Knowledge Intermediation Strategies: Novel Evidence from Canada

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Abstract

This study investigates i) difference in knowledge intermediation strategies among knowledge and technology transfer organizations (KTTOs) and ii) the factors that explain such differences. It uses data from 212 Canadian KTTOs. When knowledge delivery and integration capabilities dimensions of knowledge intermediation are simultaneously accounted for, four categories of KTTOs emerge, namely, 1) *knowledge stores*; 2) *knowledge match providers*; 3) *knowledge integrators* and; 4) *knowledge brokers*. This heterogeneity results in a differentiation in KTTOs' service delivery strategies. A high absorptive capacity and an effective customer knowledge management strategy are conducive to richer service content and custom-made solutions. Larger knowledge intermediaries suffer from internal organizational stickiness that prevents them from delivering custom-made services. KTTOs with a low degree of formalization and centralization in decision-making are likely to adopt intermediation strategies aimed at reaching the largest possible number of users. Some managerial and public policy implications are drawn.

Keywords: Knowledge intermediaries; Service delivery richness spectrum; Typology of KTTOs; Survey; Canada; Multinomial Logit Model.

1. Introduction

As national systems of innovation (SNI) become more complex, both the geographic and cognitive distances between new knowledge users and innovators increase. These, coupled with the variety of knowledge sources and the diversity of the needs and wants of new knowledge customers, have resulted in the emergence of a new breed of players, broadly known as knowledge intermediaries or knowledge and technology transfer organizations (KTTOs). Their specific role is to articulate the supply of and the demand for new knowledge and ideas. The importance of their role have been extensively studied (Gibbert et al. 2002; Szulanski, 1996; Howells, 2006; Muscio, 2010; Siegel et al., 2007; Hassik, 1997; Huysman et al., 2004; Klerkx and Leewis, 2008; Vos, 2005; Coehoorn et al., 1991; Bessant & Rush, 1995; Shohet & Prevezer, 1996). However, a review of this extensive literature shows that little attention has been paid to i) the types of KTTOs; ii) the strategies they use in deciding on the ways in which they acquire, transform and ultimately deliver knowledge to their clients. In addition, these priors study do not concern themselves with the factors that explain differences in KTTOs' intermediation strategies (Szulanski, 1996; Meyer, 2010; Howells, 2006; Callon, 1980; 1994; Cash, 2001; 2014; Bessant & Rush, 1995; Hoppe and Ozdenoren, 2005; Howells, 2006; Landry et al., 2013; Lomas, 2007; 2000; Blondel, 2006; Meyer, 2010). This study builds

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on and extends results from these previous studies. Its central question is what intermediation strategies KTTOs adopt and why?. In response, it thus investigates the following key research questions: 1) How can the integration and the delivery dimensions of knowledge brokering activities be accounted for so as to establish a typology of KTTOs to highlight differences in their knowledge intermediation strategies?; 2) What factors/determinants underline these differences in strategies?; and 3) what are the implications of these findings both from a managerial and a public policy points of view and for future research on knowledge intermediation? The paper grounds theoretically itself into the resource-base theory of the firm (Bower, 1970) and adapts and enhances the Service delivery richness spectrum (SDRS) (Simard, 2008). On the empirical ground, unlike many prior studies that relied on either case studies or a given type of KTTO, (Sieg et al. 2010; Cilio, 2005; Diaz-Puente et al., 2009; Rasmusen et al. 2006; Janis, 2003; Hanel, 2006; Hewitt-Dundas, 2012; McAdam et al. 2012) and a limited number of services (Debackere &Veugelers, 2005; Agrawal, 2001; Jensen et al. 2003; Siegel et al. 2003; 2000; 2007), this study uses data from 212 Canadian KTTOs comprised of 4 types of intermediaries, namely, university technology transfer offices (UTTO); community colleges technology transfer offices (CCTOs); not-for-profit knowledge and technology transfer offices (NPO); and public research organizations (PRO). These 212 KTTOs offer 24 different services, a much larger set of services than that found in most empirical studies.

The remaining of the paper is organized as follows. Section 2 presents the SDRS and reviews the factors that may cause KTTOs to choose a given intermediation strategy instead of another. It also sets the study hypotheses. Section 3 describes the methodology of the research. This is followed by a presentation of the theoretical model in section 4. The empirical part of the paper focuses on the presentation of the regression models and their results in section 5. Section 6 summarizes these results and draws some managerial and public policy implications of these results.

2. The Service delivery richness spectrum (SDRS) framework and knowledge/technology intermediation

The Service delivery richness spectrum (SDRS) framework was developed by Natural Resources Canada (NRCan) (Simard, 2006; Simard, 2008) to gain a better "understanding of how government departments develop and provide science-based services". It is based on the idea that as knowledge is created and flows from creators to users, it goes through a number of stages including the transformation/translation stage, the combination/integration stage, the transfer stage and ultimately the utilization stage. As such, the transmission spectrum goes from the "reach" zone where the audience is much wider, to the "rich" zone where the audience has specific technical/specialized knowledge and needs. We adapt and enhance this framework in two ways: first, we extend it to the case of other types of KTTOs to investigate and better understand the factors explaining the "*positioning and distribution of their mix of services to various users along the delivery richness spectrum*" (Natural Resources Canada, 2006; Simard, 2008). More specifically, we integrate the delivery and integration capabilities of KTTOs to establish a typology and highlight different intermediation strategies. Second, we investigate the factors that cause any given KTTO to position itself either into the "reach" zone of the delivery spectrum or into the "rich" delivery zone. Below, we present these factors successively using as background the resource-based theory of the firm. They are operationalized in Appendix A along with their descriptive statistics.

