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In-house Off-shoring of Product Development by MNCs

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ABSTRACT

This paper deals with in-house off-shoring of product development activities, here defined as the cost and efficiency motivated shifting of product development projects within the network of multinational companies (MNC) to low and medium wage countries. The aim of the paper is to develop and test a succinct model which is based on transaction cost reasoning and which explains how and why different governance forms can be combined in order to reap efficiency gains in off-shoring. The results from a structural equations model suggest support for a configuration which positively associates in-house off-shoring with local outsourcing and negatively associates in-house off-shoring with local cooperation in product development. The results are moderated by size and age of the MNC subsidiary, suggesting that larger subsidiaries are more likely to become an offshore destination and to outsource part of their product development. I argue that this combination of governance forms increases scale, flexibility and speed to market while reducing costs and knowledge leakage hazards. The results imply that the internalization theory should be extended in order to take account of off-shoring and its distinctive characteristics.

Key words: offshoring; MNC subsidiaries; product development.

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Introduction

In the past, off-shoring has been primarily concentrating on lower-value added service jobs, such as call-centers or the compilation and maintenance of databases. In recent years, however, this has changed as off-shoring is reaching increasing numbers of higher-value added activities, such as financial service back office jobs, software development or research and product development (R&D) activities.

In principle, off-shoring of R&D should be distinguished from the general globalization of R&D activities, because it follows a different logic. Basically, R&D globalization is driven by markets (strategic clients or lead markets), production facilities or science, such as world centers of excellence in cutting-edge research (Boutellier, Gassmann, & Zedtwitz, 1999), whereas off-shoring is motivated by cost considerations (Norwood *et al*., 2006).

If cost and efficiency thinking are crucial to off-shoring, then transaction cost economics may provide valuable insights into how off-shoring can be organized in order to reap efficiency gains. Distinct governance forms can be chosen to organize off-shoring of product development: in essence, the question is whether off-shoring of product development is carried out internally, by market or cooperative relationships, or by a combination of the aforementioned.

Although off-shoring of production and R&D has been discussed previously in international business literature (Kotabe & Swan, 1994), research on governance forms in off-shoring remains scarce. Furthermore, to our knowledge, off-shoring is still somewhat unexplored from a subsidiary or an offshore country perspective. Finally, from a managerial point of view, it remains ambiguous why some subsidiaries are more likely to become offshore destinations than others. This study intends to shed light on some of these issues.

The remainder of this paper is structured as follows. The next section explains the theoretical underpinnings. On this basis, testable hypotheses will be formulated. The research method section provides details on construct definitions, sampling and questionnaire development. Then empirical findings from structural equations modeling will be presented. Finally, I discuss the results and some implications for management, theory development and future research.

Conceptual Development

Definitions of Off-shoring

Before I advance the conceptual development, some definitional questions should be tackled. Though there seems to be an agreement that off-shoring refers to shifting value-chain activities abroad, Norwood *et al*. (2006, p. 35) point out that there is no “clear, universally accepted definition of what constitutes off-shoring”. Yet the same report mentions on p. 8 that “virtually all of the studies examining business off-shoring decisions and their anticipated benefits identify cost savings as the leading expected benefit”. There are also stricter and broader definitions. As regards a strict definition, “the concept of off-shoring refers to the closing down of a home location and the subsequent transfer of existing economic activities abroad” (Hertveldt *et al*., 2005, p. 9). A broader definition would not make the requirement of closing down the home location, since the home site may take on other activities (higher added value, for instance) or the closing down of the home site may only happen after a while, for example, when the results of off-shoring have been evaluated as positive. Furthermore, a company may decide not to expand in its home country and do so in an off-shore location instead (Hertveldt *et al*., 2005).

Due to the MNC subsidiary perspective (which does not enable us to make affirmations about what is happening in the home country), in this paper a broader conceptual definition of in-house off-shoring will be adopted. Accordingly, in-house off-shoring in product development is defined as shifting product development or related technical work from MNC units in high-wage to subsidiaries in low- or medium-wage countries in order to internalize cost savings.

At this point, it is important to underscore that off-shoring is conceptually distinct from outsourcing: off-shoring refers to carrying out an activity abroad. Outsourcing can be defined as shifting value-chain activities to an external entity which is generally legally independent from the contractor and which can be located at home or abroad. However, off-shoring may be combined with outsourcing (termed offshore outsourcing) – when an activity is carried out by another organization in another country – or otherwise – when an activity is carried out by a subsidiary of the same company in another country (termed captive or in-house off-shoring).

In the following, I address in-house off-shoring of product development and local inter-organizational relationships of the offshore unit (subsidiary).

In-house Off-shoring of Product Development in Multinational Companies

In the remainder of this section, I will shed some light on possible reasons why MNCs off-shore product development activities. While there are different concepts of product development processes, operations researchers seem to agree that its heart constitutes the design-build-test cycle (Clark & Fujimoto, 1991; Wheelwright & Clark, 1992). During this cycle – which may be repeated until a satisfactory solution is found or until it is abandoned – physical or virtual prototypes are built from a new product design. The prototypes are tested and results fed back into the design stage.

