important differences between the three - the network of clients appears to have the strongest influence on the firm's adoption of a computer, and the family network appears to have the weakest effect. This is in line with intuition which suggests that both information and usage externalities apply in the case of clients, but that only information externalities apply in the case of competitors. The effect of competitor networks is strongest for small firms, suggesting market following behaviour.

Family networks, while weak for computer adoption at work, are very strong in determining the purchase of a home computer, while the networks of clients, suppliers and competitors are insignificant in deciding on the home computer purchase decision. This is again in line with what we expect for both information and usage externality as the business decision is linked to the relevant business network and the home decision is linked to the relevant family network.

7. Specification Checks

This section explores how sensitive the results are to the estimation technique. As mentioned earlier, there are some weaknesses of using a linear probability model to estimate a binary response dependent variable. In this section I use the logit model, with robust errors to allow for different distributions of the error terms. Table 12 presents the estimates for the equivalent of Table 6, reporting marginal effects at the mean for the logit model. Note that the export dummy is dropped because it predicts success perfectly. Similarly, the regression is much more sensitive to the addition of product fixed effects. Two of the product categories predict failure perfectly, and those observations are lost as product fixed effects are added. The sample size drops to 92 observations when all the fixed effects are added. However, the estimates for the number of computer users known are still positive and significant.

Similarly, Tables 13-15 check if using the logit model changes the results for the specific network of clients, competitors and family. Most of the results are very similar and, most importantly, the network effects come out strongly in all three networks. However, there are some important differences. Firstly, the network of competitors appears to be the strongest of the three in the logit model. Secondly, in Table 14, as compared to people who are sure that none of their competitors have a computer, those who are unsure are more likely to own a computer. It is difficult to reconcile these results, but one of the reasons could be that the sample has changed. All 225 firms were used in the linear probability model tables. However, because some groups have an all-positive or all-negative outcome, those groups are dropped in the logit estimates. In addition, the export dummy is dropped because of an all-positive outcome. Both of these factors could bias the results.

7.1. The Identification Problem

There are some fundamental identification problems in asserting that the relationship we observe in the regressions above is one of cause-and-effect, and even if that is the case, in speculating on the nature of the interaction that has given rise to it. There are several phenomena that could potentially lead to the correlation between individual and group outcomes. These have been discussed in detail by Manski (2000), and others (Durlauf and Fafchamps (2004), for example, discuss the inadequacy of findings of a social effect in empirical research). Manski (2002) usefully divides the empirical research into three hypotheses that it seeks to distinguish between:

> "*endogenous interactions, wherein the propensity of a person to behave in some way varies with the behaviour of the group.*
>
> *contextual interactions, wherein the propensity of a person to behave in some way varies with the exogenous characteristics of the group members.*
>
> *correlated effects, wherein persons in the same group tend to behave similarly because they have similar individual characteristics or face similar institutional environments*"

The information and usage externalities that I wish to examine come under the endogenous interactions category - where the decision to adopt a computer depends positively on the decisions of the members of the agent's group.

An example of contextual interactions in this case would be if the members of the group are better educated or more experienced and, therefore, are able to provide more information to the agent, even if they did not buy a computer. An ideal estimation would include not just the complete set of individual characteristics and outcomes, but also the complete set of group characteristics and outcomes. I am restricted by having access to only group outcomes, not characteristics.

Correlated effects would be present if, for example, the government launched an information scheme directed at some groups only. Since the members of the group are all influenced by the information provided, their decisions would be correlated.

Apart from distinguishing between the interactions above, ideally, we would also like to distinguish the mechanism through which the interaction works. For example, an endogenous interaction that arises due to mimicking if a computer is a status symbol has very different policy implications from one that arises from knowledge spill-overs.

Below, I describe and discuss any further evidence from the data which might be useful in understanding the processes in play here. Complete identification would require very detailed and specific data, which I do not have. I can make some useful comments on the issues, but I do not claim to be able to resolve the problem completely.

7.1.1. Correlated Effects

As described above, correlated effects are likely to be a problem when the members of the group are all influenced by an exogenous factor, such as government interventions, which influences each member's decision in the same direction. This has proved problematic in studies which define the network geographically, for instance, the effects of soil conditions and weather shocks could mean that there is a geographical correlation in the outcomes of farmers. Even in urban setting such as in Goolsbee and Klenow (2002), the correlation observed in neighbourhoods may well be due to variables that affect specific neighbourhoods. Similarly, in studies of knowledge spill-overs amongst firms, defining a spill-over pool in terms of geography or technology runs the risk of picking up correlated effects (Griffith et al 2004).

In this paper, the information network is defined specifically by the individual, and is not restricted either geographically or by industry, and both kinds of fixed effects are controlled for. The product fixed effects are crucial in this respect as the network effects are business related and industry level variables would have been an important source of correlated effects. Furthermore, information links within three completely different networks have been identified for each person, and it is highly unlikely that all three of these will be influenced by the same correlated effects, although they may each be affected by a different set of correlated effects.

7.1.2. Endogenous Group Formation

This bias stems from the fact that people can choose who they meet with. If people form groups on the basis of some common characteristics, and these characteristics independently influence their computer adoption decision, then the regressions estimated above will be biased. For example, consider the situation where people who are interested in technology, or have more exposure, or are more open-minded etc., like to meet with other people who are also interested in technology. This interest also makes them more likely to buy a computer, regardless of any one else's decision. What we will observe is that computer owners know more computer owners, even if there are no externalities involved.

Moffitt (2000) specifies that in order to achieve identification in this situation, exclusion conditions can work. Specifically, one would need at least one variable that determines the outcome decision equation, but does not enter into the decision of group formation. Both the computer adoption decision and the decision of which of his clients/competitors to meet with regularly are influenced by business as well as personal characteristics. However, while there are some factors such as interest in computers and awareness that will influence both computer adoption and group formation, there are other factors which influence just the computer adoption decision, such as firm-size and product-type which determine the usefulness of the computer to the firm, and others which affect just group formation, such as geographical location and common contacts - therefore at least a possibility of identification. In another setting, this would have permitted the use of instrumental variables in which group membership is determined in a first regression, and the results then used in the second regression of outcome determination. However, in this setting, group membership is not defined as something with any externally imposed boundaries. The determination of the composition of the group can, therefore, only be considered qualitatively.

