Codification or Personalization as Knowledge Transfer Mechanism

Knowledge is ascribed a key role when explaining the existence and the growth of multinational companies (MNCs). The effective dissemination throughout the MNC organization of valuable knowledge acquired by its local affiliates is seen as an important source of competitive advantage. As such, it is essential that the MNC employs the most effective mechanism of transferring knowledge. We assessed the model of knowledge management strategies proposed by Hansen, Nohria and Tierney (1999). Their main argument is that in order to enable effective use of knowledge, firms should select an 80/20 knowledge strategy mix of codification and personalization with one of these strategies dominant. We examined to what extent these two knowledge management strategies are substitutes (as implied by Hansen *et al.*, 1999) or supplement each other. Furthermore, it is investigated to what extent the two knowledge strategies can be applied to mitigate the barriers when transferring knowledge across cultural, geographical and technological boundaries. The developed hypotheses are tested on a unique dataset of 303 Italian parent company-foreign subsidiary dyads.

"In fact, we believe that the choice between codification and personalization is the central one facing virtually all companies in the area of knowledge management" (Hansen, Nohria & Tierney, 1999)

1. Introduction

To an increasing extent is the survival and success of multinational companies (MNCs) considered to be contingent upon the ease and speed by which valuable knowledge is disseminated throughout the organization (Hedlund, 1986; Gupta and Govindarajan, 1991; Kogut and Zander, 1996). Thus, creation of knowledge in the spatially dispersed multinational organization is a necessary, but not sufficient condition for success in the global marketplace. If valuable knowledge remains in, or only diffuses slowly from, the individual MNC affiliates, opportunities for worldwide leverage are lost. This entails transferring of knowledge in the MNC across cultural, geographical and technological barriers. Therefore, appropriate knowledge management strategies including proper transfer mechanisms should be in place ensuring swift dissemination to other units of the multinational organization.

Hansen et. al. (1999) highlight that there exists two distinct strategies of knowledge management – the personalization and the codification strategy. Where the knowledge in the personalization strategy reside with the individuals and mainly is transferred in verbal communication, while the logic of the codification strategy is to detach the knowledge from individuals and stored in databases, manuals, documents and frameworks, making it possible to transfer the knowledge in written form. They further stress that knowledge management is only valuable for companies if it is embedded in and aligned with the company's strategy, HR and IT and not seen as an isolated or self-sufficient function. This systemic character of the knowledge management strategy makes them argue that successful companies pursue mainly

one strategy, either personalization or codification and not both strategies at the same time (Hansen et. al., 1999).

The aim of this paper is twofold in the sense that we will explore: 1) to what extent the two knowledge management strategies are, in fact, substitutes or supplementary; and 2) to what extent these two knowledge management strategies can be applied in order to mitigate the barriers of knowledge transfer when knowledge has to be transferred across cultural, geographical and technological boundaries in the MNC. The first question on whether the two strategies are substitutes or supplementary will be investigated by looking at the interaction effect between the two strategies on the level of knowledge transfer. A positive interaction effect indicates that they are supplementing and reinforcing each other; while a negative interaction effect points towards that they are substitutes and counterproductive (as suggested by Hansen et al., 1999). The question on whether the two knowledge management strategies can be applied in order to smooth the transfer of knowledge across cultural, geographical and technological boundaries are examined in the same way by looking at whether the two KM strategies moderate the level of knowledge transfer when knowledge is transferred over cultural, geographical and technological distance.

2. Knowledge Management Strategies

Knowledge management has become a key for modern organizations seeking to compete in an increasingly turbulent and competitive world. It is accepted that the only true competitive advantage for firms over the long term is knowledge. All firms need and use knowledge. Whether they are big or small, services or manufacturing, every firm take the knowledge embedded in all its units, employees and its processes, and attempts to create value in exploiting this knowledge. The firm is seen as "*a knowledge-integrating institution*" (Grant,

1996: 111) and "*a social community specializing in the speed and transfer of knowledge*" (Kogut and Zander, 1996: 503). In fact, some scholars go even further and claim that the very reason why MNCs exist is that they are efficient vehicles for creating and transferring knowledge across borders (Kogut and Zander, 1993).

The degree of knowledge use varies from firm to firm but effective management of the knowledge resources has become an important management mandate for all companies. It is no longer sufficient to focus on how to create and acquire knowledge. A proper knowledge management strategy should also focus on the dissemination and use of knowledge as knowledge often need to be transferred to other locations in order to make better use of it. Firms are forced to make the best use of and exploit all knowledge in the organization irrespective of where it has been created, which also implies that they need to have proper mechanism in place for the smooth transfer of knowledge both from headquarter to subsidiaries and from subsidiaries to other MNC units (often called reverse transfer of knowledge).

Hansen et. al. (1999) suggests a choice between two alternative approaches to the management of the knowledge resources – the knowledge management strategies of codification and personalization. The two knowledge management strategies were developed based on their work with organizations in the consulting sector, however, Hansen et. al. (1999) claim that "the strategy does not apply only to the world of consulting" (p. 110), but are central choices "facing virtually all companies in the area of knowledge management" (p. 107).

A personalization strategy (used by the likes of McKinsey) draws on interpersonal relationships to mobilize and share knowledge in tacit form across the firm. Thus, the firm aims to create and facilitate networks between people to share and learn from their individual skills, and experiences. Knowledge about clients, industry and functions resides in the minds

of the individuals and therefore firms make an effort to bring its employees together in attempts to exchange knowledge. Hansen et al. (1999) suggest that this is the 'people-to-people' approach to knowledge management and it results in an 'expert economics' that allows employees easy access to various experts and knowledgeable people in the firm. IT in a personalization strategy merely facilitate the communication of knowledge.

A codification strategy aims to capture and codify knowledge in explicit form (e.g. in documents, databases) and make these available to everyone in the firm for further reuse. In this manner, organizations invest once in the development of explicit knowledge, store it, and are able to reuse it as often as required. As a result, this 'reuse economics' avoids the cost associated with the 'reinvention' of knowledge assets. The IT-investment required to support a codification strategy is significant and they should enable people easy access to reusable codified knowledge. It is suggested that this is the 'people-to-documents' approach to knowledge management.

In the same line Hedlund (1994) argues, that "to a large extent [organizations] are 'articulation machines', built around codified practices and deriving some of their competitive advantages from clever, unique articulation." (Hedlund, 1994: 76). Cowen and Foray (1997: 595) describe codification of knowledge as a production process that includes "model building, language creation and the writing of messages" and they note that codification processes are often riddled by imperfection, that they are time consuming, and therefore costly.