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2.1 Richness service delivery capabilities

This factor refers to the degree of customization of the services offered by a given KTTO. It is measured at three different customization levels: i) KTTO offers non-customized services; ii) when mixed services are offered and iii) when fully-customized services are provided. We contend that given their limited resources, in the process of articulating and translating both the supply of and the demand for knowledge, KTTOs try to identify solutions to problems by combining/recombining new and old ideas to create new knowledge (; Coppolino & Abbate, 2012; Colombo et al., 2014; (Gwinner at al., 2005; Vargo, 2008; Teece, 2009; 1998)). This may result in custom-made solutions that are effective, convenient and affordable for their client firms. However**,** since most KTTOs are small or medium-sized with limited financial and managerial expertise and resources, a fully-customized solution may be difficult to achieve. A possible compromise is to offer services that provide a lesser level of customization by positioning oneself in the "reach" universe of service delivery.

Hypothesis 1: The higher the degree of customization of solutions offered by a KTTO, the higher the likelihood its mix of services will be in the rich zone of the delivery spectrum.

2.2 Service delivery reachness capabilities

The service delivery reachness capabilities are measured by a KTTO's innovativeness. It takes the value of 1 if the KTTO offered new or significantly improved services to its clients during the 3 years preceding the survey and 0, otherwise. As KTTOs attempt to reach a wider and more diversified clientele, they will have to offer their clientele an ever increasing number of new and/or significantly improved products/services. Thus, one would expect that the more innovative a KTTO, the greater its service delivery capabilities and the larger the audiences it may reach and deliver services to. In fact, such a KTTO is more likely to be more flexible and to think outside the box when identifying and assessing its customers' needs, and identifying the knowledge to adequately satisfy these needs (Szulanski, 1996; Simard, 2006; Salomann et al., 2005; Gebert et al., 2003).

Hypothesis 2: The more innovative a KTTO, the higher the likelihood its mix of services will be in the reach zone of the delivery spectrum.

2.3 Revenue generation capabilities

The survival of KTTOs as economic units depends largely, among other things, on the revenues they generate from their activities. The willingness of firms to pay for the services they acquire from KTTOs measures, at least in part, the value created. Thus, KTTOs must incorporate customers' wants and needs into the development of their services so as to generate maximum profits/revenues (Simard, 2006; Salomann et al., 2005; Gebert et al., 2003). This value, i.e., the cost to client firms, is likely to increase as the level of customization of services increases. Put differently, the type and the amount of services offered by KTTOs will be positively associated with higher or moderate revenue streams from client firms.

Hypothesis 3: KTTOs with smaller amounts of revenues are more likely than others to offer services in the reach zone of the delivery spectrum.

2.4 Absorptive capabilities

As convincingly argued by Klerkx and Leeuwis (2008), the adequate articulation of demand and supply of innovation is critically important as most of KTTOs' clients are SMEs which may experience difficulties in clearly stating their needs due to the lack of managerial, financial and technical expertise. Thus, KTTOs need sufficient absorptive capabilities (Cohen and

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Levinthal, 1990; Zahra and George, 2002) to intermediate effectively and to lessen the uncertainty related to new knowledge acquisition, transfer and utilization (Klerkx and Leeuwis, 2008; Hoppe and Ozdenoren, 2005). A key resource needed by KTTOs in this respect are their employees, in particular, employees with scientific and business expertise (Gwinner et al., 2005; Neu & Brown, 2005; Walsh et al., 2008). A scientific background is necessary for understanding the underlying science and technology issues involved in the services being provided. Likewise, a training in business helps KTTOs' employees understand the business issues involved in knowledge and technology transfer, and to develop and provide the business components of knowledge and technology transfer services. Overall, the larger the number of these two types of employees within a given KTTO, the more it will be able to offer increasingly more refined services (Kuhltahau, 1991; Simard, 2006).

Hypothesis 4: The number of employees with specialized technical, financial and managerial skills will positively impact on a KTTO's ability to deliver services in the rich zone of the service delivery spectrum.

2.5 Information management capabilities

Information management capabilities include the information generation and search/finding capabilities as well as information/storage and diffusion capabilities. We contend that the information search process (ISP) in the form of using general sources of information such as libraries and the Internet coupled with the ability to search specialized databases are all critical to the effectiveness of service delivery process (Landry et al. 2013; Kuhlthau, 1991; Taylor, 1986; Wilson, 1981). This process also includes putting in place both an effective information retrieval strategy and a rigorous customer knowledge management (CKM) strategy geared toward making "knowledge *for*, *from* and *about* customers" works so as to create an effective customer relationship (CRM) strategy and higher-value customer services (Bose & Sugumaran, 2003; Davenport et al., 2001; Salomann et al., 2005; Gibbert et al., 2002; Davenport & Klahr, 1998; Thomke & von Hippel, 2002; von Hippel, 1977; Woodruff, 1997) .

Hypothesis 5: An increased use of general as well as technical resources for information retrieval and customer knowledge management by KTTOs will positively impact on their capabilities to deliver services in the rich zone.