MNCs with several R&D or product engineering units in different countries may distribute R&D and NPD related activities over different units just as they do with component production and final assembly activities. Components manufactured at plant A may be assembled at plant D together with other components produced at plants B and C. Correspondingly, research may be carried out in a subsidiary located in country A, product design and prototyping in country B, testing in country C and process development in country D. Empirical evidence for separation compared to integration of the R&D function has been provided by Zedtwitz and Gassmann (2002), who propose four generic types of Research and Development internationalization depending on whether research or whether development is concentrated domestically or dispersed over different countries.

Though the design-build-test cycle is by and large deemed to remain integrated at one site, it may also become subject to international dispersion; DaimlerChrysler, for instance, centers new engine design and development at headquarters; yet, many tests are carried out in the Brazilian unit due to cost considerations. Another example is Motorola which lets design chips by Freescale, a firm created by Motorola in Campinas in 1997; the physical prototyping, tests and production of chips, however, are carried out in third countries.

Having said this, more attention should be paid to the contracting of product development activities between product development (or R&D) units of the same multinational organization. Several operational reasons may account for why this is happening. First, when there is capacity shortage at unit A, it may be cheaper to transfer a project to unit B instead of increasing unit A's capacity.

Second, cross country R&D cost differences have recently attracted considerable attention, after the off-shoring debate had predominantly been associated with service industries (call centers, back office, software development) or manufacturing (China as the world's workbench). In fact, some studies suggest preliminary empirical evidence for the cost argument: Reddy (1997), for example, sees relative cost differentials as a primary force; Davis (2000) has found that US pharmaceutical companies carry out some R&D in Denmark in order to take advantage of cost advantages.

There is some theoretical reasoning behind this: Buckley and Casson (1976, pp. 53-54) argue that, in the absence of communications costs, all R&D work would be located in those regions where costs of non-tradable production factors were cheapest and educational capacities most developed. In fact, decreasing communications costs, combined with increasing R&D capabilities in low and medium cost countries, enhance the probability that R&D work be transferred from high cost to medium or low cost countries. However, empirical research, as well as a further theoretical development on the impacts of R&D cost differences between countries where they are largest (i.e. high-wage v. medium-wage or low-wage countries), has yet to take account of this.

Third, competition increases the need to speed up product development in order to decrease time-to-market. Decreasing time-to-market may help a company either to introduce a new product much sooner than competitors or to introduce a better product at the same time (Wheelwright & Clark, 1994), which reduces the costs of launching late or the costs of doing it wrong. This may be achieved by organizational learning and capability building in fast problem solving or integrating product and process development. Furthermore, off-shoring may also contribute to shortening development time by creating an asynchronous round-the-clock development model. A second opportunity is related to the aforementioned capacity argument and can be termed a synchronous parallel development model: a project separable into several independent components can be carried out at different locations simultaneously, which may save time and increase product development capacity.

Therefore, off-shoring of research or new product development can be considered an operational strategy to face rising competitive pressure among MNCs. In addition to the already cited reasons for hierarchical governance, there are several benefits when the operational advantages mentioned above are exploited in-house: first, excess capacity or organizational slack in wholly owned subsidiaries may be utilized and thus increase the operational efficiency of the whole MNC network; second, the MNC may internalize a higher proportion of cost advantages due to direct ownership and reduced information asymmetry (offshore outsourcing partners may conceal the full potential of cost savings in order to increase their own margin); and third, complex global division of R&D work, be it the asynchronous or the simultaneous development model, may be less prone to disturbances when development units are tightly and directly controlled by headquarters.

Local Inter-organizational Relationships in Product Development

On the subsidiary level, a broad distinction between two generic forms of local inter-organizational relationships should be made: subcontracting of R&D project-related activities (outsourcing) or integrated (cooperative) relationships. Outsourcing relationships are short-term, arms-length relationships between a customer and a supplier, where the customer passes design, prototype or test specifications to a technical service supplier. Instead, a cooperative agreement or joint product development implies that both partners work in an integrated manner, creating new knowledge, new technology or a new product jointly by intense long-term, rather than short-term, interaction. Therefore, they adapt their technologies mutually, benefit by knowledge transfer and joint learning and are interdependent. Though there are several other forms of inter-organizational relationships in innovative activities, this distinction into two contrasting types of collaboration is used because it is well established in literature (Birkinshaw & Fey, 2001; Narula, 2001; Veugelers & Cassiman, 1999).

As with off-shoring, outsourcing is undertaken for the sake of efficiency enhancement. Norwood *et al*. (2006, p. 9), for instance, claim that

> Off-shoring decisions are made for many of the same reasons as outsourcing decisions, which adds to the inherent complexity of off-shoring activities. Virtually all of the studies examining business off-shoring decisions and their anticipated benefits identify cost savings as the leading expected benefit.

Moreover, Narula (2001, p. 380) argues that outsourcing is used in order to “smooth-out cyclical variations in demand”, an approach related to the capacity, time and flexibility argument. Basically, many of the reasons for off-shoring, such as capacity, costs, time and flexibility also apply to relationships between a subsidiary's R&D unit and its local outsourcing partners. This is particularly true when headquarters set local R&D units under cost pressure reducing headcounts and duplicate facilities in an attempt at global efficiency.

