

Does only size matter in the use of knowledge intensive services?

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Abstract Knowledge intensive services (KIS) have a key role in the creation and commercialisation of new products, processes and services. They are fundamental as carriers and creators of both technological and organisational innovation. Furthermore, the availability to firms of KIS in their surroundings positively affects their ability to innovate and contribute to the regional development. Nevertheless, a little is known about the factors that explain, why some firms use these services (technological advice, applied research, strategic consultancy, engineering, etc.) more frequently than other firms. This article, reporting from a database of more than 2,000 firms and with the use of binary models, analyses the factors that explain the use of KIS by small and medium-sized firms. Specifically, the services supplied by technological centres with the purpose of improving regional innovative potential are examined. The results show, in a similar way to the most consistent conclusions of the available studies, that

demand for services increases with the size of the user firms. Spatial proximity between the user and the supplier of the KIS also seems to be a relevant factor. Other variables such as age, sector, innovation level and exports are also examined.

Keywords Knowledge intensive services · Technological centres · Innovation

JEL Classifications L80 · L20 · L52 · L26

1 Introduction

Knowledge intensive services (Metcalf and Miles 2000; Miles 2003, 2005) play a crucial role in the creation and commercialisation of new products, processes and services. They are fundamental as creators, moulders and carriers of both technological and organisational innovation.

Nevertheless, there is relatively a little knowledge about the reasons why some firms make more use of such services (technological assessment, applied research, strategic and engineering consultancy, etc.). Some of the research into these questions (Smallbone et al. 1993, Johnson et al. 1998) use small-scale data or case analyses. Other research based on data on a broader scale (Bennett and Robson 1999, 2003, Johnson et al. 2004) shows the complexity of the relations that there are between the

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characteristics of firms and the use of external services.

This study investigates the factors that influence the use of Knowledge Intensive Services (KIS) by firms. Those provided by Technological Centres (TC) are specifically studied. For this purpose, a classification of the KIS is made and some of the activities carried out by the TCs are described in the following section. In Sect. 3 those variables which according to the most consistent conclusions of the available studies are associated with the use of external services are analysed: the size of the user firms, their age, geographical location and their level of technological innovation. Other control variables, such as the sector to which they belong and export activity are also analysed. On the basis of these results the possible existence of differences in the characteristics of the firms that use KIS is analysed in a more detailed manner, for different strata of firm size. The article ends with a section for conclusions.

2 Knowledge Intensive Services and technological centres

In general, a good number of the analyses of the service sector use definitions that could be described as catch-alls or all-embracing. From this point of departure (defining what something is not) conceptualisations in negative terms are arrived at. In this way services are noted for being non-transportable, immaterial (that is to say intangible), unstorable and so on.

However, a positive definition of knowledge intensive services can be made taking two basic criteria into consideration: (i) the way in which the services are provided; and (ii) their role as agents in innovation: the impact of technological improvement that the use of these services has on user firms (Mas-Verdú 2007).

With regard to the first criterion (the way in which KIS are produced), it is necessary to underline the high level of supplier and user interaction in these services (Larsen 2000; Muller 2001). In fact, interactive means co-produced. Any service is a process that requires the action of the supplier and the presence of the consumer. That is not enough in the case of KIS: here, the active participation of the client is also required for the services to have an effect.

There is a direct connection between the degree of supplier and client interrelation and the potential for innovation that the provision of the service brings with it.

It is exactly this that is the second noteworthy characteristic of knowledge intensive services: their role as facilitators of innovation (Strambach 2001; Kuusisto 2005) in terms of the 'reengineering of knowledge' (Muller and Zenker 2001). The KIS act as catalysers (Den Hertog 2000, 2002) that promote the connection between tacit knowledge (belonging to the firms and based on their specific experience) and generic knowledge (more easily codified) in such a way that the supplier of the service creates a point of fusion between the scientific or generic information and the concrete demands of their customer firms. Miles (2003) underlines their role not only in the selection of technologies and their diffusion and implementation, but also in organisational innovation and compliance with legal regulations.