2.6 Network brokering capabilities

These network capabilities are operationalized by using indicators of the strength of the relationships forged by KTTOs (Hansen, 1999; Gwinner et al., 2005) as well as the importance of market, institutional, and information networks. KTTOs facilitate the linking of "innovation seekers" and "innovation solvers" (Coppolino and Abbate, 2012) and are thus able to establish effective communication channels between "the know-how, the know-why, the know-when and the know-who". For an effective service delivery process, they have to manage many types of networks, including social, industrial, scientific and technological networks (Bidault and Fischer, 1994; Chesbrough, 2003; Fleming and Waguespack, 2007; Meyer, 2010; Lomas, 2007; 1997; Blondel, 2006; Kash & Rycott, 2000; Darroch & McNaughton, 2002; Tether, 2002; Romijn & Albaladejo, 2002). Participation in such networks allows KTTOs to identify and acquire ideas and information that complement and validate their in-house knowledge, thus contributing to increasing the likelihood of success of their service delivery projects (Malecki & Tootle, 1996; Bougrain & Haudeville, 2002; , 2006; Cooke and Wills, 1999).

Hypothesis 6: Increased KTTOs' network brokering capabilities will positively impact on their ability to deliver services in the rich zone.

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2.7 Control variables: size and types of organizations

2.7.1 Size

Based on the review of the relevant literature, two control variables were introduced into this study, namely, the size and the types of KTTOs. A KTTO's size as measured by the number of employees accounts for the impact of resource availability on knowledge delivery services (Amara et al. 2013; Tether, 2002; Landry et al., 2002; Koberg et al., 2003; Becheikh et al., 2006; Schartinger et al., 2002). Larger KTTOs are likely to have more in-house technical and financial resources as well as managerial expertise to offer their clients custom-made solutions. However, in contrast to their smaller counterparts, they may lack the necessary flexibility to respond in a timely manner to rapidly changing customer needs and wants due to internal stickiness arising from the "not-invented-here" (NIH) syndrome (Hayes & Clark, 1985; Szulanski, 1996; Katz and Allen, 1982) and their heavy tendency of relying on "core competencies" (Nelson, 1993; Traoré, 2004). We expected the negative impact of NIH syndrome to outweigh the positive impact of resource availability.

Hypothesis 7: A KTTO's size is negatively related to its ability to deliver services in the rich zone of the delivery spectrum.

2.7.2 Types of KTTOs

The type of KTTO accounts for any differences in the service delivery pattern stemming from differences in managerial philosophy and motives, as well as the environment in which the KTTO operates. Browne (2005) showed that organizations with lower degrees of formalization and centralization are more likely to be successful in transferring knowledge. Barnard et al. (2001), Landry et al. (2013); Landry et al. (2011); and Lloyd et al. (1997) also showed that other elements of organizational context as they relate to senior management willingness to engage in knowledge intermediation service delivery, do impact on the level and the type of service delivered. We therefore expect that KTTOs with lesser degrees of centralization and formalization, namely, UTTOs and NPOs, may have lesser constraining mandates in terms of performance goals and objectives and are therefore more likely to service a much larger clientele base and thus position themselves in the reach zone of the service delivery spectrum.

Hypothesis 8: UTTOs and NPOs are more likely than their counterparts to deliver services in the reach zone of the delivery spectrum.

3. Methodology: Questionnaire development and data collection

KTTOs in the study were identified by i) consulting the available listings of UTTOs and CTTOs and ii) by relying on the web sites of various Canadian and provincial government agencies to develop a list for PROs and NPOs. A snowball strategy, using references to other web sites, was also used to identify additional organizations. In the end, after excluding all those organizations that did not offer any knowledge and technology intermediation services to firms, a final population of 263 was obtained. A questionnaire developed with help from an advisory committee of the CEOs and Executive Directors of nine KTTOs was administered by a survey firm with extensive background in survey administration. By February 21, 2009, 212 interviews were completed. The response rate is thus 80.6% (212/263 organizations). This is a large enough number of organizations to capture the heterogeneity in intermediation organizations so as to develop a reliable taxonomy and investigate the factors influencing the differences in knowledge delivery strategy among KTTOs. Finally, to test for non-response bias in our sample, an analysis of early versus late respondents' answers to key variables of the study was also performed. The rationale for comparing early and late respondents is the assumption that late respondents are good proxies for non-respondents (Miller and Smith,

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1983; Radhakrishna and Doamekpor, 2008). More specifically, we performed a comparison between the first and last 10% of respondents (the latter being used as a proxy for the non-respondents) based on five explanatory variables used in the econometric models, namely, KTTO's size, market network index, institutional network index, information network index, and strength of ties index. An independent-sample T-test was run and used for the comparison. The results indicate that, on average, the early respondents sub-sample does not differ from the late respondents sub-sample, suggesting that non-respondents are similar to late respondents, and thus non-response bias is not a concern in our sample.

4. Theoretical model: Typology of KTTOs and Model's variables

As stated earlier, the typology of the KTTOs is based on the combination of two service delivery dimensions, namely, 1) knowledge transfer capacity (**knowledge delivery capacity**); and 2) knowledge integration capacity (**knowledge integration capacity**) (Table 1). The results of the Principal Component Factors Analysis (PCFA) to test for uni-dimensionality indicated that one factor explained 51.87% of the original variance of the knowledge delivery index, with an initial Eigenvalue of 2.59. Likewise, one factor explained 80.05% of the original variance with an initial Eigenvalue of 2.50. The scores of Cronbach's $\propto$ for reliability were .755 for the five items knowledge delivery capability index, and .793 for the four items of the knowledge integration capacity index. These values indicate that the items composing the two indices are reliable (Nunnally & Bernstein, 1994; DeVon et al., 2007). Using these two indices, we derived the typology of the KTTOs in two steps. First, the medians of the two indices were calculated. As can be seen in Table 1, the medians are equal to 16 and 14 for the index of knowledge delivery capacity and the index of knowledge integration capacity, respectively. Second, the four KTTOs configurations, used as dependent variables in our models, were derived by crossing the two indices as shown in Figure 1 and obtained as follows:

- **Knowledge stores**: (low knowledge delivery capacity and low knowledge integration capacity): index of knowledge delivery capacity ≤ 16 and index of knowledge integration capacity ≤ 14.

