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Broadband Divide Among SMEs

The Role of Size, Location and Outsourcing Strategies

ALESSANDRO ARBORE AND ANDREA ORDANINI
Bocconi University, Italy

While the digital gap between large and small firms is a fairly well-known phenomenon, this article focuses on the divide within SMEs. Specifically, the aim is to analyse factors that may explain the differences in broadband adoption among SMEs and to explore their significant interrelations. The investigation relies on a two-step procedure: first, using a tree-based technique, relevant variables and interactions are explored; then, through a binomial logistic regression, their impact on broadband diffusion is estimated and tested. Findings confirm that the relative size of the company (a proxy for firm's internal resources) is still relevant among SMEs; in addition, the geographical area where SMEs are located (environmental resources) can act as a further obstacle especially for the smaller companies of the sample; finally, specific ICT organizational strategies – namely the outsourcing decisions – proved to be an important mitigating factor for size and location-based broadband disadvantages.

KEYWORDS: broadband; digital divide; outsourcing; SMEs

1. External vs. Internal Digital Divide for SMEs

The 'digital divide' between large and small to medium-sized enterprises (SMEs) is a fairly well-known phenomenon, which points out the asymmetry in information and communication technologies (ICT) endowment and use. Just to make an example, at the end of 2002, the percentage of large European firms having a website was 88.5%, while the diffusion among European SMEs was only 63% (Ebusiness-Watch, 2003). Similar gaps have been observed for different ICT variables, like e-commerce or e-procurement activities: for a review, see, among others, Daniel and Grimshaw (2002).

Within these variables, the literature recognizes the adoption of broadband technology as one of the most important, since a broadband connection to the Internet is a main precondition to achieve the benefits of ICT massive adoption (Mehrtens et al., 2001; Prieger, 2003).

The importance of broadband in the business sector is related to the higher potential for data interchange and multimedia applications. This should make

the payoff of ICT investments more evident also for small firms (Sawyer et al., 2003).

While several studies investigated the digital divide between large firms and SMEs, we found no studies exploring the existence of an internal divide *within* SMEs.

It seems reasonable to expect that a digital divide based on broadband access also exists *within* the SME category. In fact, the generally accepted definition of SME, namely a firm with less than 250 employees,[1] hides important variances.

Since the adoption of a broadband connection is a complex decision, which depends on both endogenous and exogenous variables (Prieger, 2003), several factors might explain differences among SMEs: exploring some of these factors and identifying their mutual relationships is the main goal of this study.

The article is structured as follows. In the next section, we introduce some theoretical contributions and considerations on possible explanatory factors of broadband divide among SMEs. In section 3, data information, the analytic framework and a two-step methodology are reported. Section 4 focuses on the first exploratory step, while section 5 moves to the estimate and testing step. The last section contains managerial and policy implications, together with limitations and future research suggestions.

2. Theoretical Background

A recent stream of empirical evidence supports the existence of a broadband divide between SMEs and large firms (for a review see Organisation for Economic Co-operation and Development [OECD], 2002). Considering SMEs as a monolithic reality, however, might be misleading. This group of firms can be extremely heterogeneous and its average values may hide important internal variances.

First of all, the ICT absorptive capacity of an SME, namely its capability to exploit ICT potentials (Cohen and Levinthal, 1990), might vary according to the size of the firm even here, where the absolute values of the sizes are not particularly high (Dandridge, 2000). In addition, some small and medium-sized firms exhibit superior innovative and competitive capabilities, even when compared to large firms, due to their flexibility features (Freel, 2000). This 'flexibility effect' induced by the use of ICT, however, seems to be especially relevant for small firms with specific organizational, managerial and financial structures: in their analysis based on a multi-cases inquiry, Levy and Powell (1998) found that very small firms are less likely to possess changing attitudes, ICT basic skills and long-term perspectives.

Another traditional explaining factor for digital access divide is the lack of environmental resources. In this case we do not only refer to the availability of physical infrastructure, but also that of service providers and partners with expertise. This is a relevant argument suggested by literature on digital divide (Corrocher and Ordanini, 2002). As for every new technology requiring network investments, its diffusion will be initially driven by density of geographical areas (Arthur, 1994; Berry, 1992): this situation is different from the first wave of

Internet diffusion, when access largely happened through fixed telephony dial-up (Prieger, 2003). The lack of favourable environmental conditions risks enlarging rather than reducing the existing digital divide (Grubesic and Murray, 2002). Indeed, a poor location might be especially penalizing for very small firms, with less internal resources and a higher overlap between business environment and local environment. On the other hand, location may not be so relevant for bigger SMEs, whose internal resources and business network could overcome the influence of local specificities for the issue in point. This idea is confirmed by our results.

A third element, which received less consideration as a potential source of divide, is the organizational choice to internalize rather than to outsource part or the entire set of ICT activities.

ICT outsourcing can be defined as 'the significant contribution by external vendors in the physical and/or human resources associated with the entire or specific components of the ICT infrastructure in the user organization' (Loh and Venkatram, 1992). ICT outsourcing decisions are not usually considered as an explaining factor for digital divide, while they seem to play an important role when restricting the analysis to small and medium enterprises.

ICT outsourcing may become a shortcut to digitalization, since SMEs may hardly justify the cost of hiring ICT specialists or offering in-house training. Furthermore, outsourcing avoids the problem of owning small servers, which cannot support data centre functions, while it forces a stronger involvement in communication networks. From this point of view, one of the most important changes today is the rapid growth of partial outsourcing practices, which are more flexible forms of technological integration particularly suitable for SMEs' needs (Yang and Huang, 2000).