There is a growing body of empirical evidence that shows the positive impact of KIS in the capacity for innovation of the users (Antonelli 2000). Some authors even go further (Muller and Zenker 2001) and empirically test the hypothesis of the 'virtuous circle of innovation', in which the interaction between firms that supply services and clients mutually contributes to the reinforcement of their respective capacities for innovation. The importance of interaction has also been pointed to for financial services (Proença and Castro 2007) and for public services supporting entrepreneurship, as in the case of business incubators (Studdard 2006).

Therefore, the provision of these services constitutes a process of mutual transfer of knowledge that requires reciprocal learning (Den Hertog 2002). This learning is accumulative in nature and takes place incrementally, not in the form of a sudden transformation.

2.1 Services of the technological centres

Technological Centres are among the suppliers of KIS. Functions of these centres can be wide and diverse. Functional specialisation is determined by the range of the technical competence of each centre which, in turn, is determined by different variables: the demands of the users (related to the economic

characteristics and business structure of the area); the strategic options that the managing bodies of the centres adopt; and, when there are any, by the directives issued by the Administrations that contribute to TCs financing.

The services of the TCs can be classified according to different criteria. The first criterion would be functional. A distinction could be made among: (i) activities related to the diffusion of knowledge (training, information, demonstration); (ii) activities encouraging interaction between agents in the system, especially firms, promoting cooperation or improving information transactions based on the knowledge and experience of the agents (intermediation); and (iii) activities of a more individual kind consisting of the provision of specific services to specific firms (tailored training, technological assessment and consulting). As Franzoni (2007) points out the task of recognizing valuable technological opportunities is crucial for these organisations.

A second criterion for classification concerns the degree of immediacy of the problems dealt with by the services that the TCs provide. In the short term, the problems of an immediate nature related to putting products and services onto the market are dealt with by the testing laboratories; basically checking and ensuring the quality of raw materials, semi-manufactured products or final products. In the mid-term problems are dealt with that are related to the maintenance and improvement of firms' production processes; and here the whole process from conception and design to manufacture and organisation is included. These requirements can be attended to through technical assessment services. In the long term, the TCs can carry out R&D and innovative projects (new products, new production processes or new methods).

Finally, from the point of view of demand, firms can find a number of different services in the TC according to the stage of the production process (COTEC 2003). Some services are concerned with the generation and acquisition of knowledge and technology (R&D projects, producing prototypes, advice on the purchase of technological equipment, training, etc). At the stage of preparation for production firms can find testing, certification, access to laboratory facilities or pilot engineering installations. Lastly, in the phase of preparing commercialisation, some TCs can provide assistance in the launching of products or in opening up new markets.

3 Description of the variables and the results

3.1 Data and description of the variables

This section presents the database used for carrying out the analysis, the variables for the estimations, and finally the main results of these estimations.

The database for the analysis was the Directory of Innovative Companies of the Autonomous Community of Valencia (Directorio de Empresas Innovadoras de la Comunidad Valenciana) compiled by the IMPIVA for several years in the 1988–1999 period. The information included was obtained directly from the firms through a personal survey interview with their representatives. In the first edition (1988) the database included information for 1,699 companies. The last edition available, which is the one used here, is for the year 1999, and includes information on more than 2,100 firms.

The objective of this study is to determine which variables explain the use of the services of TCs. Therefore, the dependent variable has been constructed from the answers of firms as to whether they do or do not use the services of TCs (USETC). This variable is of a binary nature (1 = use services or resort to TCs; 0 = No). The proportion of those that do resort to TCs and those that do not is very similar. Of the 2,188 firms that answered this question, 53% had resorted to TCs.

In relation to the explaining variables, six possible variables were considered that could, in accordance with a review of the literature, explain the use of TCs' services. Variables refer to size of firms and their age, geographical location and technological level. These are complemented with an additional examination of the influence of the sector to which a firm belongs and the degree of its openness to foreign markets. The way these variables are constructed and the expected results are described below (the descriptive statistics of the set of variables are shown in Table 1).