- **Knowledge match providers**: (high knowledge delivery capacity and low knowledge integration capacity): index of knowledge delivery capacity >16 and index of knowledge integration capacity ≤ 14.

- **Knowledge integrators**: (low knowledge delivery capacity and high knowledge integration capacity): index of knowledge delivery capacity ≤16 and index of knowledge integration capacity > 14.

- **Knowledge brokers**: (high knowledge delivery capacity and high knowledge integration capacity): index of knowledge delivery capacity > 16 and index of knowledge integration capacity > 14.

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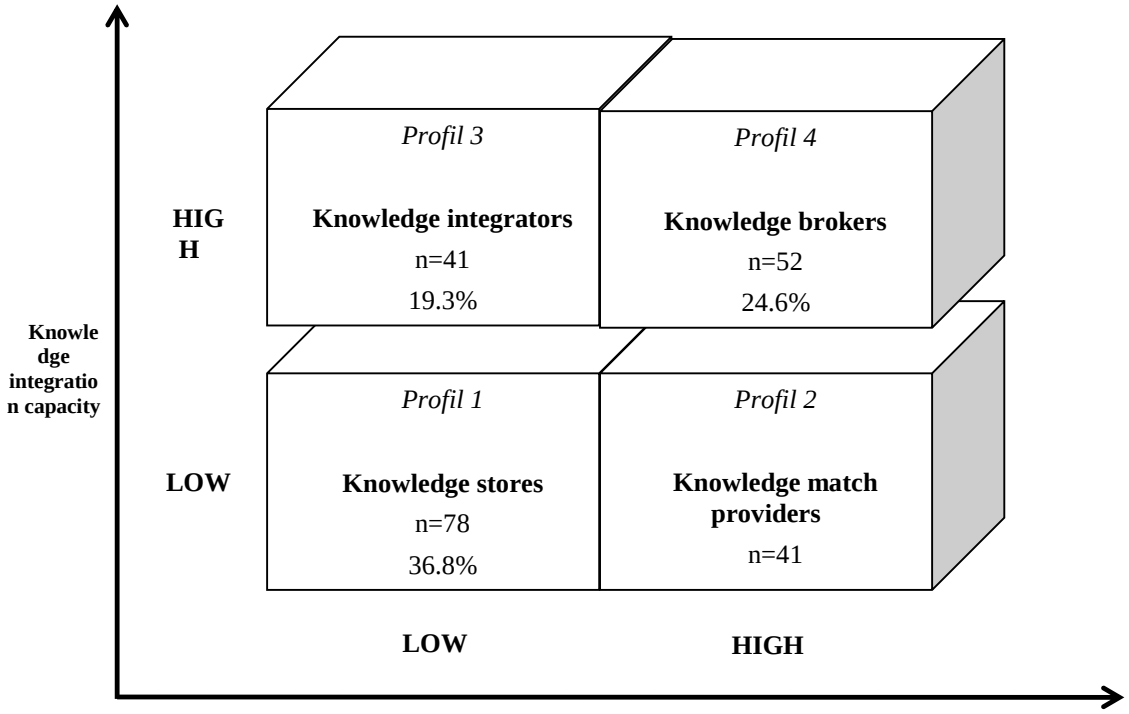

Figure 1: Typology of KTTOs with regard to their Knowledge delivery and knowledge integration capacities

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Table 1: Operational Definitions of the Four profiles of Service Delivery Richness Spectrum of Knowledge Transfer Through Services Provided to Private Firms: Configurations Are Built Using Two Indices

KNOWLEDGE DELIVERY CAPACITY	The sum on a 5-point scale, ranging from 1 (*Never*) to 5 (*Very often*), of the scores for items corresponding to respondents' answers regarding five aspects of knowledge transfer capacity through distribution of services to clients: • Seeking new geographic markets; • Extending current services to new categories of clients; developing new services; • Developing new services; • Developing and exploiting niches or specialized markets; • Providing customer-specific services (customizing services, delivery methods, after-sale services, etc.).
Median	16.00
Mean	15.39
Std	4.26
Minimum	5.00
Maximum	25.0
Eigenvalue	2.59
Variance Explained	51.87%
Cronbach's ∝	.755
KNOWLEDGE INTEGRATION CAPACITY	The sum on a 5-point scale, ranging from 1 (*Never*) to 5 (*Very often*), of the scores for items corresponding to respondents' answers regarding four aspects of knowledge integration capacity: • Using and updating databases of scientific information; • Developing measures favoring knowledge sharing between your employees; • Capturing and using knowledge obtained from other industry sources (e.g., industry associations, competitors, clients and suppliers); • Capturing and using knowledge obtained from public research institutions including universities and government laboratories
Median	14.00
Mean	13.58
Std	3.63
Minimum	4.00
Maximum	20.00
Eigenvalue	2.50
Variance Explained	62.51%
Cronbach's ∝	.793

4.1 Specification of the independent variables

The independent variables considered in this study were grouped into the 7 categories defined in section 2 and their descriptive statistics are presented in Appendix A. The reliability test for the nine multi-scale independent variables, namely, LnTIES, MARKET, INSTIT, INFOR, GENFIND, STOSPRE, LnENG, LnMNG, and LnSize, was performed by running a principal components factor analysis (PCFA) (Ahire & Devaray, 2001). The values of Cronbach's ∝ indicate that each index is reliable (see Appendix A). To test for the multicollinearity between the continuous explanatory variables in the model, we first, estimated both their pair-wise correlation coefficients and their tolerance statistic values. All the estimated values were much higher than .2, indicating that there is no multicollinearity issue (Menard, 1995; Field, 2006).