Combining internal knowledge with external outsourced technologies, SMEs may have access to an inter-organizational process of knowledge creation that, if well organized, effectively allows exploiting ICT potential, at least for a certain period of time. In this sense, we are persuaded that ICT outsourcing may become an external way to facilitate the adoption of new technologies especially for firms facing internal and environmental constraints.

Summing up, size, location and outsourcing strategies are expected to explain part of the broadband divide among SMEs, but according to a peculiar pattern of relationships.

3. Methodology

In trying to identify the factors that can help explain a divide in broadband adoption within SMEs, the review of related literature confirms the theoretical relevance of the size of a firm, of its location, and of its organizational inclinations. Moreover, by looking at these constructs, we expressed our persuasion that interactions between them may assume a key role in the model. The location in a small area, for example, may be a problem for a very small firm, since it would have both few resources inside and few resources and spurs from its local environment. Yet, probably, it would not be a problem for medium enterprises,

having already inside them all necessary resources and motivations to adopt connections. All in all, while we look for a confirmation of the importance of these factors to explain the broadband divide between SMEs – namely the size of a firm, its location and its outsourcing strategy – we also hypothesize that relevant interaction-effects exist among them.

To investigate such effects, the study adopts a two-step procedure: we used, first, a tree-based methodology to explore significant cross-relations (section 4); then, through a binomial logistic regression, the relation between broadband diffusion among SMEs and our explanatory factors was estimated and tested (section 5). The use of two different techniques provides between-method triangulation in the effort to corroborate our results (Denzin, 1978).

A two-step procedure, in fact, allows combining relative advantages of the tree-analysis with those of the regression techniques. Mainly, since regression analysis encounters difficulties when interaction, non-linear effects, and causal priorities are encountered in the data (Armstrong and Andress, 1970), a regression model built after a tree-based analysis may benefit from a more precise definition of variables and interactions, as required by our study.

Before moving to these steps, the analytic framework and the dataset that we used are introduced.

3.1. Analytic framework

Discrepancy in the adoption of broadband among SMEs is the primary focus of the analysis. The article already noted how broadband access should be considered an essential point when debating on firms' digital divide. A dichotomous variable – indicating whether an SME is connected online through a narrow or broadband connection – is the dependent variable of our analyses. Firms with no Internet connections are not considered. Analogue dial-up connections (up to 56 kbps) and ISDN connections (up to 128 kbps) are considered as narrowband. Higher transmission rates, typically starting with 256 kbps ADSL connections, are considered as broadband (see among others OECD, 2002).

For the purpose of this study the definition of SMEs is based on the number of employees of a firm. Specifically, in accordance with the EU guidelines, SMEs include all the enterprises having less than 250 employees.[2]

Consistently, the dimension of the firm – introduced here as one of the main explanatory variables – is measured in terms of employees. Since we are trying to explain a divide in broadband adoption, our hypothesis is that dimension, also within SMEs, is a relevant factor. As stated in the previous section, it may be reasonable to assume that smaller firms enjoy fewer resources, both tangible (i.e. financial) and intangible (managerial competencies in particular). Lower resources, then, would result in higher barriers for the adoption of a broadband connection: broadband connection would not be recognized as a gateway for major competitive advantages.

Other than dimension, the location of a firm – reflecting environmental conditions, or context – has been found to impact greatly on technological adoption as well as innovation. In our study, the operationalization of this construct has been made by looking at the size of the town where the firm is

located. The size of the town has been measured in terms of population and classified into the following categories: (1) cities with less than 5000 inhabitants; (2) cities with a number of inhabitants equal to or higher than 5000 but lower than 30,000; (3) cities with a number of inhabitants equal to or higher than 30,000 but lower than 100,000; (4) cities with 100,000 inhabitants or more.

By following the background literature we hypothesize, with some caveats, that firm location in a smaller town results in poorer environmental resources and weaker spurs to adopt a broadband connection (i.e. lack of specialized services such as consultants or information technology providers, or latest technologies at unaffordable conditions). The caveat refers to the fact that a 'rural' location might have a greater impact for very small firms, with less internal resources and a higher overlap between business environment and local environment. Conversely, for bigger firms such a location may be less relevant, since internal resources and business network would overcome the influence of local specificities.

Another important factor that the analysis considers as critical is the ICT outsourcing strategy of the firm. The outsourcing variable is codified to indicate if a firm is outsourcing part of its ICT activities, all of them, or none of them. The hypothesis is that outsourcing may act as a corrector of broadband gap where size and location generate obstacles to adoption – obstacles in terms of available resources, internal and environmental respectively. In these cases, the integration of firms' resources with those of specialized players – viz. using outsourcing – would allow overcoming barriers from size and location. In our hypothesis, failing in doing so would highly increase the probability of broadband non-adoption.

Finally, the industry – a variable explored in the first step – was codified into the following categories: (1) food and textile; (2) mechanics and electronics; (3) iron and still and chemical; (4) transportation, communication and finance; (5) trade; (6) other services.