With a codification strategy knowledge is extracted from the person who developed it, stored in written form (e.g. frameworks, interview guides, check lists, benchmark data etc.) and then searched, retrieved by other employees in the MNC. Personalization strategy focuses on dialogue between individuals and knowledge is shared primarily in verbal form in meetings and one-on-one conversations. The motivation of individuals to share knowledge is

expected to be higher with a personalization strategy, because they keep the control through the whole knowledge transfer process. However, the main disadvantages of the personalization strategy are a lack of standards and the dependencies on the will and the communication skills of the individuals.

Hansen and colleagues claim that "*companies that use knowledge effectively pursue one strategy predominantly and use the second strategy to support the first. We think of this as an 80-20 split* (Hansen *et al.*, 1999, p. 112). The implication is that successful companies either pursue a relatively pure personalization strategy with only 20 percent usage of codification mechanism or a codification strategy with limited use of the personalization strategy (i.e no more than 20 percent). As highlighted by Hansen et. al. (1999) "*we found that effective firms excelled by focusing on one of the strategies and using the other in a supporting role"* (p. 109).

The reason for why the two knowledge management strategies by and large in seen as incompatible is that each of them are based on different systems that are aligned with the knowledge management strategy. The codification strategy relies on the logic of "reuse economics" and the personalization strategy on the logic of "expert economics". The IT-strategy supporting the codification strategy is store of codified knowledge vs. facilitating communication and exchange of tacit knowledge for the personalization strategy. The codification strategy implies training of employees to reuse knowledge and rewarding them for contributing to databases, while the personalization strategy requires training of employees to problem solving and rewards for directly sharing of knowledge. The two knowledge management strategies will need different kinds of employees and train and reward them differently. Basically, the two knowledge management strategies has a systemic character, where the surrounding systems (of IT, HRM, business model etc.) need to be aligned with the chosen knowledge management strategy.

This obviously raises the issue of both knowledge management strategies can be pursued at the same time or whether the systemic character of the two strategies makes them incompatible e.g. one cannot have two different HRM-policies, IT-strategies etc.

Therefore, we propose the two competing hypotheses:

H1a) *Personalization and codification KM strategies are substitutes in affecting the probability of transferring knowledge from the subsidiary to the parent company*

H1b) *Personalization and codification KM strategies are supplementary in affecting the probability of transferring knowledge from the subsidiary to the parent company*

3. Impediments to Knowledge Transfer

Several scholars have pointed out that various cultural, geographical and technological factors impede the transfer of knowledge across the multinational organization (Adler, 1995; Cho and Lee, 2004; Teece, 1981). The impediments can be seen as "frictions" because they slow or prevent transfer and are likely to erode some of the knowledge as it is transferred through the MNC.

Knowledge and cognition is guided by the contextual rules and resources residing in the social structures, therefore, the transfer of knowledge from one cultural context to another is likely to fail if the underlying assumptions are to divergent of those expected to receive the knowledge (Adler, 1995). Or, as Doz and Santos (1997, p. 23) put it: '*effective transfer of knowledge is a dialogue between the sender and the receiver about their own contexts and about the object of knowledge'*. Factors such as different language, business culture, and institutional framework make up a 'cultural distance' as perceived by the knowledge receiver

that creates ‘frictions’ in the knowledge transfer. The difficulty increases further as the cultural distance between the source and recipient countries increases (Cho and Lee, 2004).

In the same vein, both geographical distance and technological distance between the sender and receiver of knowledge will entail ‘frictions’ for the transfer process. The current stock of accumulated knowledge in organizations shape their ‘absorptive capacity’ (Cohen and Levinthal, 1990), i.e. the capacity (speed, quantity) by which the organization can absorb knowledge. The larger the gap between the accumulated knowledge in the transferring and the recipient firm the more difficult and less effective the transfer. If the gap between the knowledge base of the sender and recipient is large then the recipient will fail to catch and decode the incoming signals from the knowledge-transferring firm. Furthermore, several studies suggest that geographical proximity is positively associated with knowledge transfer (Galbraith, 1990; Lester and McCabe, 1993) Epple et al. 1996).

In a study on the costs of knowledge transfer, Teece (1981) estimated that transfer costs for the intra-MNC knowledge transfer where substantial ranging from 2, 24 percent to 59 percent with a mean of 19,16 percent. Many of these costs are derived from the efforts to teach complex knowledge to recipients across cultural, geographical and technological boundaries.

However, one of the purposes of applying the two knowledge management strategies of codification and personalization is that they should ease the transfer of knowledge across boundaries in the MNC. The codification strategy offer an easy access to the knowledge stored and codified in databases from all corners of the organization. In fact, this is the core of the economic model of ‘reuse economics’ for the codification strategy. The stored knowledge has to some extent been de-contextualised in the codification process, which should make it able cut across and mitigate the frictions implied by cultural, geographical and technological distance between the knowledge sender and receiver. The personalization strategy that is

promoting all kinds of communication in the MNC is also offering a tool to overcome the frictions in knowledge transfer across boundaries and mitigate the distance between sender and receiver. In effect, both of the two knowledge management strategies are expected to mitigate and limit the negative effect of cultural, geographical and technological distance on knowledge transfer

Accordingly, we propose the following two hypotheses:

H2a) Application of personalization KM strategy will mitigate the negative effect of cultural, geographical and technological distance.

H2b) Application of codification KM strategy will mitigate the negative effect of cultural, geographical and technological distance

The conceptual model including the hypotheses is shown in Figure 1.

Insert Figure 1 around here

Methodology

Sample

This study explores knowledge transfer from foreign subsidiaries to parent companies (sometimes called reverse transfer of knowledge), within parent company-foreign subsidiary dyads. A sample frame was developed from the Reprint[1] database that provides the picture of

[1] The dataset Reprint is developed and yearly updated at Politecnico di Milano (Mariotti and Mutinelli, 2005). It provides a census of the Italian firms with foreign activities from the beginning of 1986 to the beginning of 2004, and the information available are the followings: (i) corporate name and address of the head office, for both the Italian parent companies and their foreign affiliates; (ii) the code of the industrial activity, and other relevant economic variables (the dimensional class in terms of employees and turnover) for the Italian parent

foreign activities of the Italian firms. At the beginning of 2004, we selected all the Italian manufacturing MNCs with more than 50 employees that had at least one majority-owned subsidiary located in an advanced country and involved in R&D or manufacturing. The total sample consisted of 358 MNCs. Using this sample, in December 2004 six researchers began the data collection process by contacting parent companies' top managers by telephone and sending them a personalized letter with the description of the project, the assurances regarding the confidentiality of collected data and a formal request for a face-to-face interview. By the end of July 2005, data collection was finished and 84 MNCs (response rate of about 24 percent) were studied through face-to-face structured interviews that lasted about 120-180 min. each.[2] During the interviews, the respondents went through a pre-tested questionnaire and notes were taken to ensure accurate recording of the responses. Specifically, we collected data regarding all the majority-owned foreign subsidiaries involved in manufacturing or R&D activities of each MNC under study. Such a process allowed the construction of the RITMO (Research on Innovation and Technology in Multinational Organizations) database that provides primary information on 350 Italian parent company-foreign subsidiary dyads.