In addition, market-like outsourcing complements the offs-shoring relationship also from the transaction cost perspective. In Williamson's (1996, p. 66) words, "markets can sometimes aggregate demands to advantage, thereby to realize economies of scale and scope", while hybrid forms of governance reduce the potential of reaping scale economies due to higher asset specificity. Scale and scope economies, however, are particularly relevant here, since they may contribute to the cost saving aim of off-shoring.

Accordingly, increasing scale in product development activities may render the subsidiary a more attractive destination for project assignments. Scale economies apply particularly when a minimum efficient unit size is required as a function of considerable investments in laboratory equipment (Kuemmerle, 1997). Yet, as mentioned, minimum efficient size does not only depend on in-house R&D capacities which can be extended by external capacities. Likewise, Pearce (1994, p. 187) argues that the optimal size of a laboratory may be smaller as long as it is part of a decentralized system of laboratories which share their capacities. This is also a reason why collaborations with external partners should be considered in the off-shoring context.

Moreover, this reasoning complements transaction cost analysis, suggesting that outsourcing also facilitates the creation of in-house economies of scale and scope by releasing internal capacities which can then be utilized, focusing in-house activities on related higher value added (strategic) activities. Thus, similar to Skinner's (1974) focused factory, the subsidiary may reap economies of scale and scope, precisely in its focused R&D activities.

Having said this, it remains to be asked how and why in-house off-shoring can be combined with local outsourcing, a market-like governance structure? Market-like local outsourcing is chosen when asset specificity is lower, which means, only less strategically relevant, general purpose technological activities (such as prototype tests, standard laboratory analyses, design of non-core components etc.) would be commissioned from local technological service providers. Therefore, the subsidiary R&D unit is likely to separate its product development activities into higher asset specific in-house and lower asset specific outsourced activities. Thus the benefits of flexibility with respect to capacity utilization, low cost and reduced time-to-market in off-shoring may be enhanced with local outsourcing. When subsidiaries manage to function as a hub with a strong local outsourcing network, they may consequently increase their attractiveness as offshore destinations. This leads to the following hypotheses:

H1: Local outsourcing of product development activities by MNC subsidiaries is positively related to in-house off-shoring of product development activities.

In contrast, local technological cooperation implies that specific assets are created by means of interactions between the MNC subsidiary and its local partners. The cooperating local R&D unit is in a position to participate in an inter-organizational learning process, adapting products to the requirements of local clients and to the possibilities of local suppliers, learning from the specific technological competences of its partners and creating knowledge by interaction. Thus, new knowledge creation may contribute towards building up specific technological capabilities in the local R&D unit complementing those of other MNC units. R&D units with higher capabilities may then be sufficiently qualified to carry out technical work for other MNC units.

In line with this argument, research results from Andersson, Forsgren and Pedersen (2001) suggest that strong technical embeddedness in local cooperation networks is positively associated with a subsidiary's contribution to MNC competence development, since it may gain access to specific technological knowledge and develop advanced product or process technologies which may be of interest to other MNC units. A similar argument is put forward by Frost, Birkinshaw and Ensign

(2002) who claim that external actors such as customers or suppliers have a positive and significant influence on the formation of R&D centres of excellence in MNCs, i.e. organizational units whose specific capabilities are intended to be "leveraged by and/or disseminated to other parts of the firm" (p. 1000).

At the same time, the locally cooperating subsidiary may acquire specific local knowledge and thus reduce local market uncertainty in both supply and client relations. However, reduced local market uncertainty is a rather useless benefit as far as in-house off-shoring relations are concerned, because the offshore unit's market is composed of corporate clients, i.e. other MNC units in high cost countries. In addition, uncertainty is likely to remain high with respect to the off-shoring relationship from a subsidiary respective, as there is probably competition for off-shore projects among subsidiaries located in medium and low wage countries, demand by high wage country MNC units may oscillate and off-shore projects may be risky (technological uncertainty). Also, an offshore R&D unit does not necessarily need to build up technological capabilities through local cooperation because the necessary capabilities can be transferred from other MNC units to the offshore unit (Schmid & Schurig, 2003). Therefore, the more specific assets developed by local cooperation become, the higher the increase in governance costs in regimes of high uncertainty: Williamson (1996, pp. 116-117) argues that hybrid governance is most susceptible to high uncertainty since frequent adjustment to disturbances requires a time-consuming mutual adaptation process as automatic market adaptation and hierarchical adaptation (fiat) do not apply. This time-consuming process may be particularly dysfunctional as off-shoring is undertaken precisely in order to save time and money.

In other words, from a theoretical standpoint, there seems to be a trade-off for subsidiaries concerning off-shoring and local cooperative relationships. Several empirical contributions point to the same direction, suggesting trade-offs between the internal and external learning as well as collaboration with local partners and integration into the MNC network.

The integration of different knowledge areas tends to be time-consuming and expensive; it urges firms to find an adequate balance between internal and external learning (Kessler, Bierly, & Gopalakrishnan, 2000). Other studies have also found a trade-off between efficiency and learning in product development partnerships. The higher the interdependence between partners, the greater the learning opportunities; still, higher interdependence seems to be associated with lower efficiency in product development and lower levels of efficiency are compensated by higher levels of learning (Sobrero & Roberts, 2001).