3.2. The Data

The analysis relies on a database constructed through a survey that was carried out using a computer-assisted telephone interview (CATI) methodology. It is based on a survey in a sample of 920 SMEs located in Italy, where SMEs are at the heart of the economic development. A specific questionnaire was submitted to a random stratified sample of SMEs. It is a representative sample of an area having high internal variety in terms of firms' dimensions, fields of activity, and demographics. The interviews were conducted between June and July 2003, where the respondent could be either the CEO or the person in charge for ICT. The sample is stratified to ensure that firms from different groups of industries, in different geographic locations, and within different dimensional classes (in terms of employees) are appropriately represented. This ensures that our sample has no relevant bias toward the represented population.

The questionnaire adopted for the analysis is reported in the Appendix. The resulting instrument was pilot tested through face-to-face interviews with 15 CEOs of SMEs, to ensure that the wording was understandable and the length was appropriate. The final version was modified accordingly.

4. Exploratory Analysis: Statistical Technique and Outcomes

As said, in its first step, the analysis is designed to explore relevant interactions between the variables reviewed. To that purpose, the study relies on a tree-based model. Specifically, the algorithm we used is *treedisc*, the macro written by the SAS (Statistical Analysis System) Institute. In addition to that, other tree procedures and software were used in order to assess the robustness of the technique.

Classification trees are dependence techniques especially suitable to explore interactions among the explanatory variables of a categorical dependent variable. It must be underlined that, in our study, we did not use *treedisc* to identify the independent variables, whose relevance was hypothesized *ex ante* from theoretical reasoning.

The use of tree procedures in exploring relevant interactions was suggested by their effectiveness in detecting non-additive behaviours, by their ability to accommodate non-linearity, and by their easy interpretability. Finally, like many nonparametric methods based on ranks, trees are robust to outlier observations in the sample (Yee, 2003).[3]

The target variable in the tree model was the dummy 'connection', as already defined ('narrow' vs 'broad'). The selected splitting criterion was the adjusted chi-squared test of independence in the cross-tabulation of an explanatory and dependent variable, as in CHAID (Chi-squared Automatic Interaction Detector; Hartigan, 1975; Kass, 1980).[4] To double-check the robustness of this choice, the other splitting criteria offered by SAS were also used, namely the Entropy Reduction and the Gini reduction: in all the cases, same results were produced.[5] In the study, the significance level of the test was set at 5%.

An interesting characteristic of *treedisc* is the possibility of using ordinal independent variables (pure CHAID is restricted to discrete): this allows reducing some arbitrariness of the researcher in defining the classes of a variable. In this regard, the size of a firm was introduced in the model as ordinal, leaving to the methodology – eventually – the assessment of a relevant splitting point. For analogous reasons, we left the variable 'location' fragmented into four classes, leaving their eventual aggregation to the dependence technique. Similarly, 'total outsourcing' and 'partial outsourcing' were not categorized together *ex ante*, since trees may be sensitive to these kinds of decisions: for neutrality of the investigation, combinations were left to the statistical procedure.

Finally, in the attempt to corroborate the insights produced by this first step of our analysis, we used within-method triangulation (Denzin, 1978). Accordingly, we run the tree model using pure CHAID on SPSS Answer Tree (v.2) and CART (v.5.0 by Salford System), obtaining in both the cases analogous results.

4.1. Results: The Insights for Step Two

Figure 1 contains the main outcome of our tree-based exploratory analysis.

On average in our sample 57.7% of SMEs employ a broadband connection, while the remaining 42.3% do not: it means that nearly half of these SMEs suffer

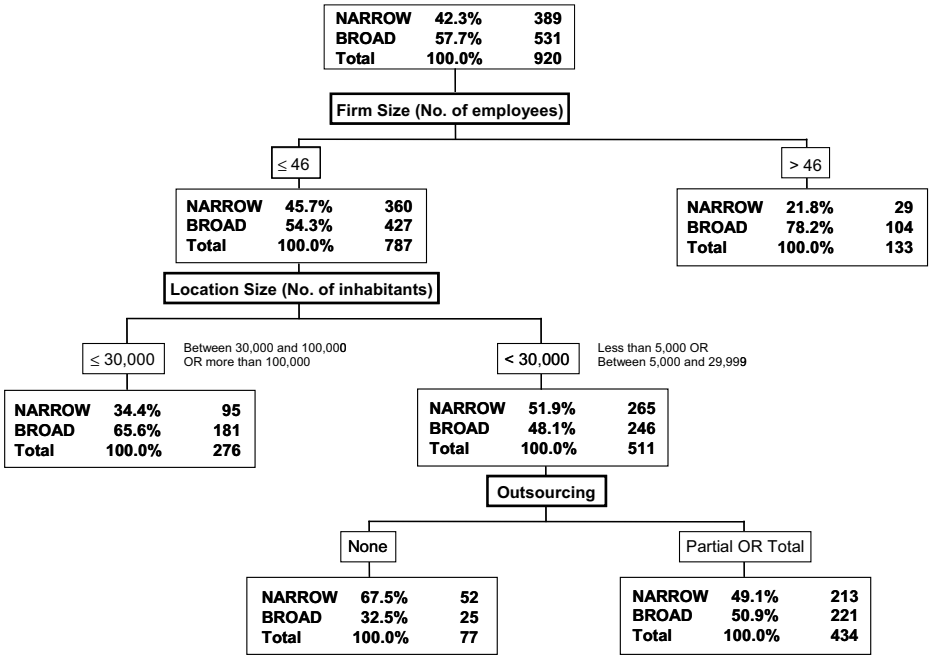

Figure 1. Broadband Adoption Among SMEs: The Role of Size, Location and Outsourcing Strategies (n = 920)

from a divide in the Internet access. This is consistent with the latest statistics on broadband adoption in Europe at the end of 2004 (55%, according to Eurostat). The picture reflects a situation where, although broadband infrastructure is now available almost for any kind of firm in any location, its rate of adoption is still relatively low. This suggests that the topic of broadband adoption by SMEs may reveal timely relevance and long-term implications.