5. Empirical models and results

5.1 Empirical Models

Five situations were deemed relevant to the identification of the factors explaining differences in knowledge intermediation strategies: 1) adopting a knowledge broker strategy rather than a knowledge store strategy; 2) adopting a knowledge broker strategy rather than a knowledge match provider strategy; 3) adopting a knowledge broker strategy rather than a knowledge integrator strategy; 4) adopting a knowledge match provider strategy rather than a knowledge store strategy; and 5) adopting a knowledge integrator strategy rather than a knowledge store strategy. A multinomial Logit regression was estimated to ascertain the first three situations, while two bivariate logit regressions for the latter two options. For the multinomial logit

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regression model, the four alternative profiles are 1, 2, 3 and 4 as presented in Figure 1 with profile 4 being the reference category. For the two binary logit models, the alternative strategies/profiles are 2, 3 and 4. The probability of choosing any given profile k (with k = 1; 2; 3; 4) is given by:

$$\text{Prob}_{ik} = \frac{e^{\beta_k X_i}}{1+\sum_{k=1}^{4} e^{\beta_k X_i}} \quad (1)$$

where X_i is the matrix of the profiles' attributes and β_k is an m x 1 vector of parameters to be estimated. As a consequence, the multinomial model is expressed in logarithmic form as:

$$\text{Ln}\left(\frac{\text{Prob}_{i1}}{\text{Prob}_{i4}}\right) = (\beta_1-\beta_4)X_i = \beta_1 X_i$$

$$\text{Ln}\left(\frac{\text{Prob}_{i2}}{\text{Prob}_{i4}}\right) = (\beta_2-\beta_4)X_i = \beta_2 X_i$$

and (2)

$$\text{Ln}\left(\frac{\text{Prob}_{i3}}{\text{Prob}_{i4}}\right) = (\beta_3-\beta_4)X_i = \beta_3 X_i$$

5.2 Regression Results

As shown in Panel A of Table 2, all the models are significant at the 1% level: The multinomial model has a very good predictive power, with 60.5% of correct predictions. The value of the Nagelkerke R^2 is .598, and the computed value of the likelihood ratio (i.e., 167.17) is much larger than the critical value of the chi-squared statistic at the 1 percent level, with 63 degrees of freedom. Consequently, the model is significant at the 1 percent level. Similarly, the computed value of the Chi-square statistics for each of the two Logit regression models is greater than its critical values (i.e., 38.93) with 21 degrees of freedom at the 1% level. The two equations have good predictive powers, with 80.7% and 81.0% of overall correct predictions, respectively. Finally, the value of Nagelkerke pseudo R^2 is .534 for the first binary Logit regression model and .499 for the second model.

Results show that hypothesis 1 is supported as higher degrees of service customization lead to KTTOs being in the rich delivery zone. In fact, developing non-customized solutions for client firms (NOCUST) or developing mixed solutions (MIXED), rather than customized solutions (CUST) have a significant and negative impact on the likelihood that KTTOs adopt a profile of knowledge broker rather than one of knowledge match provider**.** Contrary to our prior expectations, hypothesis 2 is not supported. In fact, innovative KTTOs are more likely to deliver services in the rich zone as increased innovativeness is found to increase the likelihood of being a knowledge broker rather than a knowledge store, knowledge match provider, or a knowledge integrator**.** KTTOs that generated no revenues (NOREV) or moderate revenues (MODREV) from sale of services to firms are less likely to adopt a profile of a knowledge broker rather than one of a knowledge store. Moreover, KTTOs that generated no revenues (NOREV) as opposed to more sizeable revenues are less likely to adopt a profile of a

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knowledge broker rather than one of a knowledge integrator. Put differently, increased revenue generation capabilities increases both knowledge delivery and integration capabilities and increase the chances that knowledge integrating KTTOs become knowledge brokers. Thus hypothesis 3 is supported**.**