Size: Using different techniques, the studies of Johnson et al. (1998) and Bennet et al. (1999) suggest that the use of external consultancy is positively associated with firm size. In addition, Wren and Storey (2002), on analysing the impact of a UK programme on the use of services, obtained results that indicate that the probability of using services increases with size, but that the relation

Table 1 Descriptive statistics

	Mean	Std. Deviation	Maximum	Minimum
USETC	0.532	0.499	1	0
SMALL	0.735	0.441	1	0
MED	0.232	0.422	1	0
HMTECH	0.163	0.369	1	0
AGE85	0.249	0.433	1	0
DISTRICT	0.370	0.483	1	0
METROPOL	0.459	0.498	1	0
DESRECENT	0.165	0.372	1	0
TECHLEV	0.413	0.493	1	0
RD	0.431	0.495	1	0
PAT	0.403	0.493	1	0
LABCONTR	0.355	0.478	1	0
EXP	18.671	26.573	100.0	0

becomes negative when a firm has more than 150 employees.

In relation to size, the literature increasingly underlines certain differences between manufacturing and services (Audretsch and Thurik 1999; Drejer 2004; Howells 2004a, b). In general, there is a weaker relation between size and innovation in service activities than in manufacturing, which point towards the existence of smaller economies of scale (Sirilli and Evangelista 1998, Theter et al. 2001; Theter 2003).

In this survey firms were classified according to the number of workers, in seven possible strata. Two binary variables based on these strata were constructed corresponding to small-firms (SMALL = 1 for firms with less than 50 workers; 0 in the other case) and medium-sized firms (MED = 1 for firms with between 51 and 250 workers; 0 in the other case). Of all the firms in the survey 73.5% are small, 23.2% are medium-sized and the remaining 3.3% are large firms (over 250 workers). The expected sign for this variable is uncertain. One of the main objectives of the TCs is the provision of information, quality and technological services to small firms. Nevertheless, a minimum threshold and a certain size are often necessary for firms to carry out technological activities that require the use of the services of TCs.

Age: The effect of age is ambiguous. It is not clear whether organisations tend to lose adaptive capacity as their age increases, or whether age improves their innovative capacity due to learning processes (Shane

and Katila 2003). Smallbone et al. (1993) indicate that, whilst external consulting tends to benefit young firms particularly, it can also be said that many consolidated firms could obtain benefits by combining their own experience with external support. In the field of innovation, Huergo and Jaumandreu (2004) found a negative non-linear relation between innovation and age.

With the objective of examining whether it is the older firms or the more recently established ones that are more likely to use the services of TCs, the year of establishment of the firm was included as a variable. Two categories were considered, those created before 1985 and those created in or after that year (AGE85 = 1 for firms created in or after 1985; 0 in the other case). The choice of 1985 as the criterion for age discrimination was based on the fact that TCs were set up in that year in the Autonomous Community of Valencia, which allows a distinction to be made between firms previously existent and those that were created after the services of the TCs became available. In addition, the entry of Spain into the European Union in 1986 was a stimulus for firms to look for new competitive factors, as they were faced not only with competition from products coming from member countries (with competitive advantages in technology and quality) because of the progressive disappearance of tariffs, but also from third countries (with cost advantages), because of the adoption of a common tariff that, in broad terms, was less protectionist than that in force until that time.

Geographical location: Analyses within the framework of ‘the geography of innovation’ (Audretsch 1998; Barrio and García-Quevedo 2005) point out the importance of geographical proximity in the transmission of knowledge, particularly the tacit type. Spatial proximity is commonly considered to be a factor that favours innovation by facilitating cooperation, the exchange of knowledge, reciprocity and trust (Tödtling and Kaufman 2001). In contrast Freel (2000) notes that innovators usually have extra-regional connections. On the other hand, Oerlemans and Meens (2005) maintain an eclectic intermediate position. TCs in the Autonomous Community of Valencia are located according to the presence of industrial districts, in order to so encourage external economies that, as Marshall (1920) pointed out, are part of these territorial groupings of firms. In this sense it can be expected that firms located in

industrial districts use the services of TCs in a more intensive manner. Nevertheless, there is also a significant concentration of industrial firms and a large number of TCs in the metropolitan area of Valencia. In order to analyse the influence of location, the firms were classified into four categories according to the area in which they were located, following the criteria proposed by Hernández and Soler (2003) for the demarcation of industrial agglomerations. These areas were classified into areas of recent development (DESRECENT), industrial districts (DISTRICT), metropolitan areas (METROPOL) and all the remaining areas. The great majority of manufacturing firms surveyed were located in metropolitan areas (45.9%) and industrial districts (37%), while the areas of recent development contained 16.5% and all the remaining areas only 0.6%.