The problem would have been more severe if common interests and similarities played a more important part in the group formation decision, as they do in neighbourhood choice and in social group formation. However, in this context, this problem is alleviated to some extent by the fact that the primary purpose of these relationships is business, so common interests are less likely to play an overbearing role in the formation of business networks. The groups defined earlier are clients/suppliers, and competitors (business network), supplemented with information on family members. The respondent has less control over clients and competitors than over friends or neighbours, since he chooses both friends and neighbourhood. It can be argued that an individual can choose to enter a more computer intensive industry if he is interested in technology. This is not likely to be driving the results since product fixed effects are controlled for. Similarly, which family he is born into is exogenously determined.

However, the problem remains that I have defined the business network in terms of the number of competitors/clients that the individual meets with regularly, and although the clients, competitors and family might be exogenous, the ones the respondents choose to meet more frequently may not be. There is also the problem of clients selecting manufacturers who have a computer and, therefore, the network of clients may suffer from endogenous formation. So, although it is not beyond a shadow of doubt that there are no important network variables that have been omitted, in this setting, where networks are primarily exogenous, they are unlikely to be the sole drivers of the results.

7.2. Mimicry

This effect could arise if people adopt computers when they see other people adopting simply in order to keep up with their neighbours and friends e.g. computers could be a status symbol rather than a useful technology that people learn from each other about.[19]

The results from the regressions presented thus far do not suggest this:

Firstly, if peer pressure or mimicry was causing the results, we could expect to see an increase in adoption with an increase in users known, but no increase in the use of the computer itself. However, in this case, as indicated in Table 6, people seem to use a

[19] Foster and Rosenzweig (1995), Conley and Udry (2000) and Goolsbee and Klenow (1999), all express concern that "social learning" effects may simply be picking up mimicking behaviour.

computer for a variety of reasons, with each computer user using their computer for just over 3 different things.[20] If mimicry was a major reason for purchasing the computer, it would not explain why people then use the computer for a variety of reasons.

Secondly, significant positive effects were found for all three networks. We might reasonably expect mimicry to influence the results for competitors and family members, but not clients. Firms are more likely to be judging themselves in comparison with competitors, and feeling the need to match the competition. This could also arise amongst family members in the standard "keeping up with the Joneses" behaviour. It is less clear that firms would want to copy clients/suppliers. Yet, the results for the network of clients are the strongest of the three, which indicates that mimicry cannot be the major, or only, driver of the results.

7.3. The Reflection Problem

The reflection problem was first recognised formally by Manski (1993), and is discussed in several places in the context of social interactions (for example, Moffitt (1998), Brock and Durlauf (2004)). The reflection problem arises because the group is simply an aggregation of all its members, and while the group average could affect each individual member's decision, the member's decision also affects the group, i.e. they are determined simultaneously. If the reference group composition is not known and is, therefore, defined externally, the group average is related by construction to the individuals' adoption decision and, therefore, it is not possible to infer endogenous effects.

In principle, lagged group means could be used, which would allow me to specify the direction of the causation. In this data, I have specific information on the number of people in each network who bought a computer before the respondent. The use of this variable would also allow me to comment on reverse causality - that people would chose to meet with more computer users after they have already bought a computer. However, there were some sample distortions for this variable and it could not be used. This remains on the agenda for future work.

[20] The 95% confidence interval for the number of uses that the computer is put to is from 2.6 to 3.4.

8. Conclusion

This paper looks at interdependencies in the decision to adopt computers amongst business networks. Using data gathered specifically for this purpose, I find that an increase in the number of adopters known increases the probability of computer adoption. This effect comes up in both business networks defined, and also in the network of family members. The data suggests that information deficiencies are an important deterrent in the adoption of a computer and, therefore, information spill-overs are a likely explanation of the impact I find of the networks on computer adoption. Having information on three distinct networks enables me to comment on the strength of the information externality. In particular, the impact of competitors on the probability of using a computer can reasonably define a lower bound for the information externality since we do not expect networks of competitors to give rise to usage externalities. In addition, the learning may, more likely, be via observation rather than by word-of-mouth communication regarding outcomes. The effect of the complete information network, which includes the networks examined here and also friends and neighbours, is likely to be much larger than this effect alone.

The fact that the networks are primarily exogenously determined also means that the results are less heavily contaminated with endogeneity problems. Another important strength of the data is that I can control for the people who do not know about network members' adoption decision, and also for the number of people they meet with generally, which means that I can rule out at least these two effects that could otherwise be causing a correlation not ascribable to information spill-overs. In addition, I have direct information on the individual's specific network, which allows me to control for fixed effects and ensures that I am looking at the actual network rather than a potential network.

However, there still remains work that can be done to improve the credibility of the findings:

Firstly, one of the drawbacks of the data is that we do not know the identity of the people constituting a firm's network – therefore, we cannot control for their characteristics. Another one is that firm-level decision making is complicated by strategic moves within the industry. Ideally, if additional data on the firms that they observe and interact with were available, it would allow me to control for rank, stock and order effects. In addition to these extra variables, a larger data-set would also enable me to use the variables that already exist more productively, for example, in examining additional interaction effects, which was constrained by the small sample size. A richer data-set, therefore, is on the agenda for future work.

Even with the small data-set, however, the results show strong and significant effects. This can have important policy implications. It shows, for example, that it is information constraints rather than financial constraints that are keeping firms from adopting computers. If computer adoption is believed to be an important enabler for successful businesses, this may suggest a way to improve the dissemination of such technologies. Given the spill-over effects that also arise both due to information and usage externalities, the gain to some firms of an information led approach would have impacts beyond the firms that benefit directly. The inclusion of such effects therefore is critical for correct cost-benefit analysis and targeted policy formation in this field.

