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3 NEW METHODS FOR *EX POST*  
5 EVALUATION OF REGIONAL  
7 GROUPING SCHEMES IN  
9 INTERNATIONAL BUSINESS  
11 RESEARCH: A SIMULATED  
13 ANNEALING APPROACH  
15

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19

21 **ABSTRACT**

23 *International business research has long acknowledged the importance of*  
25 *regional factors for foreign direct investment (FDI) by multinational*  
27 *corporations (MNCs). However, significant differences when defining*  
29 *these regions obscure the analysis about how and why regions matter. In*  
31 *response, we develop and empirically document support for a framework*  
33 *to evaluate alternative regional grouping schemes. We demonstrate*  
*application of this evaluative framework using data on the global location*  
*decisions by US-based MNCs from 1980 to 2000 and two alternative*  
*regional grouping schemes. We conclude with discussion of implications*  
*for future academic research related to understanding the impact of*  
*country groupings on MNC FDI decisions.*

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## 1 INTRODUCTION

3 International business (IB) research on determinants of country attractiveness  
4 for foreign direct investment (FDI) by multinational corporations (MNCs)  
5 has long emphasized the importance of a country's regional grouping.  
6 Countries in the "Triad" of North America, Western Europe and Greater  
7 Japan (Ohmae, 1985; Rugman & Verbeke, 2004) are considered more  
8 attractive for investment than similarly situated countries outside this Triad.  
9 Countries from Latin America with civil law traditions are less attractive for  
10 lending and investment than South Asian countries with common law  
11 traditions (La Porta, Lopez-de-Silanes, Shleifer, & Vishny, 1998). Alternative  
12 regional groupings based on cultural affinity (Hofstede, 2001 [1980]; Ronen &  
13 Shenkar, 1985), geo-political orientation (UN, 2006) and/or economic AU 2  
14 development levels (Vaaler & McNamara, 2004) are also considered  
15 important in understanding individual country attractiveness for MNC FDI.

16 But this IB research stream faces challenges related to the ex ante  
17 grounding of these regional groupings. Sometimes their justification follows  
18 from research intuition, bald assumption or anecdotal support. Even when  
19 grounded in theory, regional groupings are often vulnerable to reasonable  
20 refinements that can substantially change their power to explain important  
21 IB phenomena, including but not limited to MNC FDI. These concerns  
22 undermine regional grouping concepts, constructs and measures and impair  
23 the validity and reliability of theoretical and empirical IB research relying on  
24 them. In this context, we see an opportunity to contribute methodologically  
25 with an alternative approach to assessing regional grouping schemes. This  
26 approach complements ex ante theoretical assessment of regional grouping  
27 schemes with ex post assessment of their robustness to reasonable  
28 refinement. It promises insight on current and future IB research regarding  
29 the absolute and comparative robustness of different regional grouping  
30 schemes important to the study of MNC FDI patterns and broader  
31 questions of individual country attractiveness for lending and investment.

32 In the next section, we begin to develop these points, first by surveying the  
33 theoretical and practical grounding of alternative regional grouping schemes  
34 used in recent IB research. We hold that some grouping schemes lack ex ante  
35 theoretical grounding and follow from ad hoc researcher assertion or  
36 intuition. Alternatively, ex ante theoretical grounding is often weak, thus  
37 rendering schemes vulnerable to substantial change after reasonable  
38 refinement. In this context, we propose an ex post empirical technique for  
39 complementary evaluation of alternative grouping schemes using a novel  
algorithm based on simulated annealing.

1 Following the next section we describe in greater detail that, simulated  
annealing permits iterative refinement and optimization of initial grouping  
3 schemes where the number of alternative grouping schemes is great and  
global optimization of the scheme based on desired criteria is challenged by  
5 the existence of several local optima (Fox, Srinivasan, & Vaaler, 1997;  
Goffe, Ferrier, & Rogers, 1994). Given an initial regional grouping scheme  
7 and some theorized relationship between the grouping scheme and some  
phenomenon of IB research interest, we can then iteratively estimate, refine  
9 and then re-estimate the impact of alternative grouping schemes as the  
algorithm heads toward the global optimum. Comparison of differences in  
11 grouping schemes before and after simulated annealing provides the basis  
for ex post evaluation of regional grouping scheme robustness. Schemes  
13 with more (less) change in the number of groups, more (less) change in the  
sign and significance of non-group factors, and more (less) change in overall  
15 regression equation explanation of variation in phenomenon of interest are  
less (more) effective at supporting research inferences of interest.