This trade-off relationship can be particularly accentuated when it comes to MNC subsidiaries. Narula and Zanfei (2003, p. 12) point out that establishing partnerships with host country firms is costly and time-consuming: "even where the host location is potentially superior to the home location - and where previous experience exists in terms of other value adding activities - the high costs of becoming familiar with and integrating into a new location may be prohibitive". As a consequence of this, subsidiary management tends to carefully evaluate the relationship between the costs of local networking and the expected benefits in terms of access to new knowledge and technologies. The chances that such an evaluation is less favourable towards cooperation could be particularly high in countries with less developed innovation systems with few available potential partners.

In line with this, Holm and Pedersen (2000) draw attention to the **dilemma of centres of excellence**, i.e., the difficulty in simultaneously establishing and maintaining relationships with the centre's global MNC network and with its local environment. The problem lies in the fact that a centre of excellence needs to be competitive in its local market (which often demands particular context specific local capabilities) and also needs to contribute to global R&D projects using its specific knowledge at the same time. This position requires a double commitment (to the local and to the global MNC environment) which might strain a subsidiary's internal resources, particularly when both environments are not much aligned.

In short, the arguments outlined above tend to suggest that locally integrated R&D units are less likely to carry out product development activities for other MNC units in an off-shoring type of relationship.

H2: Cooperation in product development between the subsidiary and its local clients is negatively related to in-house off-shoring of product development activities.

Finally, an interesting question remains: what kind of relationship exists, if any, between local cooperation and local outsourcing? Two contradictory arguments are briefly pointed out below.

On the one hand, a product development unit which has already accumulated some experience in managing inter-organizational relationships (both with other MNC units and with outsourcing partners) could also be more likely to form more complex cooperative partnerships, because it has probably developed relationship skills. The relevance of these skills can be demonstrated by drawing on transaction costs economics: Williamson (1985) distinguishes ex-ante and ex-post transaction costs – whereas the former are related to search costs (finding appropriate partners) and negotiation costs (drafting contract clauses), the latter are related to supervision of whether the partners work conforms with specifications and adaptation costs (re-negotiation and enforcing contract clauses when problems arise). Thus, the complexity of the relation-building and joint-project development process offers a host of learning opportunities that can result in relationship skills. These skills can be transferred to other relationships, for instance, from off-shoring and outsourcing relationships to cooperative relationships, which would imply a positive association between local cooperation and local outsourcing.

By the same token, one may argue that more frequent interactions between organizations could reduce behavioral uncertainty as partners get to know each other better and may build up trust. At the same time, asset specificity could increase as the outsourcing partner dedicates a growing proportion of his capacity to the relationship with the MNC subsidiary. According to Williamson (1996), both factors would increase the probability that the market-like outsourcing relationship becomes transformed into a hybrid cooperative relationship.

H3: Local outsourcing is positively related to local cooperation in product development activities.

METHOD

Sample

The unit of analysis chosen for this study is a product family in a wholly foreign-owned MNC subsidiary for which product development activities are carried out in a broader sense (including product adaptations, systematic improvements and new product development). Henceforward, this unit of analysis will be called a **product development unit**.

Following a telephone contact procedure, 269 e-mails with hyperlinks to the server hosting questionnaires as well as self-executing questionnaire-files (in case corporate firewalls blocked web-access to questionnaires) were sent to the managers of each unit. In total, we obtained 146 valid questionnaires, which corresponds to a response rate of 54%.

The profile of the sample can be described as follows: the most important countries of origin of the subsidiaries were the US (34% of the sample), Germany (27%), France (7%), Japan (6%), the UK (5%) and Sweden (5%). With respect to the year of initiation of product development activities in the Brazilian location, the 1990s and the first three years of the 21st century were mentioned most (26% and 16% respectively). Concerning full-time staff in product development, 52% of product development units have a lean structure with up to 9 employees; the average is of 35 employees and the maximum is 506 employees. Staff figures are quite low because only full-time staff are included and because the unit of analysis was limited to product families. Test statistics did not show any significant difference due to the aforementioned sample characteristics.

Measures

A small subset of indicators was extracted from the questionnaire in order to focus on the specific research question mentioned in the introduction. Additional measures would have been interesting to include, but this would have inflated the number of parameters to be estimated.

In-house off-shoring of new product development related activities. In order to capture the extent to which the focal product development unit within a subsidiary carries out new product development activities for other MNC units located abroad, the managers were asked to what extent headquarters or other MNC units ordered the following services from the focal unit: new product designs, prototyping of new products and prototype tests. As noted in the conceptual part, the three indicators represent the main stages of the design-build-test cycle (Clark & Fujimoto, 1991; Wheelwright & Clark, 1992). The respondent was required to use a five-item Likert scale ranging from **never** to **always**. One of the three items was later eliminated in order to improve the overall model fit. The reliability check was good for all three indicators (Cronbach's Alpha = 0.89) as well as for the two indicators maintained in the model: design (DEE) and prototyping (PTE) (Cronbach's Alpha = 0.83).