Appendices

Appendix 1: Questionnaire for Network Variables

(*Translated from Urdu*)

Main Questionnaire for MR-2325/03

Serial # of Main Form (2308):	Surveyor:
City:	Supervisor:
Editor:	Coder:
Back-Checker:	

Name of Respondent:	Position in Firm:
Name of Company:	Phone Number:

Introduction

Assalam-alaikum. My name is _______ You would remember that about one month ago, I came to see you on behalf of the Lahore University of Management Sciences to interview you for their survey on the situation and problems of Small and Medium Enterprises. The results of the survey indicated that there are some additional questions that would help us understand the situation better. Let me remind you again that I am not associated with any government organisation, such as the tax department, and that the name of your firm will not be shared with anyone. I will be grateful if you could allow me to interview you over the phone. I am calling from Lahore/Karachi and will not take up more than 5 minutes of your time.

Section A

Q-80. Please can you tell me if you have a computer at home for personal use?
Yes ____________________ [1]
No ____________________ [2] → (go to Q82)

Q-81. When did you buy the computer for your home? (probe)
(Month, Year) ____________________
Don't remember ____________________ [9]

I am now going to ask you a few questions about your use of a computer at work for office/business use

Q-82. Do you think that the use of a computer at work increases/would increase the performance of your firm as compared to other competing firms?
Yes ____________________ [1]
No ____________________ [2]
Don't know (do not read out) [9]

Q-83. Please can you tell me, is a computer used in your work place for office work?
Yes____________________ [1] → (go to section B)
No ____________________ [2] → (go to section C)
Didn't answer/Don't know (do not read out) __ [9] → (go to section D)

Section B

Q-84. When did you buy the first computer for business/office use? (probe)
(Month, Year) ________________
Don't remember _______________ [9]

Q-85. Please can you tell me amongst your competing firms, how many people do you meet with at least once a month?
Quantity ________________
Don't remember (do not read out) ___________ [9] → (go to Q-88)

Q-86.

a. Please can you tell me, out of these ________ *(quantity from Q85)* firms, for how many can you say for sure that they have a computer?
Quantity ______________
None of them have a computer (do not read out) ________ [98] → (go to Q-88)
Cannot say for sure about any of them (do not read out) __ [99] → (go to Q-88)

If the quantity given in Q-86a is less than that in Q-85, go to Q-86b. Otherwise, go to Q87

b. Can you please tell me, out of these _____ (quantity from Q-85) firms, for how many can you say for sure that they do not have a computer?
Quantity ______________
Cannot say for sure about any of them (do not read out) ________ [99]

Q-87. Out of these _________ (quantity from Q-86a) firms, how many bought a computer before you, how many bought it at about the same time, and how many bought it after you?

Ask the respondent about each option separately

	Don't know
Bought it before you: quantity________________	9
Bought it at the same time: quantity____________	9
Bought it after you: quantity________________	9

Q-88. Amongst your clients/suppliers, how many people do you meet with at least once a month?
Quantity __________________
Don't remember (do not read out) _____________ [9] → (go to Q-91)

Q-89.

a. Please can you tell me, out of these _________ *(quantity from Q88)* firms, for how many of the clients/suppliers can you say for sure that they have a computer?
Quantity______________
None of them have a computer (do not read out) _______ [98] → (go to Q-91)
Cannot say for sure about any of them (do not read out) _ [99] → (go to Q-91)

If the quantity given in Q-89a is less than that in Q-88, go to Q-89b. Otherwise, go to Q90

b. Can you please tell me, out of these ______ *(quantity from Q-88)* firms, for how many clients/suppliers can you say for sure that they do not have a computer?
Quantity ________________
Cannot say for sure about any of them (do not read out) ______ [99]

Q-90. Out of these ______ *(quantity from Q-89a)* clients/suppliers, how many bought a computer before you, how many bought it at about the same time, and how many bought it after

Ask the respondent about each option separately

	Don't know
Bought it before you: quantity______________	9
Bought it at the same time: quantity__________	9
Bought it after you: quantity_______________	9

Q-91. Please can you tell me amongst your close family, for example siblings, children, parents, uncles, aunts, cousins, how many people do you meet with at least once a month?
Quantity ______________
Don't remember (do not read out) ____________ [9] → (go to Q-94)

Q-92.

a. Please can you tell me, out of these __________ *(quantity from Q91)* family members, for how many can you say for sure that they have a computer?
Quantity ______________
None of them have a computer (do not read out) _______ [98] → (go to Q-94)
Cannot say for sure about any of them (do not read out) __ [99] → (go to Q-94)

If the quantity given in Q-89a is less than that in Q-88, go to Q-89b. Otherwise, go to Q90

b. Can you please tell me, out of these _________ (*quantity from Q-85*) family members, for how many can you say for sure that they do not have a computer?
Quantity______________
Cannot say for sure about any of them (do not read out) _________ [99]

Q-93. Out of these _______ (*quantity from Q-86a*) family members, how many bought a computer before you, how many bought it at about the same time, and how many bought it after you?

Ask the respondent about each option separately

	Don't know
Bought it before you: quantity______________	9
Bought it at the same time: quantity__________	9
Bought it after you: quantity_______________	9

Q-94. Can you please tell me if you use your computer to exchange material like Emails, files and data with another computer user?
Yes _____________________________ [1]

No ______________________________ [2]
Don't know (do not read out) __________ [3]

Now go to Section D

Section C

Q-95.

a. I am now going to mention to you some possible reasons for not using a computer. After hearing all of the reasons, can you please tell me which one you would consider to be the most important reason for not using a computer?

Read out all of the options one by one and note down only one response in Column 1. If the respondent says that none of these reasons are important for him, then ask him for his own reasons.

b. The same way, can you tell me which reason is the second most important reason for not using a computer?

Read out all of the options one by one and note down only one response in Column 1. If the respondent says that none of these reasons are important for him, then ask him for his own reasons.