T-test were done between the 84 responding and 274 non-responding MNCs on group size (class of number of employees), area of location of the parent company in Italy and innovation sector (Pavitt, 1984; 1990). In general, regarding size and parent company's location area, no statistically significant differences between respondents and non-respondents were found (see Table 1). The two groups differ in terms of innovation sector: our sample is overrepresented by science based and specialized supplier firms and underrepresented by supplier dominated sectors. However, the lower number of observations in the supplier dominated sector and the greater number of observations in science based and specialized

companies; (iii) the year and the type of participation in each foreign affiliate participated by Italian firms (e.g. *greenfield* vs. acquisition, wholly/control/minority ownership).

[2] For most of the parent companies with more then 5 subsidiaries (20% of the sample), we were able to obtain longer interviews, sometimes based on two days meetings. It could be useful to note that 8.07 is the mean of the number of foreign subsidiaries for each parent company and 6.40 is the standard deviation.

supplier sectors may not be a problem. Since firms in supplier dominated sectors generally obtain foreign technology from outside the firm's boundaries (Brusoni *et al.*, 2001), we can expect that MNCs in the supplier dominated sector do not consider the possibility to transfer back knowledge from their subsidiary an important issue. During the first phone conversations with firms in the supplier dominated sectors this reason for not wanting to participate to the RITMO project was confirmed. On the other hand, MNCs in science based and specialized supplier sectors, such as pharmaceuticals, instruments, machinery, electronics and electric, have a higher tendency to transfer knowledge (among the others, see Ghoshal *et al.*, 1994; Håkanson and Nobel, 2000; Hansen, 2002). Accordingly, in the "true" population of firms transferring knowledge from the subsidiary to the parent, we will find that supplier dominated firms are underrepresented, while science based and specialized supplier firms are overrepresented. Therefore, we argue that our sample composition is reflective of the underlying population.

Insert Table 1 around here

As common method bias might affect our empirical analysis, we performed the Harman's single-factor test (Harman, 1967; Podsakoff and Organ, 1986; Jansen *et al.*, 2005) on the set of all single items included in our econometric model. If common-method bias exists in the data, a single factor will emerge from a factor analysis of all measurement items included in the study, or one general factor that accounts for most of the variance will result. The factor analysis reported 9 factors with eigenvalues greater than one, thus supporting the validity of the data. Specifically, the first factor (eigenvalues = 2.81) explained 12.8% of the variance, while the cumulative variance explained by all the 9 factors was about 68%.

Finally, we performed validity response tests on our dependent variable (the occurrence of knowledge transfer from the subsidiary to the parent company) and the

independent variables related with perceptual data. The data used in these tests were available from a questionnaire sent out to the subsidiaries' top managers of each responding parent company-foreign subsidiary dyad of the RITMO database. 68 questionnaires were returned and 62 were usable for our purpose. This allowed us to compare the assessment of the level of knowledge transfer from subsidiary to parent in both ends i.e. the assessment by the parent company as well as by the subsidiary managers. Unfortunately, we do not have comparable data for all subsidiaries, but enough to conduct the validity test. We performed the Kruskal Wallis test (Downey *et al.*, 1975; Brett *et al.*, 1995). In general, the results indicate that there is no statistically significant difference between parent companies and subsidiaries in their answers. The only exception concerns the items "transfer of managers" and "transfer of professionals". Specifically, the parent companies perceive a greater amount of personnel transfers with their subsidiaries than those perceived by the foreign subsidiaries. However, this difference is to be expected. Although personnel transfers could be one-way or two-way (from the parent company to the subsidiary and vice-versa), we know from the interviews that it is mostly a uni-directional movement (from the parent to the subsidiary). Taking also into account that the diffusion of this work practice in the MNC is usually encouraged and formalized by the parent company, it is not surprising that the foreign subsidiary report to use a smaller amount of personnel transfers than its parent company.

Measures

The dependent variable, *knowledge transfer*, equals one if any subsidiary's knowledge/competence (in R&D, manufacturing, marketing and sales, logistic and distribution, purchasing, human resource management, general management, and quality management), has been used by the parent company, and it takes value of zero otherwise. Specifically, we found that some kind of knowledge was actually transferred from 93

subsidiaries (corresponding to about the 27% of the total number of foreign subsidiaries) to their relevant 45 Italian parent companies (54%).

The independent variables *personalization* and *codification*, were measured asking the respondents to estimate the use of governance mechanisms such as "transfer of managers" and "transfer of professionals", from the parent to the subsidiary and vice versa, as well as the use of "internet instruments" – such as e-mail, forum, videoconference, instant message, etc. – and the "exchange of technical documents" (handbooks, blueprints, databases, etc.), within the parent-subsidiary dyad. Following previous studies (Roth *et al.*, 1991), we considered a 7-point Likert scale,[3] from 'used rarely' to used 'very often'.[4] We ran a principal component analysis on the four governance mechanisms (Table 2). The interpretation of the sets of factor loadings, allows us to define *personalization* and *codification* depending on which of the mechanisms play a major role. The first factor, *personalization*, captures parent-subsidiary integration based on personal ties, specifically on interactions involving people from the subsidiary and the parent company for extended period of time. In the same manner, *codification* is dominated by the use of internet instruments and the sharing of documents.

Insert Table 2 around here

In order to test whether the relationship between *personalization* (*codification*) and knowledge transfer is conditional on or moderated by *codification* (*personalization*), we add the interaction effect *personalization* × *codification*, in the regression model. If synergies exist

[3] The respondents could answer '0' whether a specific mechanism had not been used.