Local outsourcing in product development. Outsourcing relationships imply that the focal product development unit passes on specifications to a subcontractor who carries out new product design, builds prototypes or performs tests of the prototypes. Again, three indicators which represent the main stages of the design-build-test cycle were used. Respondents were asked to what extent their unit orders services of new product designs, prototyping of new products, prototype tests from local entities be they companies, technology centres or universities. The same five-item Likert scale was used as in the off-shoring construct and the construct reliability was also fairly good (Cronbach's Alpha = 0.71) both for the three and for the two indicator based construct. The latter, with outsourcing of design (DEO) and outsourcing of prototype development (PTO), was included in the model.

Local cooperation in product development. Unlike the two preceding constructs, cooperation implies longer lasting relationships, characterized by mutual involvement rather than order and delivery or arms-length relationships. The concept of cooperation entails integrated (embedded) relationships in which suppliers and buyers develop a new product jointly, involving a back-and-forth adaptation process and intense interactions which render learning opportunities, often at the cost of lower efficiency (Sobrero & Roberts, 2001).

Based on this rationale, I adapted the measure developed by Andersson and Forsgren (1996); respondents were asked whether the relationships of his/her product development unit with particular clients and suppliers led to a modification of the products developed by his/her unit. They were also asked if these relationships had been essential to generating technological knowledge in his/her unit, reflecting the idea of inter-organizational learning by interaction (Lundvall, 1988). A five-item Likert scale ranging from **totally disagree** to **totally agree** was used. Based on factor analysis, I built two-item measures and labelled them cooperation with clients (Cronbach's Alpha = 0.62), suppliers (Cronbach's Alpha = 0.79), research institutes and universities (Cronbach's Alpha = 0.72). Despite its high construct reliability the supplier as well as the research institutes and university constructs were dropped from the model since several parameter estimates turned out to be non-significant. For this reason, only two indicators were included in the model: modifications by client relations (CLM) and knowledge generation by client relations (CLC).

Control variables. In order to control for the effect of the age and the size of the product development unit, I used the number of years counted from the year of initiation of product development activities to the year when the research was conducted - 2004. The size of the unit was measured by asking about the number of full-time staff in product development. I applied log-transformations in order to compensate for severe non-normal distribution.

Data Analysis

I evaluated the model in two steps: first the complete model (structural model and the measurement model combined) and thereafter the parameter estimates. AMOS 5.0 software with the maximum likelihood algorithm was used. Altogether, from 21 to 26 parameters were freely estimated (the others were fixed); taking the sample size of 146 observations into account, the ratio between parameters and observations ranges from 1:5.6 to 1:7 which is slightly above the recommended minimum of 1:5 (Hair, Anderson, Tatham, & Black, 1998, p. 604).

Overall Model Fit

I compared three models, the first one without using control variables at all, the second one introducing **age** and the third one with **staff size** as control variables. While all three models can be accepted, the third one shows the best fit (see Table 1).

Overall model fit can be assessed using absolute, incremental and parsimony fit indices. Concerning absolute fit, the chi^2 (χ^2) values ranging from 7.93 to 11.65 are low, suggesting a slight difference between the observed and the hypothesized covariance matrices. The chi^2 (χ^2) adjusted by the degrees of freedom (parsimony fit index) results in adjusted chi^2 values ranging from 0.913 to 1.29, which is well below the recommended maximum threshold level of 2.5. Differences between the observed and the hypothesized covariance matrix are not significant (varying from p=0.23 to p=0.51) which indicates further support for the models.

In order to corroborate the relevance of the two control variables, I introduced the constraint that the endogenous variable does not depend on either size or age. As a result of this, the models had to be rejected on the basis of significance values (p=0.009 and 0.03 respectively) and heavily increased chi^2 values (23.56 and 19.90 respectively). Therefore, the introduction of both control variables is highly recommended.

Table 1: Fit Indices of Three Alternative Models

	χ^2	χ^2/df	P	NFI	CFI	RMSEA	HOELTER (0.05)
Model I (without controls)	7.93	1.32	.24	.996	.991	.047	231
Model II (using age as control variable)	11.65	1.29	.23	.954	.988	.045	211
Model III (Using staff size as control variable)	8.21	.91	.51	.970	1.000	.000	299

The S.E.M. assumption of multivariate normality does not hold, since Mardias indicates significant multivariate kurtosis ranging from 3.9 to 4.7 for the three models. Therefore, I followed Byrne's (2001) suggestion and used bootstrapping in order to find out whether the χ^2 statistics are robust. The Bollen-Stine bootstrap p-value was calculated (ranging from p=.483 to p=.647 for the three models) and also rejected the null-hypothesis that the hypothesized covariance matrix is significantly different from the observed covariance matrix.

The remaining fit indices are all above the recommended minimums; the Normed Fit Index (NFI) and the Comparative Fit Index (CFI) are all close to 1, which indicates a very good fit. The root mean square errors of approximation (RMSEA) are all below the 0.05 benchmark, also indicating a very good fit. Finally, Hoelter's critical N shows that the models would hold up to sample sizes of 299 observations at 0.05 significance for Model III, which is much higher than the sample size of this survey (N=146).

To check for model misspecification, I examined standardized residuals and modification indices. According to Joreskog and Sorbom (1988 as cited in Byrnes, 2001, p. 89) standardized residuals above 2.58 are considered to be large; fortunately, this is not the case here. Modification indices are all quite small (slightly above 1) and promise only minimal model improvements (the highest would suggest a 0.12 point χ^2 drop). Hence, there was no need to respecify the model.