Sr. No.	Reasons	Column 1	Column 2
1	Computer is not useful	1	1
2	Computer is too expensive	2	2
3	Don't know how to use a computer	3	3
4	Don't like using a computer	4	4
5	Don't know how useful/profitable a computer would be	5	5
	Others (note them down)		
	Don't know	99	99

Q-96. Please can you tell me amongst your competing firms, how many people do you meet with at least once a month?
Quantity ___________________________
Don't remember (do not read out) ________ [9] → (go to Q-98)

Q-97.

a. Please can you tell me, out of these _________ *(quantity from Q96)* firms, for how many can you say for sure that they have a computer?
Quantity _____________________
None of them have a computer (do not read out) ________ [98] → (go to Q-98)
Cannot say for sure about any of them (do not read out) __ [99] → (go to Q-98)

If the quantity given in Q-97a is less than that in Q-96, go to Q-97b. Otherwise, go to Q98

b. Can you please tell me, out of these _________ *(quantity from Q-96)* firms, for how many can you say for sure that they do not have a computer?
Quantity ____________________________
Cannot say for sure about any of them (do not read out) _________ [99]

Q-98. Amongst your clients/suppliers, how many people do you meet with at least once a month?
Quantity ___________________________
Don't remember (do not read out) _____________ [9] → (go to Q-100)

Q-99.
a. Please can you tell me, out of these __________ *(quantity from Q98)* firms, for how many of the clients/suppliers can you say for sure that they have a computer?
Quantity ______________________________
None of them have a computer (do not read out) _______ [98] → (go to Q-100)
Cannot say for sure about any of them (do not read out) _ [99] → (go to Q-100)

If the quantity given in Q-99a is less than that in Q-98, go to Q-99b. Otherwise, go to Q100

b. Can you please tell me, out of these ______ *(quantity from Q-98)* firms, for how many clients/suppliers can you say for sure that they do not have a computer?
Quantity ______________________
Cannot say for sure about any of them (do not read out) ______ [99]

Q-100. Please can you tell me amongst your close family, for example siblings, children, parents, uncles, aunts, cousins, how many people do you meet with at least once a month?
Quantity ___________________________
Don't remember (do not read out) __________ [9] → (go to Section D)

Q-101.
a. Please can you tell me, out of these __________ *(quantity from Q100)* family members, for how many can you say for sure that they have a computer?
Quantity ________________
None of them have a computer (do not read out) _____ [98] → (go to Section D)
Cannot say for sure about any of them (do not read out)[99] → (go to Section D)

If the quantity given in Q-101a is less that that in Q-100, go to Q-101b. Otherwise, go to Section D

b. Can you please tell me, out of these ________ *(quantity from Q-100)* family members, for how many can you say for sure that they do not have a computer?
Quantity _______________________
Cannot say for sure about any of them (do not read out) ________ [99]

Section D

Q-102. Can you please tell me, in the last 5 years, have you changed you production on a large scale?
Yes ________________ [1]
Increased ____________ [1]
Decreased ___________ [2]
No _________________ [2] → (go to Q-104)

Q-103. In which year did you increase/decrease *(response from Q-102)* production and by what percentage?
Year ______________________
Percentage ___________________
Don't know/No response (do not read out) ____________ [9]

Q-104.

a. I am now going to ask you an interesting question. If I give you two options for a business investment, which one would you take?

Read out the responses

An investment in which there is an equal chance of earning either 10,000 or 20,000 rupees ____________________ [1]

OR

An investment in which there is a certain return of 11,500 rupees ________ [2]

b. The same way, can you tell me out of the two options (read from below), which one would you choose?

Read out the responses

An investment in which there is an equal chance of earning either 10,000 or 20,000 rupees ______________________ [1]

OR

An investment in which there is a certain return of 13,000 rupees _______ [2]

c. The same way, can you tell me out of the two options (read from below), which one would you choose?

Read out the responses

An investment in which there is an equal chance of earning either 10,000 or 20,000 rupees __________________ [1]

OR

An investment in which there is a certain return of 14,500 rupees ________ [2]

Thank you for your cooperation.

Appendix 2: Product Fixed Effect

The firms were asked what kind of product they manufactured, which was classified by the International Standard Industrial Classification (ISIC) Code Rev.2. at the 3-Digit level.

The following table summarises the data for the firms used in the sample.

Table 1

ISIC 3-Digit Code	Main Product Manufactured	Frequency	Percentage
311	Food Manufacturing *	6	2.65
321	Textile Manufacturing	31	13.72
322	Manufacturing of Wearing Apparel Except Footwear	6	2.65
323	Manufacturing of Leather and Leather Products Except Footwear	3	1.33
324	Manufacturing of Footwear Except Rubber & Plastic	5	2.21
331	Manufacturing of Wood & Wood Products Except Furniture	4	1.77
332	Manufacturing of Wood Furniture & Fixtures, Except Metal	14	6.19
341	Manufacturing of Paper & Paper Products	3	1.33
342	Printing, Publishing & Allied Industries	23	10.18
350	Manufacturing of Drugs, Pharmaceutical, Chemical & Plastic Products *	1	0.44
351	Manufacturing of Industrial Chemical Products *	1	0.44
355	Manufacturing of Rubber Products *	2	0.88
356	Manufacturing of Plastic Procducts *	9	3.98
369	Manufacturing of Other Non-Metallic Minerals	13	5.75
371	Iron & Steel Basic Industry	8	3.54
372	Non-Ferrous Metal Basic Industry	13	5.75
381	Manufacturing of Fabricated Metal Products	30	13.27
382	Manufacturing of Machinery/Spare Parts Except Electrical	23	10.18
383	Manufacturing of Electrical Machinery	14	6.19
384	Manufacturing of Transport Equipment	4	1.77
391	Handicraft *	1	0.44
392	Manufacturing of Sports & Athletic Good*	4	1.77
393	Other Manufacturing Industries	8	3.54
	Total	**226**	**100**

** Classified as "Others" in Table 2*

The table shows that there were 23 categories that received positive responses. However, while some categories are well represented in the sample (for example textiles and fabricated metal products), others have just one firm in the sample. In order to retain degrees of freedom, I drew up 8 product categories from the 23 described above. The following table summarises:

Table 2

Code	Category	ISIC Code	Frequency	Percentage
1	Textiles	321	31	14.35
2	Wearing Apparel, Footwear & Leather Products	332, 323, 324	14	6.48
3	Wood Products	331, 332	18	8.33
4	Paper & Publishing	341, 342	26	12.04
5	Metals & Minerals	369, 371, 372	34	15.74
6	Machinery & Equipment	382, 383, 384	41	18.98
7	Fabricated Metal Products	381	20	9.26
8	Others (marked with an * in Table 1)		32	14.81
	Total		**216**	**100**

The rationale behind the categories is to keep the largest categories separate. The remaining categories are then aggregated upwards, broadly in line with the 2-Digit ISIC code. The first digit, *3*, is common to all the categories because it represents manufacturing. Categories beginning with *32* are all firms within "Textiles, Wearing Apparel and Leather Industries" and thus, for example, *322*, *323* and *324* were all aggregated to this broader category.

Appendix 3: Caste Fixed Effects

The respondents were asked which caste they belonged to, and there were 40 different categories for which responses were received. As is evident from the table below there are only five major castes, and the remaining castes are much less common.

Table 1

Caste	Frequency	Percentage
Sheikh	26	11.50
Mian / Araaeen	28	12.39
Kashmiri	6	2.65
Rajpoot / Bhatti	26	11.50
Jatt / Chaudhary	12	5.31
Syed	9	3.98
Memon / Gujrati (Kathyavaari)	5	2.21
Pathan	22	9.73
Baloch	2	0.88
Malik	5	2.21
Ansari	8	3.54
Chatha	1	0.44
Qureshi	6	2.65
Butt	3	1.33
Mughal	39	17.26
Khawaja	1	0.44
Kakkayzai	1	0.44
Muhajir	1	0.44
Rehmani	1	0.44
Siddiqui	2	0.88
Punjabi Saudagran	1	0.44
Balti	1	0.44
Mochi	1	0.44
Janjua	1	0.44
Bajwa	1	0.44
Marwari	1	0.44
Marwat	1	0.44
Bhutta	1	0.44
Atray	1	0.44
Agha Khani	1	0.44
Gandhi	1	0.44
Basra	1	0.44
Paray	1	0.44
Yousufzai	1	0.44
Cheema	1	0.44
Hazara	1	0.44
Sarayeki	1	0.44
Akhundkhel	1	0.44
Lodhi	1	0.44
Slatch	1	0.44
Not Told	2	0.88
Total	**226**	**100**

As with product categories, in order to retain as many degrees of freedom as possible, I aggregated the various scattered categories into one category "Others" and retained the five major castes as is. The table below summarises:

Table 2

Caste	Frequency	Percentage
Sheikh	26	11.50
Mian / Araaeen	28	12.39
Rajpoot / Bhatti	26	11.50
Pathan	22	9.73
Mughal	39	17.26
Others	85	37.61
Total	**226**	**100**

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Tables

Table 1: Network Variables

	Observations	Mean	Std. Deviation
Competitors			
Size of network (Note 1)	213	11.04	31.5
Computer users known (Note 2)	156	4.11	6.61
Computer users known who bought a computer *before* respondent (Note 3)	129	2.97	5.02
Computer users known who bought a computer *after* respondent (Note 4)	129	0.4	1.67
Competitors who do not have a computer (Note 5)	46	13.72	21.42
Clients/Suppliers			
Size of network	213	23.12	57.26
Computer users known	161	5.44	8.5
Computer users known who bought a computer *before* respondent	135	3.7	7
Computer users known who bought a computer *after* respondent	135	1.18	4.99
Competitors who do not have a computer	48	14	17.88
Family members			
Size of network	216	8.12	9.42
Computer users known	198	3.74	5.47
Computer users known who bought a computer *before* respondent	43	1.3	2.54
Computer users known who bought a computer *after* respondent	43	4.95	4.88
Competitors who do not have a computer	85	6.12	7.53

Notes:
The notes below summarise the questions from which the variables are derived for the network of competitors.
Similar questions were asked for the other two networks.
For details, please see the complete questionnaire in Appendix 1.

Note 1: "How many competitors do you meet with regularly (at least once a month)?
Note 2: "Out of these, for how many are you sure that they have a computer?
Note 3: "How many of the ones who you are sure have a computer bought it computer before you?"
Note 4: "How many of the ones who you are sure have a computer bought it computer after you?"
Note 5: "Out of the competitors that you meet with regularly, how many are you sure do not have a computer?"

Table 2: Summary Statistics for Computer Diffusion

	Full Sample of 10 Cities (651 firms)	Sample of 4 Major Cities (226 firms)
Computer Users (at work)	104 (*mean*: 0.161, *sd*: 0.37)	69 (*mean*: 0.31. *sd*: 0.46)
Email Users	65 (10%)	34 (15%)
Internet Users	47 (7%)	31 (14%)

Table 3: Summary Statistics

(With 95% Confidence Intervals in Parentheses)

	Full Sample (226)	Non-Users (156)	Computer Users (69)
Years of Schooling	10.56 (10.02 – 11.09)	13.1 (12.53 – 13.67)	9.42 (8.76 – 10.10)
Experience	12.51 (11.10 – 13.92)	10.71 (9.22 – 12.21)	16.7 (13.71 – 19.68)
Permanent Employees	10.47 (8.62 – 12.31) 214 obs	6.32 (5.12 – 7.52) 144 obs	19.16 (14.59 – 23.73)
Total Employees	17.67 (15.43 – 19.91)	14 (11.85 – 16.15)	25.9 (20.83 – 30.97)
Number of Clients	22.57 (15.47 – 29.67) 121 obs	16.32 (9.66 – 22.97) 79 obs	32.73 (16.58 – 48.88) 41 obs
Number of Generations in Business	1.39 (1.31 – 1.49)	1.33 (1.23 – 1.42)	1.56 (1.38 – 1.75)
Years of Father's Schooling	5.77 (5.04 – 6.50) 190 obs	4.62 (3.84 – 5.41) 134 obs	8.67 (7.28 – 10.07) 55 obs
TV Viewership Dummy	0.71 (0.65 – 0.77)	0.71 (0.63 – 0.77)	0.72 (0.62 – 0.83)
Newspaper Readership Dummy	0.76 (0.71 – 0.82)	0.7 (0.62 - 0.77)	0.9 (0.83 – 0.97)