[4] The most prominent mechanism used by the sampled parent companies and foreign subsidiaries to communicate and interact, appeared to be the use of internet instruments (mean = 5.2 and median = 6). However, also the sharing of documents is frequently used in the parent-subsidiary relationship (mean = 3.8 and median = 5), followed by transfer of managers (mean = 3.2 and median = 3), and transfer of professionals (mean = 3.0 and median = 3).

from using together personal ties, ICT-based, and written media, then the interaction effect should exert a positive impact upon the dependent variable.

The variable *cultural distance* is measured utilizing Kogut and Singh's (1988) cultural distance index (among the others that have previously adopted this measure, see for instance Håkanson and Nobel, 2001; Ambos *et al.*, 2006). The *geographical distance* is captured by kilometers (thousand of) between Rome – capital city of Italy – and the capital city of the foreign subsidiary's country. The operationalization of the variable *technological distance* is based on the answers ('yes' or 'no') given by the respondents on the following three statements: (1) "the subsidiary has competence/technology inferior to those available at the parent company"; (2) "too high costs are required to adapt the subsidiary's competence to the parent company context"; and (3) "there is technological incompatibility between the subsidiary and the rest of the MNC". Specifically, *technological distance* is measured as the addition of 'yes' obtained in the aforesaid questions. In centering the variables *cultural-*, *geographical-*, and *technological distance* by subtracting the mean, we avoid high correlations between these variables and the interaction terms (Smith and Sasaki, 1979). Accordingly, to hypothesis 2a and 2b, we multiplied the personalization and codification measures by the 'distance' measures, obtaining the following interaction terms: *personalization* × *cultural distance*; *codification* × *cultural distance*; *personalization* × *geographical distance*; *codification* × *geographical distance*; *personalization* × *technological distance*; and *codification* × *technological distance*.

As other reasons may explain why knowledge transfer occurs from foreign subsidiaries to their parent companies, it is important to control for these reasons to avoid a spurious relationship between our independent variables and *knowledge transfer*. Accordingly, we defined the following control variables:

- *subsidiary propensity to innovate*. Respondents were asked to indicate whether 'the foreign subsidiary *j* has provided the MNC with: (i) new technology, (ii) significant modification of technology already in existence; (iii) marginal modification of technology already in existence; (iv) new product, (v) significant modification of product already in existence; (vi) marginal modification of product already in existence. The final measure was a weighted average of responses to the six items where the most complex contributions (new technology/product) was given a weight of 3, the intermediately complex contributions (significant modifications of technology/product) was given a weight of 2, and the least complex contributions (marginal modification of technology/product) was given a weight of 1;

- *greenfield* equals one for foreign subsidiaries that were new establishment of the MNC;

- *subsidiary size* was measured as logarithm of the subsidiary's number of employees in 2004;

- *subsidiary autonomy*. Respondents were asked to indicate the allocation of strategic decision-making. Specifically, we have detailed information on the three following firm's strategic decisions: (i) definition of R&D projects, planning, resources, etc.; (ii) introduction of new technologies; (iii) changes in products/services. Following the operationalization by Ghoshal et al. (1994), we used a five levels scale, where: (1) 'the parent company decides alone'; (2) 'the parent company decides but considers subsidiary inputs'; (3) 'both parent company and subsidiary have roughly equal influence on decision'; (4) 'the subsidiary decides, but considers parent company suggestions'; (5) 'the subsidiary decides alone'. The variable *subsidiary autonomy* was defined as the average of responses to the three strategic decisions (Cronbach alpha=0.81);

- *parent intangible assets/N° of employees* (intangible assets in million of euros). This variable was based on parent companies' balance sheet data in 2004, and it aims to control for the existence of prior knowledge in the parent company as this knowledge is expected facilitate the understanding of possible incoming knowledge from the subsidiary.

It should be observed that because of missing values of data relevant for our econometric exercise, the number of observations was further reduced to 303 dyads. Table 3 shows descriptive statistics and the correlation matrix of all the variables.

Insert Table 3 around here

Results

The models reported in Table 4 predict whether knowledge transfer from the foreign subsidiary to the parent company occurred or not. Model 1 reports the baseline model including the control variables and the independent variables without interact terms.

Concerning the results for the control variables, it is interesting to note that, not surprisingly, the coefficients of the variable *subsidiary propensity to innovate* are positive and significant in all the models. This result suggests that the ability of the foreign subsidiary of developing and/or modifying products and technologies had a positive impact of the parent company's chances of transfer back that knowledge. Conversely, for the other control variables we do not find any results statistically significant at the standard level.

Insert Table 4 around here

As far as the main effect of the independent variables is concerned, the results in Table 4 reveal that an increase in personalization or codification strategies increases the probability of transferring knowledge from the foreign subsidiary to its parent company. Likewise, an increase in the cultural and/or the technological distance between the parent company and the foreign subsidiary reduce the probability of observing reverse knowledge transfer. However, previous studies have highlighted that for a logistic regression model the effects of a predictor depends on the levels of the other covariates in the model (Long, 1997; Norton *et al.*, 2004; Mitchell and Chen, 2005; Hoetker, 2007). Therefore, as suggested by Mitchell and Chen

(2005, p. 69), the relationship between the independent variable *x* and P(*y*) – the predicted probabilities of the dependent variable being 1 – can be expressed in two dimensions by considering the aggregate contribution of all the covariates.[5] It would be possible to represent the relationship between any given predictor and P(*y*), considering multiple values selected on the covariates contribution. In particular, Figure 2 displays the relationships between the independent variables that we have found being statistically significant and P(y) with three different lines corresponding to the 20th, 50th, and 80th percentiles on the covariates contribution. Examining the graphs in Figure 2, we can distinguish two different patterns. The relationship between the cultural and technological distance and P(*y*) is a decreasing function (a greater distance between the parent company and the subsidiary decrease the probability of observing knowledge transfer); while, we can see an increasing function for the relationship between the KM strategies and P(*y*). Moreover, when the covariates contribution is low (at the 20th percentile), the relationship between the generic independent variable and P(*y*) is flatted because the curves are pressing against the floor value of 0, but as the covariates contribution increases to the 50th, and 80th percentiles, the effects of the main independent variables (negative or positive) on P(*y*) become steeper. Although the test of Hypothesis 1a and 1b requires further investigations considering the interaction term of personalization and codification, these findings partially support the argument that a larger cultural and technological distance between the parent company and the subsidiary reduces the probability of observing reverse knowledge transfer.

Insert Figure 2 around here

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[5] The covariates contribution is the linear combination of the remaining predictors in the model multiplied by their corresponding logit coefficient (Mitchell and Chen, 2005).