As for the absorptive capability variables, an increase in the number of employees with scientific or engineering training (LnENG) increases the likelihood that KTTOs be knowledge brokers rather than knowledge match providers, whereas an increase in the number of employees with management training (LnMNG) increases the likelihood that KTTOs be knowledge brokers rather than knowledge integrators and offer services in the rich zone of the delivery spectrum. These results lend support to hypothesis 4. Likewise, for the Information management capability variables, generation and finding of knowledge (GENFIND) has a significant and positive impact on the likelihood that a given KTTO adopts a profile of knowledge broker rather than one of a knowledge store, or one of a knowledge match provider, whereas storing and spreading knowledge (STOPRE) has a significant and positive impact on the likelihood that KTTOs adopt a profile of knowledge broker rather than one of a knowledge integrator. Thus, stronger knowledge search and retrieval capabilities increase the chances that KTTOs with knowledge store, knowledge match provider and knowledge integrator profiles better process knowledge *for, from* and *about* customers and ultimately allow them to deliver more refined and higher-value services and increases their likelihood of adopting a knowledge broker profile. Likewise, increased knowledge storage and diffusion/dissemination capacity will increase the probability for KTTOs with strong integration capacities (knowledge integrators) to strengthen their delivery capabilities and become knowledge brokers. In summary, hypothesis 5 is supported by the results. Hypothesis 6 is partially support. In fact, all the indicators of the network brokering activities, except for the strength of ties between KTTOs and their clients (LnTIES) lead to intermediation service delivery in the rich zone of the spectrum. As shown by the results, LnTIES has a significant and negative impact on the likelihood that KTTOs adopt a knowledge broker profile rather than a knowledge match provider or knowledge integrator profiles. In contrast, the market network index (MARKET) has a significant and positive impact on the likelihood that KTTOs be knowledge brokers rather than knowledge stores or knowledge integrators, whereas institutional networks (INSTIT) and information networks (INFOR) have significantly positive impacts on the likelihood that KTTOs be knowledge brokers rather than knowledge match providers. Thus, increased KTTOs brokering activities with regard to the cognitive distance with their customers and their leadership in different networks including market, information and institutional networks are conducive to higher level of customization of knowledge intermediation services**).**

Finally, for the control variables, the results show that an increase in the KTTO's size (LnSIZE) decreases its likelihood of being a knowledge broker rather than a knowledge store. Thus, larger KTTOs are less likely to provide custom-made services than their smaller counterparts and therefore are more likely to deliver services in the reach zone. This result suggests that organizational stickiness prevail in knowledge intermediation among the KTTOs surveyed and lends support to hypothesis 7**.** Likewise, with regard to the types of KTTOs, the results show that being Not-for-profit Organizations (NPOs) or University Technology Transfer Offices (UTTOs) rather than Public Research Offices (PROs) or CTTOs, decreases the likelihood that KTTOs be knowledge brokers rather than knowledge stores. Since NPOs and UTTOs are likely to be subjected to a lower degree of centralisation and formalization than other types of KTTOs, these results support the contention that such organizations are more successful in delivering knowledge intermediation services in the reach zone of the delivery spectrum that are geared toward a wider clientele base (Browne, 2005). Thus, hypothesis 8 is support

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Table 2. Results of the regression models

	PANEL A: Multinomial Logit Estimation						PANEL B: Binary Logit Estimation			
	[Knowledge store to Knowledge broker]		[Knowledge match provider to Knowledge broker]		[Knowledge integrator to Knowledge broker]		[Knowledge store to knowledge match provider]		[Knowledge store to Knowledge integrator]	
Independent variables	*Coeff. (β)*	*P-value*	*Coeff. (β)*	*P-value*	*Coeff. (β)*	*P-value*	*Coeff. (β)*	*P-value*	*Coeff. (β)*	*P-value*
Intercept	-5.977	.013	-14.310	.001	-1.860	.263	-1.896	.478	-4.272	.033
RICHNESS SERVICE DELIVERY CAPABILITIES										
Non-Customized solutions [NOCUST]	.845	.234	-1.977 ***	.007	-.330	.323	-1.141 **	.039	.560	.221
Mixed solutions [MIXED]	-.361	.693	-1.812 **	.023	-.153	.431	-3.506 ***	.004	.055	.492
Customized Solutions [CUST]	Benchmark		Benchmark		Benchmark		Benchmark		Benchmark	
REVENUE GENERATION CAPABILITIES:										
No revenues from sale of services [NOREV]	-1.322 **	.049	.948	.193	-1.531 **	.048	-1.058 *	.071	-.896	.284
Moderate revenues from sale of services [MODREV]	-1.446 *	.061	.550	.289	-.347	.739	.140	.473	.071	.537
Important Revenues from Sale of Services [IMPREV]	Benchmark		Benchmark		Benchmark		Benchmark		Benchmark	
ABSORPTIVE CAPAPABILITIES:										
Number of employees with scientific or engineering training [LnENG][a]	-.024	.492	.061 ***	.001	-.282	.223	.618 **	.048	-.022	.945
Number of employees with management training [LnMNG][a]	.465	.150	.175	.363	.782 **	.038	.585 *	.081	.018	.966
INFORMATION MANAGEMENT CAPABILITIES:										
Generation & finding of knowledge [GENFIND]	1.580 ***	.001	.485 ***	.002	.535	.254	1.317 ***	.009		
Storing & Spreading of knowledge [STOPRE]	.369	.185	.403	.425	.555 *	.081	.091 **	.029	.125	.391
NETWORK BROKERING CAPABILITIES:									-.152	.697
Strength of ties [TIES)	-.567	.287	-2.198 **	.046	-.156 ***	.009	-1.983 **	.043	-1.442 *	.081
Market networks [MARKET]	.205 **	.037	.191	.112	.188 **	.031	.222 *	.060	.213 **	.040
Institutional networks [(INSTIT]	.080	.185	.220 **	.029	-.071	.419	-1.28	.178	.131 *	.075
Information networks [INFOR]	.024	.430	.235 *	.072	-1.79	.192	-.059	.633	.250 ***	.009

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SERVICE DELIVERY REACHNESS CAPABILITIES:										
Innovative KTTO [INNOV) (YES=1)	1.036 **	.047	1.293 *	.091	2.246 ***	.003	1.202 **	.039	-.147	.419

Table 2. Results of the regression models (Continued)