Table 4: Network Sizes

(With 95% Confidence Intervals in Parentheses)

	Computer Users	Non-Users
Clients/Suppliers who have a computer	9.44 (6.67 – 12.2)	3.53 (2.20-4.86)
Competitors who have a computer	6.89 (4.35 – 9.43)	2.95 (1.97 – 3.94)
Family who has a computer	6.37 (4.34 – 8.40)	2.54 (2.00 – 3.07)

Table 5: Reasons for NOT Using a Computer

Insufficient information on how to use it	39%
Insufficient information on profitability	6%
Don't need it/don't think it is useful	34%
Can't afford it	7%
Others (no time, interest, other constraints)	14%

Table 6: Most Important Activity Performed by Computer User

Writing Letters	34%
Accounts/Finance	27%
Email	15%
Internet	5%
Others (Designing, Bills etc)	19%

Table 7: The Determinants of Computer Adoption

Dependent Variable = '1' if a computer is used at work, '0' otherwise
Linear Probability Model

	(1)	(2)	(3)	(4)	(5)
Number of Computer Users Known		0.007*	0.007**	0.007**	0.008**
		(0.004)	(0.004)	(0.004)	(0.003)
Education	0.035***	0.035***	0.028***	0.026**	0.027**
	(0.006)	(0.009)	(0.009)	(0.011)	(0.011)
Export Dummy	0.566***	0.475***	0.500***	0.428**	0.406**
	(0.084)	(0.151)	(0.171)	(0.186)	(0.182)
Production Decreased Over Last 5 Years	-0.136**	-0.023	-0.04	-0.019	-0.054
	(0.069)	(0.097)	(0.096)	(0.100)	(0.102)
Production Stayed Constant Over Last 5 Years	-0.120*	-0.088	-0.043	-0.099	-0.123
	(0.062)	(0.099)	(0.096)	(0.092)	(0.090)
TV Dummy	-0.079	-0.034	-0.041	-0.064	-0.061
	(0.057)	(0.088)	(0.084)	(0.089)	(0.092)
Experience in this Business	0.007***	0.007*	0.006	0.006*	0.007*
	-0.003	-0.004	-0.004	-0.004	-0.004
Credit Dummy	-0.025	-0.022	-0.016	0.009	0.002
	(0.029)	(0.042)	(0.042)	(0.044)	(0.044)
Inherited	-0.019	0.024	-0.001	-0.038	-0.044
	(0.061)	(0.086)	(0.082)	(0.085)	(0.082)
Total Number of Employees	0.004**	0.003	0.004*	0.004	0.003
	(0.002)	(0.002)	(0.003)	(0.003)	(0.002)
Constant	-0.105	-0.266	-0.345**	-0.375**	-0.360**
	(0.085)	(0.129)	(0.135)	(0.159)	(0.175)
City Fixed Effects			Yes	Yes	Yes
Product Fixed Effects				Yes	Yes
Caste Fixed Effects					Yes
Observations	225	107	107	107	107
R-Squared	0.36	0.37	0.42	0.49	0.52
% Predictions Outside 0-1 Interval	11.90	6.18	6.19	11.06	10.62

Robust Standard Errors in Parentheses
* = Significant at 10%
** = Significant at 5%
*** = Significant at 1%

Table 8: The Network of Clients/Suppliers

Dependent Variable = '1' if a computer is used at work, '0' otherwise
Linear Probability Model

	(1)	(2)	(3)	(4)
Clients/Suppliers Who Have a Computer	0.015*** (0.004)	0.033*** (0.010)		
Clients/Suppliers Who Have a Computer - Squared		-0.001* (0.000)		
(Clients/Suppliers You Meet With Regularly) x 0.1	0.0002 (0.004)	0.0004 (0.004)	0.003 (0.005)	0.002 (0.005)
Don't Meet With Any Clients/Suppliers Regularly			0.072 (0.097)	0.072 (0.099)
Don't Know About the Computer Ownership of Any Clients/Suppliers			0.024 (0.080)	0.041 (0.080)
At Least One Client/Supplier Has a Computer			0.199*** (0.071)	
1-3 Clients/Suppliers Have a Computer				0.035 (0.084)
4-9 Clients/Suppliers Have a Computer				0.230** (0.105)
10+ Clients/Suppliers Have a Computer				0.345*** (0.086)
Constant	-0.309** -0.14	-0.368*** (0.138)	-0.299** (0.133)	-0.290** (0.130)
Firm/Individual Characteristics	Yes	Yes	Yes	Yes
City Fixed Effects	Yes	Yes	Yes	Yes
Product Fixed Effects	Yes	Yes	Yes	Yes
Caste Fixed Effects	Yes	Yes	Yes	Yes
Observations	161	161	212	212
R-Squared	0.51	0.53	0.45	0.48
% Predictions Outside 0-1 Interval	12.83	13.72	15.93	19.47

Robust Standard Errors in Parentheses
* = Significant at 10%
** = Significant at 5%
*** = Significant at 1%

Table 9: The Network of Competitors

Dependent Variable = '1' if a computer is used at work, '0' otherwise
Linear Probability Model