But what features are able to characterize these laggard firms? In the picture, the average value of broadband adoption has been broken down according to the discriminating variables identified.

First of all, the primary role of size seems to be confirmed, even within the SMEs category. The percentage of broadband use shifts to 78.2% for relatively larger firms (more than 46 employees), while it falls down to 54.3% for very small ones. The methodology adopted suggests that, approximately, a discriminating level of 50 employees would be the best threshold to predict broadband divide in our sample: note that this situation affects 86% of cases in our dataset (787 firms). Such a discriminating level will be adopted for step two, the regression analysis (see next section).

Looking at the tree, 'size' appears as the first node in the hierarchical root, meaning that it is more powerful than the other variables in discriminating for broadband adoption.

The next node considered in the tree refers to the size of the local area where

firms are located. Notably, this appears to be relevant only for the group of smaller firms.

This would reaffirm that, for smaller SMEs, the fact of being located in a more or less populated area is a further element of divide: very small businesses which operate in geographical areas with more than 30,000 inhabitants still exhibit a broadband diffusion of 65.6%, almost 10% higher than the sample average. On the other hand, broadband connections drop down to 48% when very small firms are located in smaller areas.

For bigger SMEs, on the other hand, the location does not appear to be as relevant, which seems to confirm our considerations: tangible and intangible internal resources, in this case, may be able to overcome the environmental limits of a small area.

Outsourcing choices enter the model as the third level of the tree and they provide a correction for the cluster of laggard firms emerging in the previous steps of the analysis. In fact, for very small firms located in 'rural' areas, outsourcing decisions split the group into two: smaller firms in smaller areas that externalize some or all ICT activities show a higher diffusion of broadband adoption (50.9%), while those managing ICTs internally suffer a huge digital gap (32.5%).

Considering that, in our sample, the total number of SMEs using outsourcing is 466, the analysis reveals that this strategy belongs almost exclusively (93%) to very small firms located in small areas. This last finding is particularly interesting, since it suggests how a strategic choice of the managers may partially compensate the gap in broadband adoption related to firm's size and location: in this case, outsourcing mitigates the lack of technical expertise and external support. By the same token, outsourcing might also help in situations where, although the broadband is available in the area, a firm chooses a narrowband connection, since this decision is reasonably motivated by the same reasons just explained.

In a nutshell, we found that:

- Firms' size is the primary discriminating factor even among SMEs: companies with less than approximately 50 employees suffer from a broadband divide;
- Especially within these smaller companies, a poor location further hampers the adoption of broadband: being located in an area with less than 30,000 inhabitants aggravates the gap;
- ICT outsourcing strategies may act as a mitigating factor of this divide: partial or total outsourcing of ICT activities reduces the negative effects of small size and rural location.

5. Regression Analysis and Final Results

After a theory-driven validation of the tree model, we moved, then, to the second step of our analysis, in which a logistic regression model was refined and employed to finally test our model.

The analysis estimates the probability that an SME in the sample would have a broadband connection to the Internet. Specifically, given the theoretical

considerations made in the previous sections and the insights provided by the tree analysis, our model hypothesizes the following relations:

$$\ln\left(\frac{\text{BROAD}_i}{1-\text{BROAD}_i}\right) = \beta_0 + \beta_1 \ln \text{SIZE}_I + \beta_2\left(\text{RURAL}_i \times \text{SMALL}_i\right) + \beta_3\left(\text{OUTSOURC}_i \times \text{SMALL}_i \times \text{RURAL}_i\right) + \varepsilon_1$$

Where BROAD_i is a dichotomous variable that equals 1 when the Internet connection of the *i*th SME is broadband, 0 otherwise. The ratio BROAD_i / (1 – BROAD_i) is the odds of having a firm with a broadband connection. The expected value of BROAD_i is the probability that the *i*th firm has a broadband connection;

SIZE_i is the number of employees of the *i*th SME. Since the impact of SIZE is expected to affect the dependent variable at decreasing rates, SIZE is introduced into the model in a natural log form.

RURAL_i is a dichotomous variable that equals 1 when the *i*th SME is located in an area with no more than 30,000 inhabitants, 0 otherwise. The threshold of 30,000 inhabitants was suggested by the tree procedure;

SMALL_i is a dichotomous variable that equals 1 when the *i*th firm is a smaller SME, meaning a firm with less than 50 employees, 0 otherwise. A discriminating level of approximately 50 employees was suggested by the tree procedure;

OUTSOURC_i is a dichotomous variable that equals 1 for SMEs that adopt either partial or total outsourcing for their ICT activities. The aggregation of partial and total outsourcing strategies was suggested by the tree procedure.