	PANEL A: Multinomial Logit Estimation						**PANEL B: Binary Logit Estimation**			
	[Knowledge store to Knowledge broker]		**[Knowledge match provider to Knowledge broker]**		**[Knowledge integrator to Knowledge broker]**		**[Knowledge store to knowledge match providers]**		**[Knowledge store to Knowledge integrator]**	
Independent variables	*Coeff. (β)*	*P-value*	*Coeff. (β)*	*P-value*	*Coeff. (β)*	*P-value*	*Coeff. (β)*	*P-value*	*Coeff. (β)*	*P-value*
CONTROL VARIABLES:										
Size [LnSIZE] [c]	-.673 **	.035	-.073	.431	-.239	.240	-.278	.447	-.213	.484
Types of organizations										
College technological transfer office [CTTO]	-2.675	.342	1.045	.272	1.285	.325	.009	.995	-4.036 ***	.005
Not-for-profit organization [NPO]	-3.711 ***	.008	.386	.405	1.078	.358	-.868	.516	-4.436 ***	.001
University technological transfer office [UTTO]	-3.717 ***	.007	1.751	.181	1.219	.317	-1.449	.313	-3.804 ***	.002
Public Research Organization [PRO]	Benchmark		Benchmark		Benchmark		Benchmark		Benchmark	
Number of cases: (Total = 212)	78/52		41/52		41/52		78/42		78/41	
Chi-square (d.f.):	167.17 (*63*)						55.26 (*21*)		52.05 (*21*)	
Nagelkerke R^2 (Pseudo R Square):	.598						.534		.499	
Percentage of correct predictions:	60.5%						80.7%		81.0%	

*, ** and *** indicate that the coefficient is significant, respectively, at the 10%, 5% and 1% thresholds.
[a] Ln indicates a logarithmic transformation.

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6. Summary, managerial and public policy implications

The central research question of the study was how do KTTOs actually combine and manage their internal and external resources and capabilities to deliver services to customers with substantial differences in terms of needs, desires and wants? Our results show that when knowledge delivery and knowledge integration are simultaneously accounted for, 4 types of KTTOs emerge, namely, 1) *knowledge stores* with limited knowledge delivery and integration capabilities; 2) *knowledge match providers* with extensive delivery capabilities but limited integration capabilities; 3) *knowledge integrators* with limited delivery capabilities but extensive integration capacities and 4) *knowledge brokers* with extensive delivery and integration capabilities. Factors that are conducive to a richer service content and custom-made solutions include i) increased innovativeness; ii) increased absorptive capacity; iii) stronger information search and storage capabilities and; iv) shorter cognitive distance with customers; v) increased networking capabilities. Likewise, managing knowledge *from, for and about* customers is an effective value-creating intermediation strategy as it leads to a higher level of service customization. Larger firms suffer from internal organizational stickiness that prevents them from delivering custom-made services. As well, NPOs and UTTOs are more likely than others to adopt an intermediation strategy geared toward reaching the largest possible number of users.

These results suggest that for KTTOs' intermediation strategies to be effective, their managers need to i) adapt their positioning and distribution of mix of services to various users and ii) assess their knowledge delivery and integration capabilities by taking into account both their internal and external resource endowments. From a public policy perspective, this suggests that to promote more effective innovation diffusion/dissemination throughout the knowledge value-chain, decision-makers should no longer rely solely on the linear model of innovation diffusion. Rather, they should recognize KTTOs as an integral part of the national innovation system and use them as knowledge service delivery channels to reach different audiences. The results also suggest that managers of larger KTTOs will be more successful if they concentrate on providing more general types of intermediation services. The same holds for managers of less centralized and less formalized KTTOs such as university technology transfer offices (UTTOS) and not-for-profit organizations (NPOs). Thus, public policies aimed at reaching the greatest possible number of knowledge/technology users will be more effective if resources are provided to larger KTTOs and/or to UTTOs and NPOs to support their implementation. In contrast, resources should go to smaller KTTOs for services aimed at fulfilling specific clients' needs or at reaching specific audiences. Furthermore, public policies aimed at enhancing the role of knowledge intermediaries, if geared toward i) increasing KTTOs' access to more highly qualified workers such as engineers, scientists and management experts and/or ii) increasing KTTOs' information management capabilities, are likely to be successful as both of these factors lead to higher value services. Finally, the results suggest that KTTOs' managers can increase their revenues by improving both their service delivery and integration capabilities through greater service customization.

Some limitations of our study are worth mentioning. The study is about Canadian KTTOs This provides an opportunity for a comparative empirical study with for example some OECD countries with similar challenges in terms of the complexity of the innovation systems and knowledge markets. Moreover, as a cross-sectional study, it cannot capture the dynamics of knowledge intermediation. For example, any given KTTO may choose at any time to move along the knowledge delivery spectrum. This could not be accounted for in our model. In addition, we introduced into our models the types of KTTOs (UTTOs, NPOs, PROs and CTTOs) to account for differences in knowledge delivery strategies stemming from differences

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in managerial philosophy and motives. We were able to make only general statements in regards to the impact of such factors. Given the results suggesting that such differences may in fact play an important role in defining the position and the mix of services provided by KTTOs, further research is warranted to further investigate this issue. In spite of these limitations, the results of this study have enhanced our understanding of the knowledge intermediation process from both a theoretical and an empirical points of view.