Parameter Estimates

Parameter estimates for Model I will be provided below. Having tested all three hypotheses, I introduced the two control variables, resulting in Model II and Model III. Some parameters of the latter will be examined at the end of this section (as parameter estimates are similar and critical values significant, the presentation of Model II and III parameter estimates will be dispensed with). As shown in Table 2, the critical ratios (C.R.), i.e. the parameter estimates divided by standard errors (S.E.), for all but one parameter are above ±1.96 which signals that these estimates are significant. Please note that the standardized estimates are displayed in the column with the label **Stand. estimate**.

Therefore, the data suggest support for Hypothesis 1 (standardized coefficient = + 0.43), which hypothesized that local outsourcing of product development activities by MNC subsidiaries, is positively related to in-house off-shoring of product development activities. As for Hypothesis 2, which conjectured that cooperation in product development between the subsidiary and its local clients is negatively related to in-house off-shoring of product development activities, the model estimated a significant negative relationship (standardized coefficient = - 0.45), supporting the proposed relationship.

However, the effect size of the relationship between Local Outsourcing and Cooperation is positive, very small (0.14) and non significant (*p*=0.42), which rejects the proposed relationship of Hypothesis 3 that local outsourcing is positively related to local cooperation in product development activities.

Table 2: Regression Weights (Model I – Without Control Variables)

Constructs and Indicators	Estimate	S.E.	C.R.	P	Stand. estimate	R^2
Off-shoring ✱ Local Outsourcing *H1*	.592	.172	3.447	***	.434	
Off-shoring ✱ Cooperation (clients) *H2*	-.607	.194	-3.128	.002	-.450	.339
Cooperation ✱ Local Outsourcing *H3*	.136	.167	.815	.415	.135	.018
DEE ✱ Off-shoring	.849	.141	6.021	***	.814	.663
PTE ✱ Off-shoring	1.000				.889	.789
CLC ✱ Cooperation (clients)	1.000				.681	.464
CLM ✱ Cooperation (clients)	.921	.322	2.863	.004	.667	.445
DEO ✱ Local Outsourcing	.893	.255	3.499	***	.756	.571
PTO ✱ Local Outsourcing	1.000				.735	.541

The last column of Table 2 shows the variances explained by the dependent variables; for instance, the latent constructs local outsourcing and local cooperation explain together 34% of the variance of the endogenous latent variable off-shoring. The variances of the observed endogenous variables (DEE, PTE, CLC, CLM, DEO and PTO) are explained by the unobserved variables local outsourcing, local cooperation and off-shoring; e.g. the latent variable local outsourcing explains 79% of the variance of the manifest variable DEO (outsourcing of design activities).

The variances of the observed variables together with the standardized estimates are also indicators of item validity. All but one of the variances are above the recommended minimum values of 0.4 (see Table 2). Cronbach's Alpha coefficients are indicators of convergent validity (see above section on measures). Churchill (1979, p. 68) citing Nunally (1967) considers coefficients above 0.6 as acceptable for the "initial stages of basic research". Hence, both item and convergent validity appear to be satisfactory.

Table 3: Discriminant Validity

		Constructs		
		Off-shoring	Outsourcing	Cooperation
observed variables	Design ordered by MNC (DEE)	**0.92****	0.24**	-0.27**
	Prototyping ordered by MNC (PTE)	**0.93****	0.29**	-0.27**
	Design outsourced by subsidiary (DEO)	0.23*	**0.86****	0.13
	Prototyping outsourced by subsidiary (PTO)	0.28**	**0.90****	0.02
	Cooperation implying product modifications (CLM)	-0.28**	0.00	**0.84****
	Cooperation generating knowledge in subsidiary (CLC)	-0.22*	0.14	**0.86****

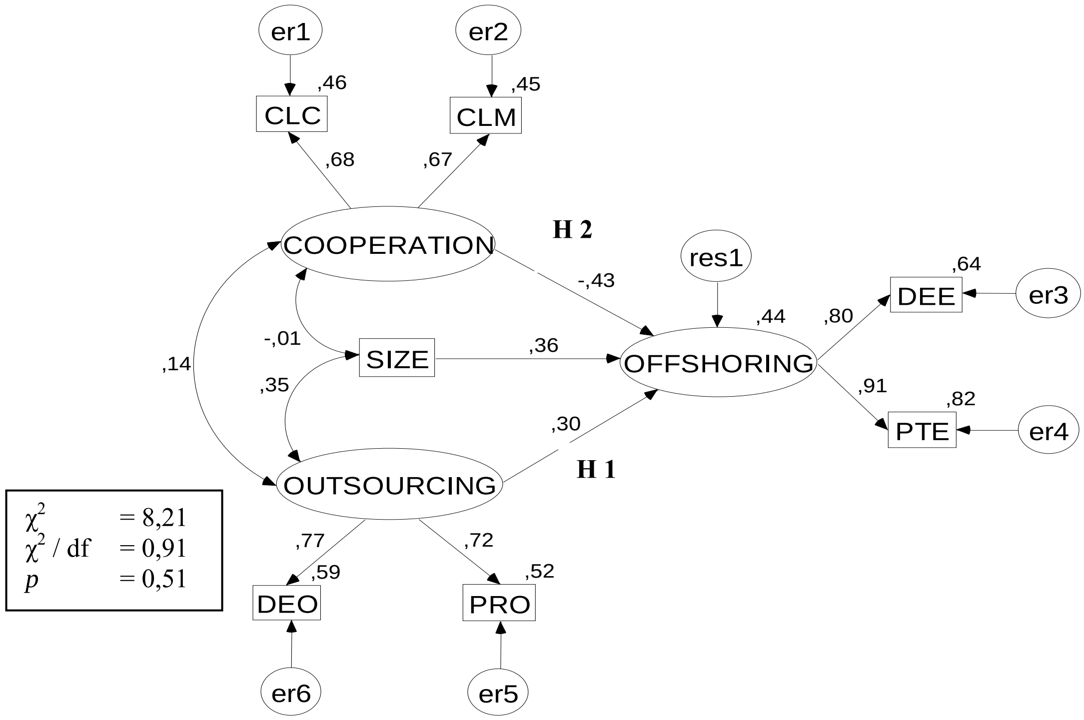
Note: ** $p < 0.01$; * $p < 0.05$.