5.1. Outcomes

The parameters in the logistic regression model are estimated by using Maximum Likelihood:

$$\widehat{\ln\left(\frac{\text{BROAD}_i}{1-\text{BROAD}_i}\right)} = -0.951 + 0.517 \ln \text{SIZE}_i - 1.366\left(\text{RURAL}_i \times \text{SMALL}_i\right) + 0.793\left(\text{OUTSOURC}_i \times \text{SMALL}_i \times \text{RURAL}_i\right)$$

n = 842 (SMEs) $R_P^2 = 0.615$ Cox & Snell $R^2 = 0.08$ Iterations = 4

That is:

$$\hat{\text{BROAD}}_i = \frac{1}{1+e^{-[-0.951+0.517\ln \text{SIZE}_i - 1.366(\text{RURAL}_i \times \text{SMALL}_i)+0.793(\text{OUTSOURC}_i \times \text{SMALL}_i \times \text{RURAL}_i)]}}$$

where $\hat{\text{BROAD}}_i$ is the predicted probability for the *i*th firm to have a broadband connection on the basis of its size, of its being a small firm in a rural area or not, and – for small firms in rural areas – on the basis of its use of outsourcing for ICT activities.

A test of the full model versus a model with intercept only was statistically significant, $\chi^2(3, N = 842) = 67.55$, $p < .001$. The model is able to correctly classify 70% of the SMEs in the sample with a broadband connection and 51% of those using narrowband, for an overall success rate of 61.5%.

Table 1. Logistic Regression Summary Output

Independent Variables	*b*	*S.E.*	*Wald* χ^2	*p value*	e^b
LN_SIZE***	0.517	0.122	17.998	< 0.001	1.678
RURAL by SMALL***	–1.366	0.283	23.206	< 0.001	0.255
OUTSOURC by RURAL by SMALL***	0.793	0.275	8.296	0.004	2.209
Constant term**	–0.951	0.407	5.448	0.020	0.386

Notes: *** Indicates statistical significance at the 0.01 level and ** at the 0.05 level (two tailed).

Table 1 shows the logistic regression coefficient, standard error, Wald statistics, *p*-value and odds ratio for each of the predictors. All the parameter estimates are statistically significant at the 0.05 level.

Raising the natural base *e* to the power of each estimated parameter, the last column of Table 1 reports the odds ratio of each independent variable under the hypothesis of keeping constant all the other variables in the model.

The odds ratio for the natural log of SIZE indicates that, for every 1% increase in the firm's size, the odds of having a firm with a broadband connection increases – on average – by 1.68 times (hp.1).

The result for the interaction term RURAL × SMALL shows that the odds of having a broadband connection among smaller SMEs (less than 50 employees) in smaller locations (less than 30,000 inhabitants) are, on average, only 0.25 times those of any other SME: that is, the odds decrease by 75% (hp.2).

On the other hand, the odds ratio for the interaction term OUTSOURC × RURAL × SMALL suggests that the use of outsourcing by smaller SMEs in smaller locations increases by 2.2 times the odds of having a broadband connection. Notably, compared to other smaller SMEs in smaller locations, those using outsourcing are approximately 9 times more likely to have a broadband connection (2.2/0.25 or $e^{\Delta_{b3}^{b2}}$) (hp.3).

In conclusion, all the explanatory variables introduced in the model have a significant partial effect consistent with our hypotheses.

In conclusion, findings reveal the existence of a peculiar nexus of relationships between broadband diffusion and some of these factors. First, the relative size of the firm still remains the main explanatory factor even within SMEs, although at decreasing rates. At the same time, the geographical area where SMEs are located, namely their 'environmental resources', acts as a further obstacle only for smallest companies. Further, ICT organizational strategies, particularly ICT outsourcing decisions, act as important 'correctors' of size and location-based broadband disadvantages, suggesting further attention to SMEs' managerial behaviours.

6. Implications and Future Research

Our analysis had the purpose to investigate some explanatory factors of broadband gap within SMEs. Currently, the theme is particularly relevant since the real rate of broadband adoption among SMEs is still much lower than expected. In

2001 the European Commission predicted a rate of broadband adoption among firms of 70–75% by 2005, while the actual number is 55% (Eurostat, 2005). Even within the most developed countries, like Finland and USA, these percentages reach, respectively, 63% and 68% (Small Business Advocacy [SBA], 2004). Our findings reveal the existence of a relevant access divide among SMEs, but – more important – suggest that, while broadband availability is negligible as an external source of digital divide, broadband adoption is relevant, and it is also a matter of a firm's resources and decisions. This leads to managerial and policy implications.

The main implication for managers is that they can be responsible for their digital gap even when it originates from exogenous variables. The choice to outsource some ICT activities to specialized providers becomes extremely important, since it allows digital inclusion of otherwise excluded firms. An outsourcing strategy can be profitably employed to face structural weaknesses (size) or environmental scarcity (rural areas), integrating SMEs processes in virtual networks governed by technology providers. Since the financial cost of this integration does not appear particularly burdensome, the main barrier can be the cultural approach of SMEs' management toward innovation (Thong and Yap, 1995): changing this attitude might reduce the size of digital gap in general, and broadband gap in particular.

By the same token, the analysis reveals the potential of smaller firms in rural areas as an uncovered target market for ICT providers, whose attention has been traditionally dedicated to larger firms and to more developed geographical clusters (Loh and Venkatram, 1992). In this way, ICT companies might focus on satisfying resource-seeking strategies of small firms, rather than providing cost-saving solution for large companies, catching up new market opportunities.