Turning to the results for the moderating effects, it is crucial to clarify that in non linear models, such as logit models, the impact of the interaction term on the dependent variable is "a function of not only the coefficient for the interaction, but also the coefficients for each interacted variables and the values of all the variables." (Hoetker, 2007, p. 336). More unexpectedly, the sign of the effect of the interaction may be different for different observations, and the statistical significance cannot be determined from the *z*-statistic reported in the regression output (Norton *et al.*, 2004). Accordingly, in order to provide an appropriate and complete interpretations of the resulting coefficients of our logit estimations, we calculated and graphed the magnitude and significance of the interaction effects over the sample of observations (Hoetker, 2007), using the Stata code provided by Norton et al. (2004). Based on results from Model 5, Figures 3-6 report two distinctive graphs. For each observation: graph (a) compares the interaction effect calculated by the conventional linear method with the interaction effect calculated by the method suggested by Norton et al. (2004) against predicted probabilities of *knowledge transfer* equals to one; graph (b) plots the statistical significance of the interaction effect against predicted probabilities of *knowledge transfer* equals to one. In graph (b), the two horizontal lines represent the z-statistic at ±1.64. All the observations above +1.64 and below –1.64 are significant at least at $p<0.1$.

We have previously shown (see Figure 2 and Table 4) that the main effects of *personalization* and *codification* are positive and statistically significant at the conventional level. Also their interaction term shows a positive coefficient with statistical significance of $p<0.05$. These results would suggest that Hypothesis 1b is supported while Hypothesis 1a is refused. However, from Figure 3 we can observe that Hypothesis 1b holds only for those parent companies whose predicted probability of transferring knowledge from their foreign subsidiaries is within the 0.1-0.5 interval. In this range of predicted probabilities, about 80% of the observations have a positive and statistically significant interaction effect between

personalization and *codification* (see Figure 3b), while none of the negative interaction effects (5 observations out of 98) results to be significant. Specifically, the results indicate that this group of parent companies can increase of 22.4% the probability of reverse knowledge transfer (mean of the interaction effect=0.224 and s.d.=0.068) combining personalization and codification KM strategies. Conversely, for those parent companies with the predicted probability of transferring knowledge from their foreign subsidiaries in the right side of Figure 3a, two different paths can be observed. Within the 0.5-0.8 interval of the predicted probability, there are 47 observations of which 38 with a positive interaction effects and 9 with a negative interaction effects. With the exception of 27.6% of the observations, the majority of the interaction effects in the 0.5-0.8 interval of the predicted probability is not statistically significant at the conventional level. Accordingly, in this range of predicted probabilities, the results suggest that parent companies do not affect reverse knowledge transfer combining personalization and codification strategies lending support to Hypothesis 1a against 1b. The substitutive effect of personalization and codification becomes stronger for parent companies whose predicted probability of transferring knowledge from their subsidiaries is within the 0.8-1 interval. In this case, the interaction effect between personalization and codification is always negative and in general statistically significant: about 83% of the observations show an interaction effect significant at the statistical conventional level. In particular, parent companies of this group of observations will reduce of 16.4% (mean of the interaction effect= –0.164 and s.d.=0.049) their probability of transferring knowledge from their foreign subsidiaries if they adopt personalization and codification KM strategies in combination.

The remaining observations with predicted probability of knowledge transfer smaller than 0.1 have very low interaction effects (mean= 0.022 and s.d.=0.041) and they are never statistically significant at the conventional level.

It can be observed that the geographical distance in general does not affect the probability of transferring knowledge from foreign subsidiaries to parent companies. In fact, not only the coefficient of *geographical distance* is not statistically significant (see Table 4), but also the coefficients of the interaction terms *personalization* × *geographical distance* and *codification* × *geographical distance* are never statistically significant at any conventional level. The same results are confirmed for each observation by the Norton et al.'s (2004) procedure.[6]

Considering the test of Hypothesis 2a for the cultural and the technological distance, the coefficients of *personalization* × *cultural distance* and *personalization* × *technological distance* are positive but not statistically significant at any conventional level (see Table 4). This result is confirmed for each observation[7] and does not support Hypothesis 2a. However, although the coefficient of *personalization* × *technological distance* is not statistically significant at any conventional level, it is interesting to observe that in the range of 0.7-0.9 of the predicted probability of knowledge transfer, the interaction term is positive and predominantly statistically significant. In particular, the probability of observing reverse knowledge transfer can increase of 12.7% in average (s.d.=0.017) when parent companies increase their personalization strategy in presence of high technological distance (see Figure 6).

As far as Hypothesis 2b is concerned, the estimations in Table 4 reveal a positive and significant ($p<0.1$) coefficient of the interaction between *codification* and *cultural distance*. This result suggests that with an increase in the cultural distance between the parent and the subsidiary, an increase in using a codification KM strategy enhances the parent company's probability of transferring knowledge from its foreign subsidiary, thus reducing the negative effect due to the cultural distance (the coefficient of *cultural distance* is negative and

[6] For the sake of space, the output of Norton et al.'s (2004) procedure is available from the authors under request.
[7] See footnote 6.

significant at p<0.1). However, to assess the right impact of the interaction of *codification* and *cultural distance* on *knowledge transfer*, we should analyze the graphs plotted in Figure 4. Clearly, it emerges that only for those parent companies whose the predicted probability of transferring knowledge from the foreign subsidiary is within the 0.4-0.8 interval, the interaction effect of codification and cultural distance has a positive and statistically significant impact (about 75% of the observations) on knowledge transfer. In particular, an increase of the codification KM strategy in presence of high cultural distance amplifies the probability of observing reverse knowledge transfer of 21.3% in average (s.d.=0.025). If we consider the observations within the other ranges of the predicted probability of knowledge transfer, the interaction effects result positive, with the exception of a bunch of observations around 0.1, with a negative interaction effect. However, for very few (about 3%) of these observations the interaction effect is statistically significant at any conventional level.

Insert Figures 3-6 around here

The estimations in Table 4 also show that the negative effect of *technological distance* on the probability of observing knowledge transfer form the foreign subsidiary to the parent company can be reduced through a greater utilization of the codification KM strategy, as shown by the positive and significant (p<0.1) coefficient of *codification* × *technological distance*. However, from the analysis of the graphs plotted in Figure 5, the moderator effect of *codification* on *technological distance* emerges to be significant only for those parent companies whose the predicted probability of transferring knowledge from their foreign subsidiaries is within the 0.6-0.9 interval. In this range about 94% of the observations have a significant interaction term. When parent companies enhance their codification KM strategy in presence of high technological distance the probability of observing reverse knowledge transfer can increase of 26% in average (s.d.=0.048). For the observations in the left side of

the predicted probability, the effect of the interact term is mix. However, the majority of these observations have the *z*-statistic included in the lower band of statistical significance. Accordingly, Hypothesis 2b is only partially supported.