	(1)	(2)	(3)	(4)	(5)
Competitors Who Have a Computer	0.010* (0.005)	0.013** (0.005)	0.025** (0.013)		
Competitors Who Have a Computer - Squared			-0.0003 (0.0003)		
Competitors You Meet With Regularly		-0.002*** (0.001)	-0.002*** (0.001)		-0.003*** -0.001
Don't Meet With Any Competitors				0.084 (0.071)	0.079 (0.071)
Don't Know About the Computer Ownership of Competitors				0.117 (0.153)	0.114 (0.151)
At Least One Competitor Has a Computer				0.130* (0.067)	
1-3 Competitors Have a Computer					0.058 (0.078)
4-9 Competitors Have a Computer					0.169** (0.085)
10+ Competitors Have a Computer					0.315** (0.126)
Constant	-0.231* (0.131)	-0.220* (0.131)	-0.208 (0.130)	-0.217* (0.115)	-0.204* (0.115)
Individual-/Firm-Level Characteristics	Yes	Yes	Yes	Yes	Yes
City Fixed Effects	Yes	Yes	Yes	Yes	Yes
Product Fixed Effects	Yes	Yes	Yes	Yes	Yes
Caste Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	156	156	156	213	213
R-Squared	0.44	0.47	0.47	0.43	0.45
% Predictions Outside 0-1 Interval	11.50	11.50	12.39	15.04	17.70

Robust Standard Errors in Parentheses
* = Significant at 10%
** = Significant at 5%
*** = Significant at 1%

Table 10-A: The Network of Family Members

Dependent Variable = '1' if a computer is used at work, '0' otherwise
Linear Probability Model

	(1)	(2)	(3)	(4)
Family Members Who Have a Computer	0.018** (0.008)	0.023** (0.011)		
Family Members Who Have a Computer - Squared		-0.0002 (0.0002)		
Family Members You Meet With Regularly	-0.001 (0.005)	0.0003 (0.005)	0.005** (0.002)	0.002 (0.003)
Don't Meet With Family Regularly			0.189 (0.119)	0.174 (0.121)
Don't Know About Computer Usage of Family			0.105 (0.182)	0.1 (0.179)
At Least One Family Member Has a Computer			0.031 (0.062)	
1-3 Family Members Have a Computer				-0.035 (0.065)
4-9 Family Members Have a Computer				0.132 (0.082)
10+ Family Members Have a Computer				0.216* (0.123)
Constant	-0.065 (0.117)	-0.068 (0.118)	-0.156 (0.114)	-0.083 (0.131)
Individual-/Firm-Level Characteristics	Yes	Yes	Yes	Yes
City Fixed Effects	Yes	Yes	Yes	Yes
Product Fixed Effects	Yes	Yes	Yes	Yes
Caste Fixed Effects	Yes	Yes	Yes	Yes
Observations	198	198	216	216
R-Squared	0.47	0.47	0.44	0.46
% Predictions Outside 0-1 Interval	15.92	15.92	15.49	15.04

Robust Standard Errors in Parentheses
* = Significant at 10%
** = Significant at 5%
*** = Significant at 1%

Table 10-B: Home Computer Use & Family Members

Dependent Variable = '1' if a computer is used at home, '0' otherwise
Linear Probability Model

	(1)	(2)
Family Members Who Have a Computer	0.041*** (0.010)	
Family Members You Meet With Regularly	-0.017*** (0.006)	-0.007 (0.004)
Don't Meet With Family Regularly		0.139 (0.168)
Don't Know About Computer Usage of Family		0.399** (0.185)
1-3 Family Members Have a Computer		0.299*** (0.086)
4-9 Family Members Have a Computer		0.398*** (0.102)
10+ Family Members Have a Computer		0.641*** (0.123)
Constant	0.153 (0.159)	0.072 (0.155)
Individual-/Firm-Level Characteristics	Yes	Yes
City Fixed Effects	Yes	Yes
Product Fixed Effects	Yes	Yes
Caste Fixed Effects	Yes	Yes
Observations	198	216
R-Squared	0.36	0.35
% Predictions Outside 0-1 Interval	10.20	7.08

Robust Standard Errors in Parentheses
* = Significant at 10%
** = Significant at 5%
*** = Significant at 1%

Table 10-C: Home Computer Use & Clients/Suppliers

Dependent Variable = '1' if a computer is used at home, '0' otherwise
Linear Probability Model

	(1)	(2)
Clients/Suppliers who have a computer	-0.005 (0.006)	
(Clients/Suppliers You Meet With Regularly) x 0.01	-0.008 (0.053)	0.013 (0.060)
Don't Meet With Clients/Suppliers Regularly		0.066 (0.117)
Don't Know About Computer Ownership of Clients/Suppliers		-0.029 (0.112)
1-3 Clients/Suppliers Have a Computer		-0.003 (0.117)
4-9 Clients/Suppliers Have a Computer		-0.026 (0.120)
10+ Clients/Suppliers Have a Computer		-0.111 (0.122)
Constant	0.977*** (0.193)	0.923*** (0.176)
Individual-/Firm-Level Characteristics	Yes	Yes
City Fixed Effects	Yes	Yes
Product Fixed Effects	Yes	Yes
Caste Fixed Effects	Yes	Yes
Observations	161	212
R-Squared	0.28	0.26
% Predictions Outside 0-1 Interval	3.40	6.20

Robust Standard Errors in Parentheses
* = Significant at 10%
** = Significant at 5%
*** = Significant at 1%

Table 11: Differences in the Effect of the Competitor Network by Size of Firm

Dependent Variable = '1' if a computer is used at work, '0' otherwise
Linear Probability Model

Competitors Who Have a Computer	0.036***
	(0.012)
Size	0.243***
	(0.071)
(Competitors Who Have a Computer) x Size	-0.032**
	(0.013)
Constant	-0.234*
	(0.124)
Individual-/Firm-Level Characteristics	Yes
City Fixed Effects	Yes
Product Fixed Effects	Yes
Caste Fixed Effects	Yes
Observations	156
R-Squared	0.45

Robust Standard Errors in Parentheses
* = Significant at 10%
** = Significant at 5%
*** = Significant at 1%

Table 12: The Determinants of Computer Adoption

Dependent Variable = '1' if a computer is used at work, '0' otherwise
Logit Estimates, Marginal Effects Reported