Further consideration for managers of small companies is that quality and quantity of their internal resources (know-how, financial capital) may overcome the gap of being located in a less-developed area: SMEs' internal traits appear more important than environmental resources in determining the digital divide.

The analysis may have policy implications as well. The vast majority of national and local policies on broadband were supply-driven, in terms of ensuring infrastructure availability and promoting competition among ICT carriers. Outcomes of our analysis suggest a shifting perspective for policy actions on broadband, paying more attention to demand issues, especially in the SME segment (OECD, 2003).

When network infrastructures are relatively available and some business strategies may partially overcome their eventual lack, the attention of policy actions should rebalance on the demand side, creating an appropriate structure of incentives for adoption in the less-developed segments of demand (Ricci, 2000). In this way, when the most relevant barrier to new technology adoption for SMEs seems to be of cultural/managerial nature, even the focus on financial instruments to stimulate the demand should be partially reconsidered, and the attention might shift to real services, training and support (OECD, 2003).

From a theoretical point of view, the analysis may provide an original contribution to the debate on information technology adoption processes (for a review of the main models see Riemschneider et al., 2003). Specifically, our approach

suggests a different perspective on the interactions between endogenous and exogenous elements affecting the technology acceptance phenomenon. The role of ICT outsourcing strategies, for example, is a relatively understated variable in the literature, while our results suggest reconsidering its role in mitigating the impact of traditional exogenous variables. Following this exploratory finding, further research on the role of ICT outsourcing should be encouraged in order to improve the understanding of such a complex phenomenon.

The analysis obviously has some limitations. First, usual caveats on causality of cross-sectional analyses have to be applied. Then, the analysis is focused on a basic measure of digital divide. Future studies might complete the picture by looking, for instance, at more sophisticated Internet business applications, like Customer Relationship Marketing (CRM) and Enterprise Resource Planning (ERP), as well as by extending the analysis to different samples. In particular, given the contingency nature of the analysis, generalization of the findings should be made carefully across different geographical contexts, due to the peculiar features of the Italian system of small and medium-sized enterprises (aggregation in clusters, high specialization on traditional industries).

Finally, some fitting measures of the analysis are not completely satisfactory, particularly in the regression analysis. This may suggest the existence of explanatory factors other than those considered in this article or suggested by the existing literature. Further speculation, enlarged datasets and continuous exploration might certainly enrich the contribution of this study.

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Notes

1. This parameter, together with turnover and assets criteria, defines the status of an SME by EU Commission (Commission Recommendation of 3 April 1996 concerning the definition of Small and Medium-sized enterprises [SMEs]), OJ L 107 of 30.4.1996, p. 4).
2. See note 1.
3. Despite the advantages of tree-based models for the specific purposes of this study, their main limitation is the risk of overfitting and subsequent instability. Overfitting may occur when a tree-algorithm identifies too many relevant variables: likely, in this case, the tree will reflect too closely its generating sample – including its random noise – and will hardly generalize to a different sample. From this point of view, CHAID uses some heuristic procedures in the attempt to stop growing the tree before overfitting occurs. *Treedisc*, in particular, stops growing the tree when new leaves, even if significant, do not increase the estimated predictive accuracy of the model (lift). More important, however, the risk of overfitting in our model should be reduced by our pre-selection of the relevant variables, as hypothesized in the previous sections; this is associated with the use of a fairly conservative level of significance, which is 5%, as already reported.
4. *Treedisc*, as with CHAID, uses a Bonferroni adjustment for the *p*-values computed from these cross-tabulations, which is conditional on the number of branches in the partition.

In addition to the Bonferroni adjustment, %TREEDISC uses Gabriel's adjustment to increase the power for multiple comparisons in a contingency table as suggested by Hawkins & Kass (1982) (SAS document, p. 3, available online at URL [consulted February 2003]: http://www.stat.lsu.edu/faculty/moser/exst7037/treedisc.pdf). According to SAS, this precaution makes their procedure more effective at obtaining small *p*-values.

5. The maximum number of subsets in a partition (i.e. the branches from a node) was set to two, in order to generate a binary tree, as in CART (Breiman et al., 1984). (Given our sample size, binary splits are to be preferred because multiway splits would fragment the dataset too quickly, risking leaving too little data at the next level down. Since multiway splits can still be achieved by a sequence of binary splits, the latter was chosen). We required a minimum number of 50 observations in each leaf, and 100 observations for a split search. To check the robustness of this choice (suggested, for instance, in Haughton and Oulabi, 1993), we run the same model with a minimum number of 30 observations in each leaf, and 60 observations for a split search: also in this case the results were identical.

References

Armstrong, J. S. and Andress, J. G. (1970) 'Exploratory Analysis of Marketing Data: Trees vs. Regression', *Journal of Marketing Research* 7: 487–92.

Arthur, B. (1994) *Increasing Returns and Path Dependence in the Economy*. Ann Arbor: University of Michigan Press.

Berry, S. T. (1992) 'Estimation of a Model Entry in the Airline Industry', *Econometrica* 60(4): 889–917.

Breiman, L., Friedman, J. H., Olshen, R. A. and Stone, C. J. (1984) *Classification and Regression Trees*. Belmont, CA: Wadsworth.

Cohen, W. M. and Levinthal, D. A. (1990) 'Absorptive Capacity: A New Perspective on Learning and Innovation', *Administrative Science Quarterly* 35(1): 128–52.