Implications and Conclusion

Implications for research and practitioners, limitations and future research directions. Limitations: number of observations and interaction effects.

Tables and Figures

Table 1 – Sample's representativeness

	Sample frame	Non Respondent	Respondent	χ^2 test
Sectors				
Science based	44	29	15	0.0757*
Specialized suppliers	65	42	23	0.0122**
Scale intensive	163	125	38	0.9765
Supplier dominated	86	78	8	0.0003***
Size				
50 – 249	98	80	18	0.1624
250 – 499	81	66	15	0.2325
500 – 5000	145	102	43	0.0225**
> 5000	34	26	8	0.9924
Parent company's location area				
North West	202	149	53	0.1587
North East	109	82	27	0.6994
Centre	40	36	4	0.0330**
South – Island	7	7	0	0.1390

* p< .10; ** p< .05; *** p< .01

Table 2 –Measure of Knowledge Transfer Mechanisms [a]

Variable	*Personalization*	*Codification*
TRANSFER OF MANAGERS	0.942	0.040
TRANSFER OF PROFESSIONALS	0.942	0.062
EXCHANGE OF TECHNICAL DOCUMENTS	0.104	0.846
INTERNET INSTRUMENTS	0.012	0.858
Eigenvalues	1.876	1.367
Cumulative variance %	46.89	81.08
Cronbach's alpha	0.877	0.629

[a] The factors are obtained using a principal component analysis.

Table 3 – Descriptive statistics

N° observations = 303	Mean	S.D.	Min.	Max	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) Knowledge transfer	0.25	0.43	0.00	1.00										
(2) Subsidiary propensity to innovate	1.83	2.40	0.00	9.00	0.16									
(3) Greenfield	0.31	0.46	0.00	1.00	0.10	–0.14								
(4) Subsidiary size	4.25	1.29	0.69	9.32	–0.02	0.10	–0.27							
(5) Subsidiary autonomy	2.31	0.83	1.00	5.00	0.03	0.19	–0.02	0.02						
(6) Parent intangible assets/N° employees	0.02	0.07	0.00	0.32	0.19	–0.04	0.00	0.06	–0.10					
(7) Personalization	0.00	1.00	–1.41	1.81	0.32	–0.20	0.03	0.10	0.28	–0.15				
(8) Codification	0.00	1.00	–2.29	1.24	0.18	–0.01	0.18	–0.06	0.14	–0.01	–0.03			
(9) Cultural distance[a]	1.21	0.95	0.23	3.87	–0.00	–0.17	0.04	–0.17	0.05	–0.15	0.12	0.04		
(10) Geographical distance[a]	3.44	3.44	0.49	16.33	–0.08	–0.06	0.15	0.01	0.11	0.00	–0.01	–0.03	–0.08	
(11) Technological distance[a]	0.35	0.52	0.00	2.00	–0.39	–0.12	0.00	–0.08	–0.18	–0.15	–0.28	0.03	0.07	–0.08

[a] The variable is centralized. The table lists the means, standard deviations, minima, and maxima of these variables prior to the centralization.

Table 4 – Logit analysis results for the probability of observing knowledge transfer from the foreign subsidiary to the parent company

	Model 1	Model 2	Model 3	Model 4	Model 5
Intercept	–2.17 (1.06)**	–2.21 (1.06)**	–2.37 (1.07)**	–2.33 (1.06)**	–2.57 (1.08)**
Subsidiary propensity to innovate	0.24 (0.09)***	0.22 (0.10)**	0.24 (0.10)**	0.24 (0.10)**	0.24 (0.10)**
Greenfield	0.57 (0.45)	0.34 (0.42)	0.26 (0.41)	0.27 (0.41)	0.27 (0.41)
Subsidiary size	–0.09 (0.17)	–0.03 (0.18)	0.01 (0.19)	0.00 (0.18)	0.01 (0.19)
Subsidiary autonomy	0.00 (0.26)	–0.08 (0.26)	–0.15 (0.24)	–0.16 (0.24)	–0.16 (0.24)
Parent intangible assets/N° employees	1.48 (3.09)	0.17 (3.09)	–0.05 (3.19)	0.10 (3.17)	0.15 (3.18)
Personalization	0.76 (0.32)**	0.61 (0.39)	0.57 (0.34)*	0.56 (0.33)*	0.67 (0.34)*
Codification	0.53 (0.31)*	0.42 (0.39)	0.76 (0.39)*	0.77 (0.38)**	1.23 (0.40)***
Cultural distance	–0.23 (0.19)	–0.38 (0.20)*	–0.64 (0.34)*	–0.64 (0.34)*	–0.64 (0.34)*
Geographical distance	–0.11 (0.07)*	–0.11 (0.07)	–0.09 (0.07)	–0.08 (0.07)	–0.08 (0.07)
Technological distance	–1.90 (0.58)***	–1.88 (0.57)***	–1.86 (0.57)***	–1.86 (0.57)***	–2.23 (0.64)***
Personalization×Codification		0.99 (0.50)**	0.85 (0.40)**	0.85 (0.39)**	0.86 (0.39)**
Personalization×Cultural distance			0.24 (0.26)	0.23 (0.27)	0.24 (0.27)
Codification×Cultural distance			0.89 (0.48)*	0.88 (0.48)*	0.88 (0.49)*
Personalization×Geographical distance				–0.03 (0.08)	–0.03 (0.08)
Codification×Geographical distance				0.00 (0.09)	0.01 (0.09)
Personalization×Technological distance					0.18 (0.37)
Codification×Technological distance					0.79 (0.41)*
N° of observations	303	303	303	303	303
Log-likelihood	–117.60	–107.60	–103.37	–103.26	–102.91
Wald χ^2	29.62***	39.09***	41.93***	44.97***	82.48***
McFadden's Adjusted Pseudo-R^2	0.265	0.316	0.329	0.318	0.309

In brackets robust standard errors corrected for heteroschedasticity and cluster-correlated data.
* p< .10; ** p< .05; *** p< .01 (two-tailed tests applied)

Figure 1 – Conceptual Model of the Study (with Indication of Hypotheses)