Technological level: The use of the services provided by TCs is frequently an action complementing the development by firms of their own technology. However, this process can also be regarded as the reverse: a certain technological level becomes necessary to efficiently use the services that the TCs provide. Four alternative variables are used to measure the technological level of the firms, all of a binary nature. These variables are the firm's own evaluation of the technological level of its machinery (TECHLEV = 1 if it is judged to be high; 0 = in the cases where it is medium and low); the availability of a Research and Development Department (R&D) and the possession of patents (PAT). In the absence of information on R&D expenditure or staff dedicated to R&D, which are commonly used in the literature as the best indicators of the technological level of a firm, the existence of an R&D department can be considered as the second best indicator.

Complementing the technological level, the influence of the application by firms of quality control procedures on the intensity of the use of the services of the TCs is also examined. Once again, and as in the case of the technological level, the expected sign is positive as it can be supposed that higher levels of quality in firms are associated with the use of TCs. In this case, the variable used is the availability of a quality control laboratory (LABCONTR).

Sector: A revision of Italian technology policy, in the field of high-tech start-ups (Colombo and Grilli 2006), has shown the inefficiency of horizontal actions. In the Autonomous Community of Valencia

the technological centres are mainly oriented towards specific sectors (medium or low technology sectors: textiles, furniture, footwear, ceramics, etc.), as they were set up with the purpose of encouraging innovation of these traditional sectors and increasing the added value improving the components of the value chain that allow competitive advantages to be achieved. In this sense, Nooteboom (2007) has categorised the sectors according to their value adding process to identify sources of efficiency of scale, scope and experience. Although most of the TCs are oriented towards medium or low technology sectors, a few of them are oriented towards activities with greater technological content such as bio-mechanics or information technology. For this reason, although a greater use of the services of the TCs by firms in traditional sectors is to be expected, the actual result is uncertain. In order to examine this question, firms were divided into two groups, according to the classification proposed by the OECD, in relation to the technological content of the activities carried out. In this way a distinction is made between firms included in the high and medium-high technology sectors and those in sectors with a medium-low or low technological content (HMTECH = 1 for the high and medium-high technology sectors; 0 in the other cases). The majority of firms surveyed, almost 85%, are involved in medium-low or low technology activities. This is a similar proportion to that found in industrial firms in Valencia as a whole, in which 88.5% of firms carry out activities with a medium-low or low technological content.

Openness to foreign markets: the last variable considered is the degree of openness of firms to foreign markets. The sign expected is positive, given that it is foreseeable that those firms with greater activity in foreign markets are more exposed to competition and will attempt, therefore, to achieve competitive advantages in terms of differentiation, for which the use of TCs is a possibility. The variable used, which is the usual one in the literature, is the propensity to export (EXP), measured as the percentage of exports in the total turnover.

3.2 Results of the estimations

The results of the estimations are presented in Table 2. Given the binary nature of the dependent

Table 2 Results of the estimations (Logit model). Dependent variable: USETC

	(1)	(2)	(3)	(4)	(5)	(6)
C	−0.147 (−1.290)	0.269 (2.253)*	−0.564 (−6.601)**	−0.051 (0.437)	0.065 (0.582)	−0.392 (−3.260)**
SMALL	−0.430 (−3.984)**	−0.380 (−3.549)**		−0.439 (−4.043)**	−0.530 (−4.991)**	−0.248 (−2.212)*
MED			0.429 (3.840)**			
HMTECH	−0.263 (−2.039)*	−0.278 (−2.153)*	−0.269 (−2.081)*	−0.001 (−0.011)	−0.059 (−0.474)	−0.203 (−1.585)
AGE85	−0.266 (−2.520)*	−0.254 (−2.413)*	−0.282 (−2.673)**	−0.272 (−2.578)**	−0.219 (−2.090)*	−0.156 (−1.455)
DISTRICT	0.684 (6.999)**		0.675 (6.921)**	0.659 (6.805)**	0.661 (6.860)**	0.730 (7.367)**
METROPOL		−0.478 (−5.173)**				
RD	0.829 (8.549)**	0.818 (8.477)**	0.845 (8.749)**			
TECHLEV				0.536 (5.702)**		
PAT					0.434 (4.679)**	
LABCONTR						1.142 (10.931)**
EXP	0.006 (3.474)**	0.007 (4.163)**	0.006 (3.533)**	0.006 (3.503)**	0.006 (3.543)**	0.007 (3.761)**
N	2143	2143	2143	2133	2146	2139
Log likelihood	−1387.19	−1398.72	−1387.73	−1401.58	−1414.57	−1358.82
Restr. Log L.	−1480.23	−1480.23	−1480.23	−1473.82	−1482.52	−1477.72
LR statistic	186.09	163.02	184.99	144.48	135.90	237.81