	(1)	(2)	(3)
Number of Computer Users Known	0.008**	0.0084**	0.014**
	(0.004)	(0.004)	(0.006)
Education	0.051***	0.048***	0.061**
	0.017	(0.016)	(0.023)
Production Decreased Over Last 5 Years	-0.083	-0.129	-0.197**
	(0.093)	(0.089)	(0.090)
Production Stayed Constant Over Last 5 Years	-0.047	-0.07	-0.185*
	(0.106)	(0.101)	(0.099)
TV Dummy	-0.016	-0.01	-0.043
	(0.103)	(0.104)	(0.132)
Experience in this Business	0.008	0.008	0.014
	(0.006)	(0.006)	(0.049)
Credit Dummy	-0.028	-0.028	-0.049
	(0.055)	(0.056)	(0.080)
Inherited	0.006	-0.006	-0.064
	(0.092)	(0.093)	(0.094)
Total Number of Employees	0.005	0.005	0.006
	(0.003)	(0.003)	(0.003)
Individual-/Firm-Level Characteristics	Yes	Yes	Yes
City Fixed Effects	Yes	Yes	Yes
Product Fixed Effects			Yes
Caste Fixed Effects		Yes	Yes
Observations	107	107	92
Y = Pr (Computer Adoption) *(Predict)*	0.193	0.188	0.214
P-value of Model	0.0001	0.0002	0.0024

Robust Standard Errors in Parentheses
* = Significant at 10%
** = Significant at 5%
*** = Significant at 1%

Table 13: The Network of Clients/Suppliers

Dependent Variable = '1' if a computer is used at work, '0' otherwise
Logit Estimates, Marginal Effects Reported

	(1)	(2)	(3)	(4)
Clients/Suppliers Who Have a Computer	0.016** (0.007)	0.040*** (0.014)		
Clients/Suppliers Who Have a Computer - Squared		-0.0008** (0.0003)		
Clients/Suppliers You Meet With Regularly	-0.00003 (0.0007)	0.0001 (0.0006)	0.0001 (0.0004)	0.0001 (0.0004)
Don't Meet With Any Clients/Suppliers Regularly			0.151 (0.188)	0.150 (0.183)
Don't Know About the Computer Ownership of Any Clients/Suppliers			0.139 (0.169)	0.176 (0.184)
At Least One Client/Supplier Has a Computer			0.301*** (0.116)	
1-3 Clients/Suppliers Have a Computer				0.134 (0.148)
4-9 Clients/Suppliers Have a Computer				0.546*** (0.198)
10+ Clients/Suppliers Have a Computer				0.586 (0.171)
Individual-/Firm-Level Characteristics	Yes	Yes	Yes	Yes
City Fixed Effects	Yes	Yes	Yes	Yes
Product Fixed Effects	Yes	Yes	Yes	Yes
Observations	161	161	212	212
Y = Pr (Computer Adoption) (*Predict*)	0.1664	0.15	0.158	0.148
P-value of Model	0.0002	0.0010	0.0000	0.0000

Robust Standard Errors in Parentheses
* = Significant at 10%
** = Significant at 5%
*** = Significant at 1%

Table 14: The Network of Competitors

Dependent Variable = '1' if a computer is used at work, '0' otherwise
Logit Estimates, Marginal Effects Reported

	(1)	(2)	(3)	(4)	(5)
Competitors Who Have a Computer	0.099* (0.006)	0.021*** (0.007)	0.032** (0.015)		
Competitors Who Have a Computer - Squared			-0.0004 (0.0003)		
Competitors You Meet With Regularly		-0.009*** (0.003)	-0.008*** (0.003)	-0.003* (0.002)	-0.007*** (0.002)
Don't Meet With Any Competitors				0.32 (0.205)	0.259 (0.210)
Don't Know About the Computer Ownership of Competitors				0.613** (0.304)	0.606* (0.354)
At Least One Competitor Has a Computer				0.333*** (0.113)	
1-3 Competitors Have a Computer					0.319* (0.212)
4-9 Competitors Have a Computer					0.624** (0.223)
10+ Competitors Have a Computer					0.892*** (0.066)
Individual-/Firm-Level Characteristics	Yes	Yes	Yes	Yes	Yes
City Fixed Effects	Yes	Yes	Yes	Yes	Yes
Product Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	156	156	156	213	213
Y = Pr (Computer Adoption) (Predict)	0.168	0.090	0.090	0.142	0.113
P-value of Model	0.0000	0.0000	0.0013	0.0000	0.0000

Robust Standard Errors in Parentheses
* = Significant at 10%
** = Significant at 5%
*** = Significant at 1%

Table 15: The Network of Family Members

Dependent Variable = '1' if a computer is used at home, '0' otherwise
Logit Estimates, Marginal Effects Reported

	(1)	(2)	(3)	(4)
Family Members Who Have a Computer	0.033** (0.014)	0.038** (0.016)		
Family Members Who Have a Computer - Squared		-0.0004 (0.0005)		
Family Members You Meet With Regularly	-0.0006 (0.010)	-0.0004 (0.010)	0.006 (0.004)	0.002 (0.003)
Don't Meet With Family Regularly			0.507 (0.230)	0.0489** (0.237)
Don't Know About Computer Usage of Family			0.316 (0.439)	0.327 (0.461)
At Least One Family Member Has a Computer			0.096 (0.076)	
1-3 Family Members Have a Computer				0.030 (0.096)
4-9 Family Members Have a Computer				0.237* (0.137)
10+ Family Members Have a Computer				0.386** (0.192)
Individual-/Firm-Level Characteristics	Yes	Yes	Yes	Yes
City Fixed Effects	Yes	Yes	Yes	Yes
Product Fixed Effects	Yes	Yes	Yes	Yes
Caste Fixed Effects	Yes	Yes	Yes	Yes
Observations	182	182	216	216
Y = Pr (Computer Adoption) (Predict)	0.231	0.224	0.183	0.179
P-value of Model	0.0000	0.0000	0.0000	0.0000

Robust Standard Errors in Parentheses
* = Significant at 10%
** = Significant at 5%
*** = Significant at 1%