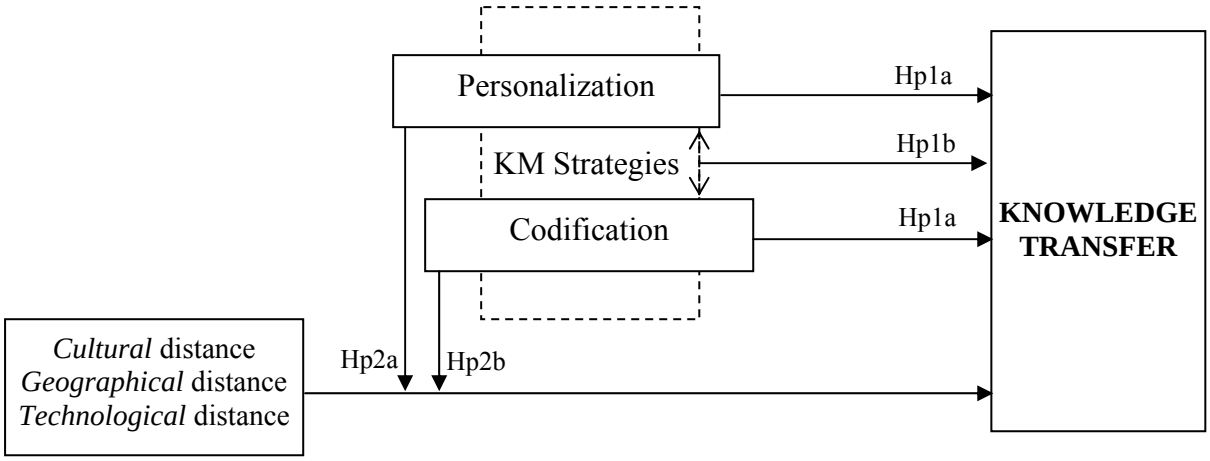
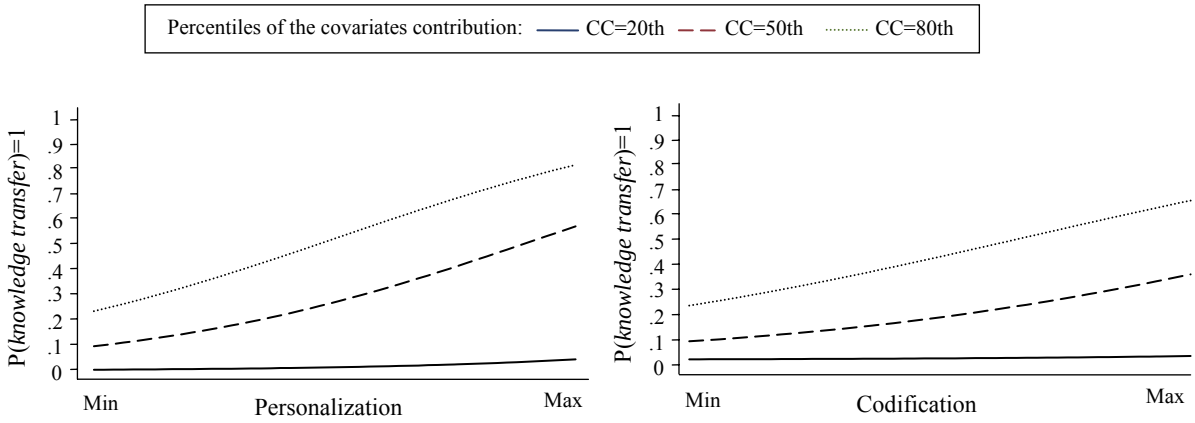


Figure2 – Main effects: two-dimensional graphs of logistic regression surface in probability scale

(a) Predicted probabilities of knowledge transfer as a function of personalization and codification and the covariates contribution.



(b) Predicted probabilities of knowledge transfer as a function of cultural and technological distance and the covariates contribution.

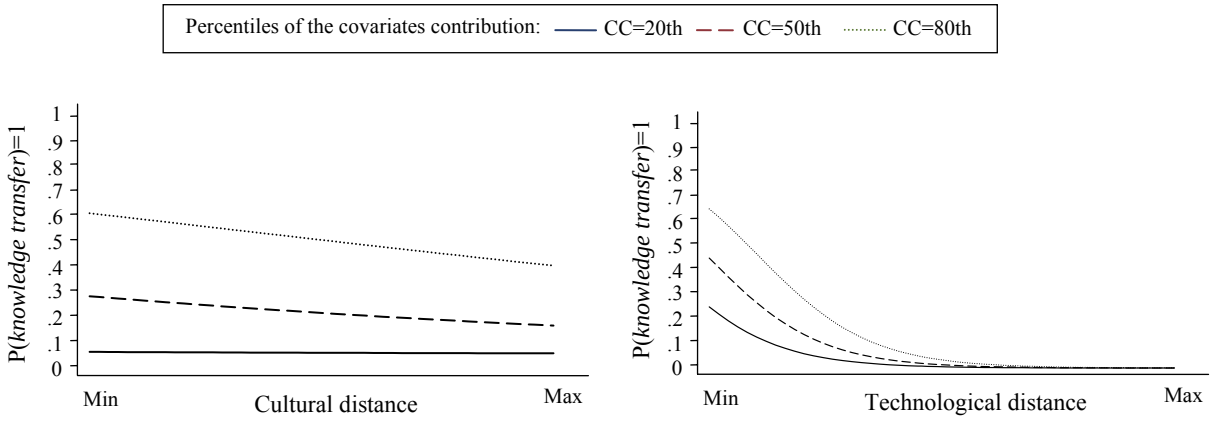


Figure 3 - Effect and Statistical Significance of the Interaction of Personalization and Codification on Knowledge Transfer

Figure 3a

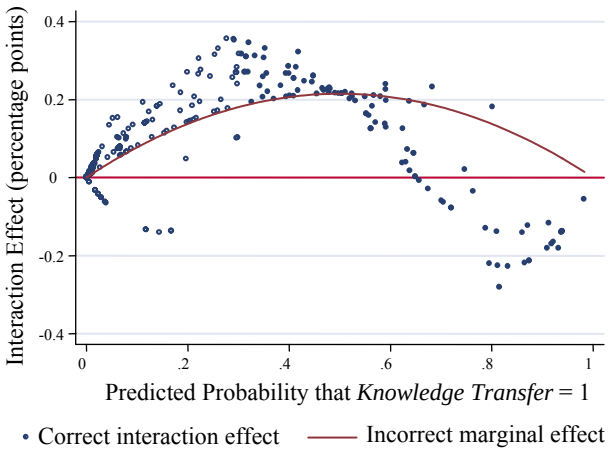


Figure 3b

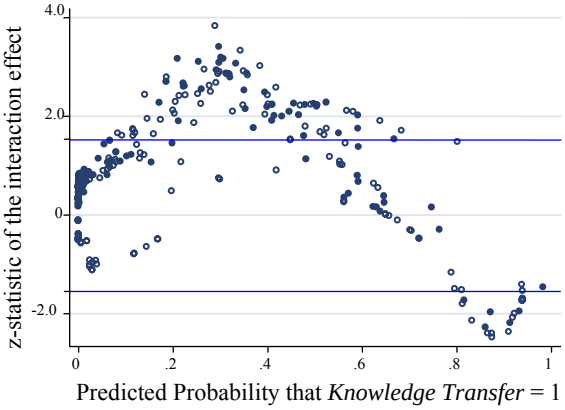


Figure 4 - Effect and Statistical Significance of the Interaction of Codification and Cultural Distance on Knowledge Transfer