Z statistics in brackets

*Statistically significant at 95% level of confidence; **at 99%

variable (use of TC services), the estimations have been carried out using a logit model. The alternative use of a probit model leads to very similar results. The vector of the estimated parameters reflects the impact that the independent variables have on the probability of the use of TC services. However, it should be noted that their interpretation is not direct, since the coefficients estimated are not, as in any non-linear regression model, the marginal effects of the linear regressions.

The results show the influence that size, belonging to an industrial district and the availability of a certain technological level have on the use of TC services. First, a greater probability of using TC services by medium-sized firms is confirmed: in all the estimations, the coefficients corresponding to the variable SMALL are significant and negative. Using,

as an alternative, a binary variable with a value of 1 for the medium-sized firms, confirms these results with a significant and positive coefficient. These results show that a certain minimum size threshold seems necessary for the development of innovations and for the use of the services of the TCs. Consequently this demonstrates the desirability of carrying out specific action for small firms to develop their capacity to innovate and to enhance the use of the services of TCs by these firms. Problems of asymmetrical information are, usually, greater in small firms, and this requires policies directed towards lowering the threshold above which firms become involved in innovative activities of a certain importance.

Second, as regards the use of TCs according to the location of the firms, the DISTRICT variable is

significant in all the regressions, which shows that firms located in industrial districts have a greater probability of making use of TC services. On the other hand the METROPOL variable is not significant in spite of the presence of a number of TCs in the metropolitan area of Valencia.

Third, the results also show that firms that have a certain level of technology or that apply quality procedures in their production processes have a greater probability of using TCs. The four variables that measure these factors (R&D, technological level of the machinery, ownership of patents and the availability of a quality control laboratory), used as indicators of the technological level of firms, show statistically significant coefficients with a positive sign. Consequently even though TCs try to stimulate the use of services by non-innovative firms, the estimations show that firms that use TCs to a greater extent are those that seek to complement their own internal development of innovations.

Another relevant result is that consolidated firms (created before 1985) are those that most frequently use the TCs. Similarly the estimations confirm that the degree of openness to foreign markets and the necessity of reaching, as a consequence, higher levels of competitiveness, explain the degree of use of the services of TCs.

3.3 Estimations according to firm size

With the aim of examining whether there are differences in the characteristics of firms that use knowledge intensive services with regard to the size of the firm, the sample was stratified into three groups corresponding to the small, medium-sized and large firms, according to the criteria already mentioned.

Previously it was examined whether some specific groups of small firms, in particular those that are innovative (with an R&D department) and those located in districts, have a greater propensity to use the services of TCs. The results, presented in the estimation (1) in Table 3, show that although the sign is negative for the small firms as a whole, the small innovative firms (SMALLRD) and those located in districts (SMALLDISTR) have a greater propensity to use the services of TCs. These results demonstrate the convenience of examining in greater detail the

characteristics of firms that influence the use of KIS within each of the size strata.

In order to make this analysis, two estimations were carried out for each size interval, using the existence of an R&D department and the ownership of patents as variables indicating the innovative level of the firm.

The results of the estimations show that, within each size stratum, there are substantial differences in the characteristics of the firms that use the services of TCs. In the case of the small firms, of which almost 50% are users of TCs, consolidated firms, created before 1985, innovative firms, companies that export a part of their production and firms located in districts show a greater propensity to use KIS. On the other hand, in the case of medium-sized firms, of which 64% use TC services, age is not significant. For the large firms, of which 63% use TC services, only slight evidence exists to show that it is the innovative firms that use KIS. Specifically, in estimation (7), the parameter corresponding to the ownership of patents has a positive sign and is 90% statistically significant. Nevertheless, in the case of the large firms, the estimations should be regarded with caution, given the small number of observations. These results show that if the TCs want to encourage innovation in small firms of recent creation, alternative action to that which is currently being carried out is necessary. Similarly, the use of TC services by non-innovative firms is very rare, which means that increasing the number of innovative firms in the region requires other measures that complement the activities of the TCs.