Discriminant validity is given when the observed variables (indicators) which define a certain construct show low correlations with the remaining constructs. This is the case with respect to all six indicators as can be seen in Table 3.

We may now turn to the models II and III which include age and staff size as control variables. As the hypothesized relationship between local outsourcing and local cooperation is small and non significant, I replaced the path by a covariance. Models including both control variables would not be valid since the increase in freely estimable parameters would lead to a sharp drop of the parameter-sample size ratio (below the suggested yardstick of 1:5).

The effect of staff size is 0.36 (p = 0.000) and the effect of age is 0.26 (p = 0.002) suggesting a highly significant impact of both control variables. Consequently, both Model II and Model III increase the explained variance of off-shoring to 39% and 44% respectively. The control variable staff size strongly correlates with Local Outsourcing (effect size = 0.35; p = 0.002) and its combined impact reduces the effect size of the relationship between Local Outsourcing and Off-shoring from 0.43 to 0.30 (see Figure 1).

Figure 1: Model III Explaining Off-shoring with Two Latent Constructs & Controlling for Staff Size



DISCUSSION

Aiming to evaluate the research question of how different governance forms can be combined in order to reap efficiency gains in off-shoring, in this study, I specified and tested a model which estimated the relationships among local outsourcing, local cooperation and in-house off-shoring. The results indicate that the subsidiary's local relationships matter and may also contribute to explaining why some product development units operate as offshore development units while others do not.

Specifically, the significant and positive relationship between local outsourcing and in-house off-shoring (H1) implies that the efficiency advantages of local outsourcing are likely to coincide with those of in-house off-shoring. A possible interpretation of this is that MNCs may use a mechanism which enables them to increase their R&D capacities globally in a flexible manner and to control or reduce overall R&D costs and speed up new product development.

Compared to previous research on subsidiary roles, external and internal MNC networks (Ghoshal & Bartlett, 1990; Andersson, Forsgren, & Holm, 2002; Frost *et al.*, 2002), this paper has made a distinction between two different forms of local inter-organizational relationships, cooperation and outsourcing. The relevance of this distinction for the analysis of off-shoring relationships has been substantiated by theoretical arguments and by empirical results which show significant impacts on the endogenous variable (off-shoring).

Accordingly, results complement existing approaches to R&D globalization which consider Science & Technology (S&T) access as the main driver for corporate research internationalization and market access as the main driver for product development internationalization (Zedtwitz & Gassmann, 2002).

This research shows that off-shoring of product development is different from other forms of R&D globalization, since the latent variable **cooperation with clients** is negatively associated with the off-shoring variable (H2). This finding seems to be consistent since requirements and specifications are transmitted by other MNC units (the off-shoring clients) and do not have be negotiated, adapted to or elaborated together with local clients (or other cooperation partners).

Moreover, the significant negative path coefficient between local cooperation and off-shoring variables seems to support the theoretical reasoning exposed in the literature review. In particular, units pursuing the mission to develop products through interaction with their clients are probably more result or effectiveness oriented (e.g. customer satisfaction, local learning or joint product development) than efficiency oriented. This could make them less eligible for off-shoring which is rather motivated by efficiency seeking than by foreign market or asset seeking. Also, product development units which maintain strong cooperative relationships with clients may have fewer resources at their disposal which are deployable for projects commissioned by other MNC subsidiaries or headquarters. In contrast, units that maintain a network of outsourcing partners increase their resources deployable for MNC projects (scale argument). Furthermore, the transaction costs of cooperative relationships (hybrid) may be higher than those of outsourcing (market) relationships in environments characterized by higher uncertainty.

Therefore, the data suggest that a trade-off between local and global integration appears to exist: product development units which cooperate with local partners, and carry out projects for other MNC units abroad at the same time, face higher costs and possibly inefficiencies. Following this interpretation, local outsourcing instead of local cooperation could reflect a transaction costs and trade-off reducing form of local collaboration which makes it possible to link up with other MNC units and local entities at the same time.