Figure 4a

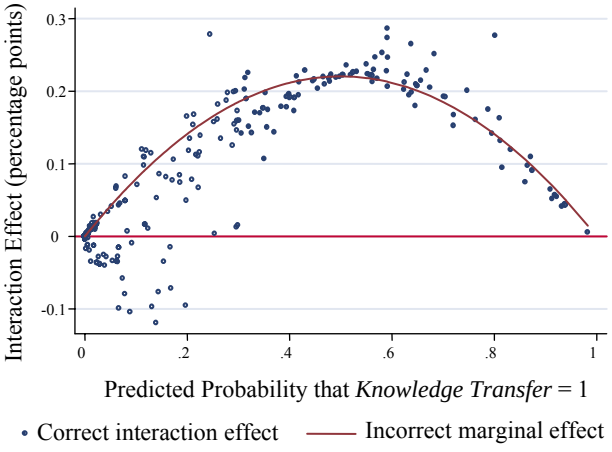


Figure 4b

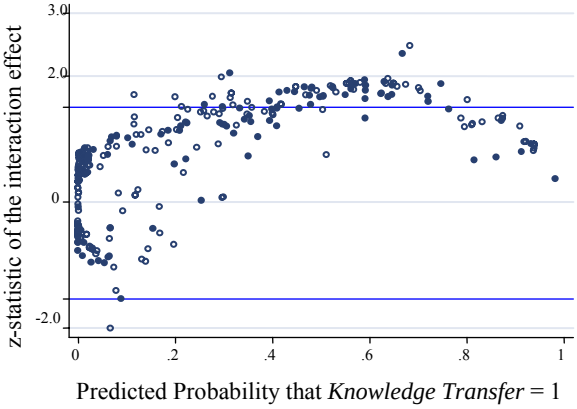


Figure 5 - Effect and Statistical Significance of the Interaction of Codification and Technological Distance on Knowledge Transfer

Figure 5a

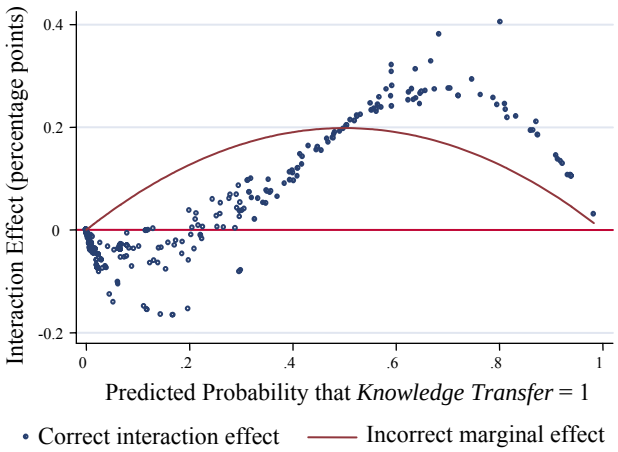


Figure 5b

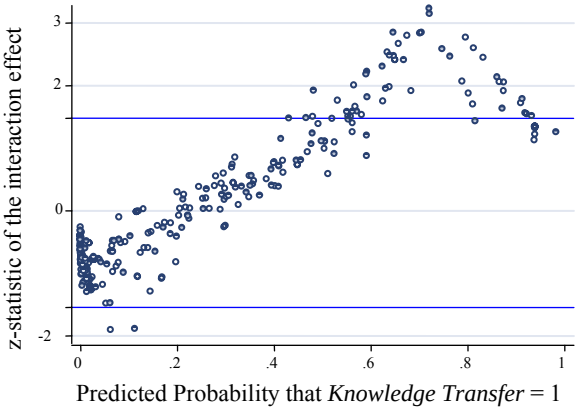


Figure 6 - Effect and Statistical Significance of the Interaction of Personalization and Technological Distance on Knowledge Transfer

Figure 6a

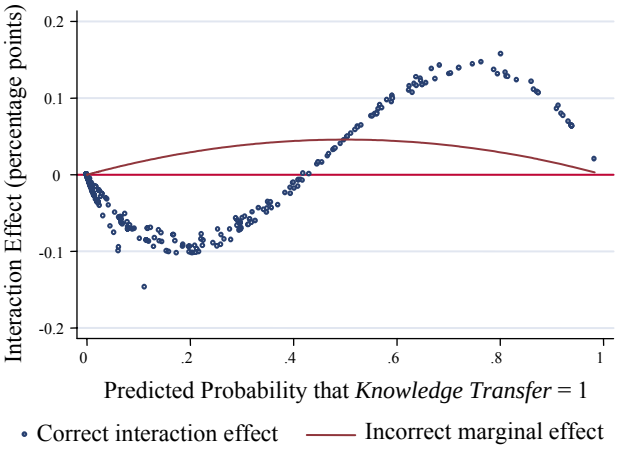
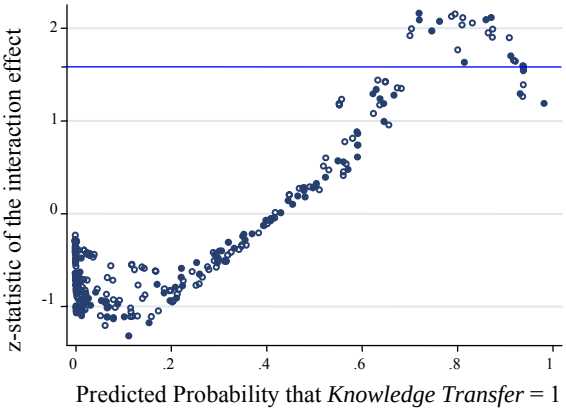


Figure 6b



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