4 Conclusions

International experience (especially in the UK and Germany) increasingly point towards the role of external services as agents of innovation in the area of public policy (Mole 2002; Curran and Storey 2002; Hjalmarsson and Hohansson 2003; Czarnitzki and Spielkamp 2003). In spite of the limitations of the available methods to evaluate support policies for SMEs, fundamentally those consisting of the promotion of services (Robson and Bennet 1999; Lean et al. 1999; Curran 2000; Storey 2000; Smallbone et al. 2003), present experience seems to indicate that resources dedicated to offering knowledge intensive

Table 3 Results of the estimations (Logit model) according to the size of the firm. Dependent variable: USETC

	All firms	Small firms		Medium firms		Big firms	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
C	0.474 (4.783)	−0.501 (−5.339)**	−0.391 (−4.155)**	−0.369 (−2.105)*	−0.109 (−0.647)	−0.424 (−0.760)	−0.492 (−0.974)
SMALL	−1.039 (−8.578)**						
HMTECH	−0.215 (−1.693)*	−0.432 (−2.917)**	−0.215 (−1.521)	0.231 (0.730)	0.482 (1.566)	0.648 (0.842)	0.501 (0.643)
AGE85	−0.269 (−2.555)*	−0.296 (−2.578)**	−0.235 (−2.072)*	−0.119 (−0.401)	−0.194 (−0.679)	−0.367 (−0.249)	0.348 (0.233)
DISTRICT		0.655 (5.963)**	0.630 (5.812)**	0.811 (3.542)**	0.791 (3.502)**	0.458 (0.641)	0.137 (0.183)
RD		0.809 (7.101)**		0.998 (4.926)**		0.643 (1.104)	
PAT			0.408 (2.492)*		0.478 (2.491)*		1.025 (1.759)
EXP	0.007 (4.021)**	0.005 (2.458)*	0.005 (3.756)**	0.008 (1.976)*	0.009 (2.141)*	0.015 (1.222)	0.014 (1.199)
SMALLRD	0.763 (6.811)**						
SMALLDISTR	0.658 (6.013)**						
N	2143	1573	1577	502	500	68	69
Log likelihood	−1407.47	−1037.30	−1058.45	−302.75	−310.08	−42.23	−41.89
Restr. Log L.	−1480.23	−1090.28	−1093.02	−327.60	−326.13	−44.72	−45.18
LR statistic	145.51	105.96	69.14	49.71	32.11	4.98	6.58

Z statistics in brackets

*Statistically significant at 95% level of confidence; **at 99%

services obtain greater additionality than traditional subsidising instruments.

Nevertheless, there is relatively a little knowledge available on the profiles of firms that use KIS, and the recent literature underlines the complexity of the relations that exist between the characteristics of firms and the use of external services (Smallbone et al. 1993; Johnson et al. 1998; Bennett and Robson 1999; 2003; Johnson et al. 2004).

Using a database with microeconomic information on more than 2000 firms, various estimations have been carried out from which the importance of dimension, location in industrial districts, technological level and openness to foreign markets can be stated to influence the use of the services of technological centres. It has also been shown that the characteristics of the firms that use the TCs are different according to the stratum of size to which

they belong. In particular, age appears as non-relevant for the medium and large firms whilst in the case of small firms it is those that are consolidated that more commonly tend to resort to TCs.

Two of these results seem particularly relevant because of their importance for the definition of public policy: on the one hand, the existence of a certain threshold, in terms of firm size as well as technological level, in order for a firm to be able to make efficient use of KIS; and on the other hand the importance of proximity, both geographical and functional (sectoral), between the suppliers and users of the services.

Although the results of the estimations are sufficiently robust there are some limitations. Specifically, the use of binary variables, both in the case of the dependent variable and the explaining variables, whilst facilitating the gathering of the information,

does constitute a limitation in determining the relation between the different variables with a greater degree of precision.

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