Interestingly, both the age and the staff size of the product development unit have a positive and significant effect on the probability that other MNC units commission product development related activities (off-shoring). Size is also positively related to local outsourcing and age is correlated with size (see Table 4 in the Appendix). This may suggest that scale is important both for outsourcing and off-shoring. As for outsourcing, relationship management, i.e. searching for partners and their coordination, requires human resources which might explain why very small units are not very active outsourcers. The effect of size on off-shoring is also straightforward, since off-shoring only makes sense from an efficiency point of view if projects have a certain minimum size, for which a minimum staff size is needed. If project size is below a minimum threshold, however, coordination costs between the off-shoring partners (MNC units in different countries) could exceed cost savings and other efficiency gains.

Age seems to be important, not only because of its correlation with size but also because of its possible relation with managerial and technological experience and capabilities which are assumed to be path-dependent; experience is important to evaluate information about potential outsourcing partners and capabilities are important qualifying factors for a product development unit that develops for other MNC units. According to a Siemens Manager at headquarters, the trade-off between effectiveness and costs is most important in decisions concerning R&D off-shoring, since lower technological experience may offset low cost gains.

Implications

Implications for Theory

Buckley and Lessard (2005, p. 598) as well as Doh (2005) have already suggested that research into the off-shoring phenomenon might draw on internalization theory. The original version of internalization theory (Buckley & Casson, 1976) claims that MNCs would prefer to set up wholly owned subsidiaries in a foreign country in order to internalize (hierarchy) foreign markets, providing the costs were lower than those of licensing (market). Technology transfer to foreign markets by licensing has limitations due to the tacit nature of knowledge, the risk of leakage or spill-overs to foreign competitors and information asymmetries, among others.

Though off-shoring is not about internalizing markets for products developed abroad, I believe there are two points which might justify extending internalization theory to the off-shoring phenomenon, similar as has been suggested before with other issues (Chen, 2005; Rugman & Verbeke, 2003; Buckley & Casson, 1998).

First, internalization changes its signs as MNCs commence to internalize markets for the supply of R&D work instead of markets for the demand of products developed abroad. Here, the choice between governance forms encompasses two alternatives at the outset: in-house off-shoring (hierarchy/internalization) or offshore outsourcing (market and hybrid respectively). This article has discussed the internalization of the supply of R&D work located abroad. What is striking about this is that (in-house) offshore units are likely to outsource some R&D work to local partners. In other words, we are probably dealing with an intermediary form of R&D supply internalization instead of a pure form, since the latter would imply that the local partner was bought up by the MNC.

Secondly, theoretical arguments together with the empirical findings presented in this paper explain how MNCs may create competitive advantages using in-house off-shoring in combination with local outsourcing. These advantages, based on trade-off reducing as well as transaction costs economizing mechanisms, require an underlying capability nurtured or implemented by the subsidiary. However, the capability stressed here, the creation of a local outsourcing network which might complement the MNC network and leverage the product development unit's role as an off-shore destination, is not necessarily a capability transferred from other MNC units to the off-shoring destination, but may have arisen within the local context. Accordingly, internalization, as discussed here, does not necessarily refer to ownership advantages transferred from the home country to the in-house offshore destination, but also to the internalization of ownership advantages developed by offshore subsidiaries through their integration into global R&D work.

Implications for Future Research

For obvious reasons, no country can remain a low or medium cost producer for ever. Particularly, medium cost countries such as Brazil or Mexico compared to low cost countries such as India and China, are sort of **stuck-in-the-middle** to paraphrase Porter's competitive strategy dictum: they should either opt for a low cost or for a differentiation strategy. Two sets of questions result from this which should be explored in future research: first, what kind of strategies are being implemented by product development units in middle-income countries in order to differentiate themselves from low-cost off-shoring sites? In other words, how do they add value and what kind of value do they add? Second, why do product development units in middle-income countries use local outsourcing and not local cooperation? To put it differently, do product development units which are heavily relying on outsourcing opt for a cost leader strategy in order to be competitive as MNC off-shoring sites in product development with respect to low-income countries?

Future research in this field should also be carried out in other medium and low cost countries in an attempt to find out to what extent my results can be generalized and to what extent they are context-specific. Aiming at verifying or sharpening the tentative explanations given, more complex models should be developed trying to capture additional factors that could contribute to explaining off-shoring from a subsidiary perspective; for instance, taking into account the degree of relative cost differentials, the configuration of MNC R&D activities on a global level or coordination forms that regulate the exchange relationships among different MNC units.

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APPENDIX

Table 4: Means – Standard Deviations - Correlations

	Mean	s.d.	1	2	3	4	5	6	7	8
1. DEE	2,62	1,19	1,00							
2. PTE	2,61	1,29	0,72**	1,00						
3. DEO	1,76	0,99	0,20*	0,23**	1,00					
4. PTO	2,03	1,14	0,23**	0,29**	0,56**	1,00				
5. CLM	3,88	1,17	-0,23**	-0,28**	0,03	-0,03	1,00			
6. CLC	3,41	1,25	-0,22**	-0,18*	0,19*	0,06	0,45**	1,00		
7. Staff	2,32	1,57	0,36**	0,43**	0,27**	0,25**	-0,03	0,02	1,00	
8. Age	2,55	1,13	0,29**	0,17*	-0,10	-0,07	-0,12	-0,12	0,28**	1,00

Note: ** p<0,01 ; * p<0,05 ; s.d. = standard deviation