Corrocher, N. and Ordanini, A. (2002) 'Measuring the Digital Divide: A Framework for the Analysis of Cross-countries Differences', *Journal of Information Technology* 17(1): 9–19.

Dandridge, T. (2000) 'High-tech Potential?: An Exploratory Study of Very Small Firms' Usage of the Internet', *International Small Business Journal* 18(2): 81–91.

Daniel, E. M. and Grimshaw, D. J. (2002) 'An Exploratory Comparison of Electronic Commerce Adoption in Large and Small Enterprises', *Journal of Information Technology* 17(3): 133–47.

Denzin, N. K. (1978) *The Research Act*. New York: McGraw-Hill.

Ebusiness-Watch (2003) 'The European e-Business Report', European Commission, Enterprise Directorate General.

Eurostat (2005) *Eurobarometer Database*. Brussels: European Commission.

Freel, M. S. (2000) 'Barriers to Product Innovation in Small Manufacturing Firms', *International Small Business Journal* 18(2): 60–80.

Grubesic, T. H. and Murray, A. T. (2002) 'Constructing the Divide: Spatial Disparities in Broadband Access', *Papers in Regional Sciences* 81(2): 197–221.

Hartigan, J. A. (1975) *Clustering Algorithms*. New York: Wiley.

Haughton, D. and Oulabi, S. (1993) 'Direct Marketing Modeling with CART and CHAID', *Journal of Direct Marketing* 7(3): 16–26.

Hawkins, D. M. and Kass, G. V. (1982) Automatic Interaction Detection, in D. M. Hawkins (ed.) *Topics in Applied Multivariate Analysis*, pp. 267–302. Cambridge: Cambridge University Press.

Kass, G. V. (1980) 'An Exploratory Technique for Investigating Large Quantities of Categorical Data', *Applied Statistics* 29(2): 119–27.
Levy, M. and Powell, P. (1998) 'SME Flexibility and the Role of Information Systems', *Journal of Small Business Economics* 11(2): 183–96 .
Loh, L. and Venkatram, N. (1992) 'Determinants of Information Technology Outsourcing: A Cross-sectional Analysis', *Journal of Management Information Systems* 9(1): 7–24.
Mehrtens, J., Cragg, P. B. and Mills, A. M. (2001) 'A Model of Internet Adoption by SMEs', *Information and Management* 39(3): 165–76.
Organisation for Economic Co-operation and Development (2002) 'Broadband Access For Business', Working Paper JT00136306, OECD.
Organisation for Economic Co-operation and Development (2003) 'Broadband Driving Growth: Policy Responses', Working Paper JT00151116, OECD.
Organisation for Economic Co-operation and Development, UN, World Bank (2003) *Global Forum on the Knowledge Economy*: *Integrating ICT in Development Programmes*. Paris: OECD Press.
Prieger, J. E. (2003) 'The Supply Side of the Digital Divide: Is there Equal Availability in the Broadband Internet Access Market?', *Economic Inquiry* 41(2): 346–63
Ricci, A. (2000) 'Measuring Information Society: Dynamics of European Data on Usage of Information and Communication Technologies in Europe since 1995', *Telematics and Informatics* 17(1–2): 141–67.
Riemenschneider, C. K., Harrison, D. A. and Mykytn, P. P., Jr (2003) 'Understanding IT Adoption Decisions in Small Business: Integrating Current Theories', *Information & Management* 40(4): 269–85.
Sawyer, S., Allen J. P. and Lee, H. (2003) 'Broadband and Mobile Opportunities: A Socio-technical Perspective', *Journal of Information Technology* 18(2): 121–36.
Small Business Advocacy (SBA) (2004) *A Survey of Small Business' Telecommunications Use and Spending*. Washington, DC: US Government.
Thong, J. and Yap, C. S. (1995) 'CEO Characteristics, Organizational Characteristics and Information Technology Adoption in Small Businesses', *Omega* 23(4): 429–42.
Yang, C. and Huang, J. B. (2000) 'A Decision Model for IS Outsourcing', *International Journal of Information Management* 20(3): 225–39.
Yee, T. W. (2003) 'Classfication and Regression Trees', Notes for STATS301, Statistics Department, University of Auckland, New Zealand.

ALESSANDRO ARBORE is Assistant Professor of Management and Business Administration at Bocconi University and Assistant Professor of Marketing at SDA Bocconi, Bocconi University Graduate School of Management. Please address correspondence to: IEGI, Bocconi University, Via Bocconi, 8, 20136 – MILAN, Italy. [email: alessandro.arbore@sdabocconi.it]

ANDREA ORDANINI is Associate Professor of Management and Business Administration at Bocconi University. He is co-director of I-LAB (Centre for Research on Digital Economy) at the same University. Please address correspondence to: IEGI, Bocconi University, Viale Filippetti, 9, 20122 – MILAN, Italy. [email: andrea.ordanini@unibocconi.it]

Appendix. The Questionnaire

1. *Does your firm have an Internet access?*
   - ❑ Yes
   - ❑ No => EXIT

2. *What kind of connection do you have?*
   - ❑ narrowband, namely through 56 kbps dial up modem or ISDN (up to 128 kbps)
   - ❑ broadband, like ADSL or other connections faster than 256 kbps

3. *Concerning ICT and information system management, do you adopt outsourcing strategies?*
   - ❑ Yes, outsourcing regards all ICT activities
   - ❑ Yes, we partially outsource ICT activities
   - ❑ No, ICT and information system are managed within the firm