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Appendix A. Definitions of independent variables and descriptive statistics

	Measure	Sub-items	Mean (SD)	Percentage (Number)	Cronbach's alpha [Unidimen-sionnality][a]
RICHNESS SERVICE DELIVERY CAPABILITIES	Three dichotomous variables constructed with respect to the responses of the organization to the following question: *Which of the following statements best describes the services you offered to private firms over the last three years?*				
		Non-customized solutions (NOCUST): (*Mainly basic research* & *Almost only basic research=1; Else=0)*		19.3 %	
		Mixed solutions (MIXED): (*Half-customized solutions and half-basic research=1; Else=0)*		38.7 %	
		Customized solutions (CUST): (*Almost only customized solutions* & *Mainly customized solutions=1; Else=0)*		42.0 %	
		CUST is the reference category.			
REVENUE GENERATION CAPABILITIES	Three dichotomous variables constructed with respect to the responses of the organization to the following question: *Please estimate (as best you can) the percentage of sale of services in your organization's total budget over the last three years?*				
		Non-revenue from sale of services (NOREV): (*0% of organization's total budget from sale of services=1; Else=0)*		47.6 %	
		Moderate revenue from sale of services (MODREV): (from *1% to 25% of organization's total budget from sale of services=1; Else=0)*		24.1 %	
		Important revenue from sale of services (IMPREV): (*more than 25% of organization's total budget from sale of services=1; Else=0)*		28.3 %	
		IMPREV is the reference category.			
SERVICE DELIVERY REACHNESS CAPABILITIES [INNOV]	Dichotomous variable indicating whether the KTTO has offered, over the last three years preceding the survey, to private firms, any new or significantly improved services?				
		% of Yes		73.1 %	

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NETWORK BROKERING CAPABILITIES :				
Strength of ties with clients [LnTIES]	Measured as a weighted index on a 5-point Likert scale (1 = *Very close: practically like being in the same work group; 2= Somewhat close: like discussing and solving problems together; 3= Somewhat distant: like with people that you do not know well; 4= Distant: like a working group with which you can only have a quick exchange of information; 5= Very distant: practically like with people that you do not know at all*) describing the working relationship between organizations and their clients in the following sectors.	Industry Public sector organizations, government departments/agencies universities colleges	1.82 (.54)	.692
Market networks [MARKET]	Measured as a weighted index on a Likert scale of frequency ranging from 1 = *Never* to 5 = *Very often* of the use of the organization, over the last three years preceding the survey, to rate the degree of frequency of use of the following four information sources for the development and improvement of services offered to private firms:	Suppliers of equipment, materials, components, or software Clients or customers Competitors or other organizations in your sector Consultants	2.99 (.73)	.744

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Institutional networks [INSTIT]	Measured as a weighted index on a Likert scale of frequency ranging from 1 = *Never* to 5 = *Very often* of the use of the organization, over the last three years preceding the survey, to rate the degree of frequency of use of the following six information sources for the development and improvement of services offered to private firms:	Universities or other higher education institutions Colleges/technical institutes Federal government research laboratories Provincial government research laboratories Private non-profit research laboratories Patent databases	2.48 (.84)	.835
Information networks [INFOR]	Measured as a weighted index on a Likert scale of frequency ranging from 1 = *Never* to 5 = *Very often* of the use of the organization, over the last three years preceding the survey, to rate the degree of frequency of use of the following four information sources for the development and improvement of services offered to private firms:	Conferences, fairs, exhibitions Scientific journals and trade/technical publications Investors (banks, venture capitalists, etc.) Industry associations	2.90 (.84)	.694

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Appendix A (Continued). Definitions of independent variables and descriptive statistics

INFORMATION MANAGEMENT CAPABILITIES:				
Generation & Finding of knowledge [GENFIND]	Measured as a weighted index on a Likert scale of frequency ranging from 1 = *Never* to 5 = *Very often* of the use by the organizations, over the last three years preceding the survey, of the following five tools for the development and improvement of their services offered to private firms:	Data mining/ text retrieval software Expert or decision support software Automatic e-mail alerts Intelligent agent or artificial intelligence Mind/knowledge mapping software	2.28 (.98)	.770
Storing & Spreading of knowledge [STOSPRE]	Measured as a weighted index on a Likert scale of frequency ranging from 1 = *Never* to 5 = *Very often* of the use by the organizations, over the last three years preceding the survey, of the following four tools for the development and improvement of their services offered to private firms:	Content/document management software Intranet or enterprise information portal Knowledge repository or digital archive Workflow/process management software	2.86 (.95)	.738
ABSORPTIVE CAPABILITIES:				
Employees with scientific or engineering training [LnSCENGIN]	Measured as number of employees with scientific or engineering training. This variable was matched with the normal distribution using a logarithmic transformation		26.19 (55.27)	
Employees with business training [LnMNG]	Measured as number of employees with business training. This variable was matched with the normal distribution using a logarithmic transformation		4.87 (8.47)	
CONTROL VARIABLES:				

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Size of KTTOs [LnSIZE]	Measured by the total number of full-time employees (equivalent full time) in 2008. This variable was matched with the normal distribution using a logarithmic transformation	46.57 (85.68)
Types of organizations	A series of dichotomous variables indicating the types of organization. The organizations are regrouped in four types:	
	Not-for-profit organization (NPO)	36.3 %
	College technological transfer office (CTTO)	25.5 %
	University technological transfer office (UTTO)	19.8 %
	Public research organization (PRO)	18.4 %
	The reference category is Public Research Organization (PRO).	

[a] The unidimensionality of constructs with multiple item scales was assessed by conducting a principal components factor analysis for each construct (PCFA). The results of these analyses indicate that the unidimensionality criterion was satisfied

Biography:

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Dr. Namatié Traoré is a Visiting Professor with the Telfer School of Management and a former Fulbright Fellow.

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