4. *How many employees work in your firm?* _____

5. *Your firm is located into a geographical area with:*
   - ❑ less than 5,000 inhabitants
   - ❑ a number of inhabitants equal to or higher than 5,000 but lower than 30,000
   - ❑ a number of inhabitants equal to or higher than 30,000 but lower than 100,000
   - ❑ 100,000 inhabitants or more

6. *In which industry does your firm operate?*
   - ❑ Food and textile
   - ❑ Mechanics and electronics
   - ❑ Iron and steel and chemical
   - ❑ Transportation, communication and finance
   - ❑ Trade
   - ❑ Other services

International Small Business Journal 24(1)

La large bande et les divisions entre les PME

Le rôle des stratégies de taille, d'emplacement et d'externalisation

Alessandro Arbore et Andrea Ordanini
Bocconi University, Italie

Bien que le fossé numérique entre les grandes et les petites entreprises soit un phénomène relativement bien connu, notre article met l'accent sur les divergences existant au sein des PME. En fait, il a pour objectif d'analyser les facteurs susceptibles d'expliquer le pourquoi des différences attitudes qu'affichent les PME en matière de large bande, et d'en étudier les rapports essentiels. Cette étude fait appel à une procédure à deux phases: d'abord, elle s'appuie sur une méthode arborescente pour examiner les variables et interactions applicables ; puis, à partir d'une analyse de régression logistique, elle en calcule et vérifie l'impact sur la diffusion de la large bande. Les résultats obtenus confirment que la relativité de la taille de la société (une représentation des ressources internes de l'entreprise) est un facteur également important chez les PME. Par ailleurs, l'emplacement géographique où sont implantées les PME (ressources environnementales) peut constituer un obstacle supplémentaire, surtout pour les plus petites entreprises de l'échantillon. Et, pour finir, il s'est avéré que les stratégies inhérentes aux organisations TIC – à savoir notamment les décisions d'externalisation – représentent un facteur modérateur de poids en ce qui concerne les inconvénients de taille et d'emplacement normalement associés à la large bande.

Mots clés: large bande; fossé numérique; externalisation; PME

La banda ancha y la línea divisoria entre las PYME

El papel de las estrategias de tamaño, emplazamiento y aprovisionamiento en fuentes externas

Alessandro Arbore y Andrea Ordanini
Universidad Bocconi, Italia

Aunque la brecha digital entre las grandes y pequeñas empresas es un fenómeno bastante conocido, este artículo se centra en las divergencias dentro de las PYME. El objetivo en concreto es analizar los factores que explican las diferencias en la adopción de la red de banda ancha entre las PYME. y estudiar sus interrelaciones significativas. La investigación se basa en un procedimiento en dos fases que emplea primero una técnica de estructura arbórea para explorar las variables e interacciones aplicables; y a continuación, por medio de una regresión logística binomial, calcula y comprueba su impacto sobre la difusión de la banda ancha. Los resultados confirman que el tamaño relativo de la empresa (una representación de los recursos internos de la firma) también tiene importancia entre las PYME. Además, la región geográfica en que están situadas las PYME (recursos ambientales) puede constituir un obstáculo, especialmente para las empresas más pequeñas de la muestra. Por último, las estrategias específicas de organización ICT, es decir, las decisiones de aprovisionamiento en fuentes externas, resultaron ser un importante atenuante de las desventajas basadas en el tamaño y emplazamiento de la red de banda ancha.

Palabras clave: banda ancha; brecha digital; aprovisionamiento en fuentes externas; PYME

Die Broadband-Kluft unter Klein- und mittelständischen Betrieben

Die Rolle der Größe, des Standorts und der Outsourcing-Strategien

Alessandro Arbore und Andrea Ordanini
Bocconi-Universität, Italien

Die „digitale Kluft" zwischen großen Konzernen und kleinen Unternehmen ist ein wohlbekanntes Phänomen. Dieser Beitrag jedoch konzentriert sich auf die Kluft unter Klein- und mittelständischen Betrieben. Ganz spezifisch liegt das Ziel darin, die Faktoren, die möglicherweise die Unterschiede bei der Einführung des Broadband in Klein- und mittelständischen Betrieben erläutern können, zu analysieren und deren erhebliche wechselseitige Beziehungen zu untersuchen. Die Untersuchung stützt sich auf eine zweistufige Vorgehensweise: Erstens werden unter Einsatz einer Baummethode relevante Variablen und Wechselwirkungen untersucht. Dann wird anhand einer binomischen logistischen Regression deren Auswirkung auf die Broadband-Verbreitung geschätzt und geprüft. Die Ergebnisse bestätigen, dass die relative Größe des Unternehmens (stellvertretend für die internen Ressourcen eines Unternehmens) auch bei Klein- und mittelständischen Betrieben von Relevanz ist. Zusätzlich kann der Standort, an dem Klein- und mittelständische Betriebe angesiedelt sind (Umweltressourcen), ein weiteres Hindernis darstellen, insbesondere für die kleineren Unternehmen dieser Stichprobe. Zuletzt erwiesen sich spezifische organisatorische ICT-Strategien – nämlich Entscheidungen des Outsourcing – als ein erheblich mildernder Faktor für größen- und standortbezogene Broadband-Nachteile.

Schlagwörter: Broadband; digitale Kluft; Outsourcing; Klein- und mittelständische Betriebe