17 In the penultimate section, we illustrate our approach to ex post  
evaluation of alternative regional grouping schemes using recent empirical  
19 analyses reported in Flores and Aguilera (2007). They estimate the  
likelihood of US MNC FDI in countries around the world in 1980 and  
21 2000 using regression equation with several country-specific economic and  
cultural factors as well as regional group dummies. We re-create their  
23 analyses using two different regional grouping schemes: (1) regional  
grouping based on continental location (North American, South American,  
25 Europe, Africa, Australia-Asia) and (2) regional grouping based on a  
scheme proposed by Vaaler and McNamara (2004) to explain differences in  
27 country sovereign risk (North America, Latin America-Caribbean, Western  
Europe, Central-Eastern Europe, Africa-Middle East, Australia-Asia).  
29 After initial Logit estimation of the likelihood of US MNC investment in  
foreign countries using these country specific and one of these two  
31 alternative regional grouping schemes, we submit the initial schemes to  
simulated annealing analysis. At the conclusion of this analysis, we compare  
33 the extent of before and after change for each scheme and assess robustness  
of each scheme alone and in comparison.

35 Lastly, we summarize the central issue and findings of this methodological  
research paper. We note several implications for IB and related management  
37 research reliant on the validity and reliability of groups, whether they are  
regionally, or otherwise defined. We propose practical strategies for  
39 implementing such ex post schemes for evaluating schemes and suggest how  
simulated annealing itself might be incorporated into future empirical work.

## 1 REGIONAL GROUPING SCHEMES IN IB RESEARCH

### 3 *MNCs, FDI and Regional Groups*

5 How and why are regional grouping schemes important in IB research?  
 6 To address this question and set the context for our survey of alternative  
 7 grouping schemes we rely primarily on Aguilera, Flores, and Vaaler  
 8 (forthcoming), who answer this question in detail in a companion paper.  
 9 The last two decades of research in IB and related management fields have  
 10 seen substantial debate about the significance and relative importance of  
 11 country location for understanding its attractiveness for MNC investment.  
 12 Democratization in local polities, privatization and deregulation in local  
 13 economies, as well as international regimes promoting trade liberalization  
 14 have all promoted the position of MNCs as instruments of country  
 15 investment and growth, as well as instruments of regional integration and,  
 16 indeed, globalization of formerly segmented national markets (Dicken,  
 17 1998; Giddens, 1999; Held, 2000).

18 Yet, research on central tendencies in MNC internationalization remains  
 19 inconclusive and requires more systematic analysis. On the one hand, IB  
 20 scholars such as Rugman and Verbeke (2004, 2007) hold that MNCs  
 21 locational patterns have become increasingly regional as opposed to global.  
 22 Thus, understanding the impact of regional country groupings is increas-  
 23 ingly important for explaining whether and how MNCs internationalize.  
 24 They contrast with other IB scholars who emphasize the value of global  
 25 scale and scope in MNC operations (Agmon, 2003; Bird & Stevens, 2003;  
 26 Clark, 1997; Clark & Knowles, 2003; Clark, Knowles, & Hodis, 2004).  
 27 Regional patterns of operation are still important to study from this  
 28 alternative view, however, as they represent intermediate steps in the  
 29 internationalization trajectories of firms transforming themselves from  
 30 domestic to regional to worldwide competitors. Thus no matter the side  
 31 researchers take in this debate, understanding alternative regional grouping  
 32 schemes and their impact on MNC internationalization behavior becomes  
 33 critical. We survey those schemes and raise issues related to their prudential  
 34 use, validity and reliability in recent IB research.

35

### 37 *Defining Regional Groups*

39 In this context of debate over MNC internationalization patterns and the  
 40 impact of regions, we see value first in seeking to define the concept of

1 central interest. The term *region* might be intuitively defined as a “fairly  
2 large area of a country or of the world, usually without exact limits”  
3 (Longman, 1995). This definition implies proximity between countries based  
4 on physical dimensions of measurement. As we will see below, however,  
5 scholars in IB and related fields have defined regions by alternative  
6 dimensions of proximity. Countries have been grouped based on broad  
7 patterns of trade and economic relationships (e.g., Rugman & Verbeke,  
8 2004), based on broad cultural indices (e.g., Hofstede, 2001 [1980]), based on  
9 key components of culture such as language, religion, law, politics and  
10 popular media (e.g., Guiso, Sapienza, & Zingales, 2006) as well as on shared  
11 physical proximity (e.g., Vaaler & McNamara, 2004). We survey some such  
12 schemes and note their key findings related to debate over MNC  
13 internationalization patterns.

15

#### *Regional Grouping Schemes Based on Economics and Trade*

17

18 Though readers might intuit that physical proximity is the most common  
19 dimension for grouping, dimensions related to common levels of economic  
20 development tend to dominate most schemes in IB research. Several studies  
21 stress the need of looking at the outcomes of regional economic integration  
(Frankel, 1997). One of the forerunners of this approach was Ohmae (1985),  
22 who grouped countries into a Triad of three regions centered on Japan,  
23 the US and Western Europe, primarily France, Germany, and the UK. He  
24 claimed that MNC survival required some dominant market positioning in  
25 at least one these three national economies, and by implication, the North  
26 American, European and/or Asian countries that depended on each Triad  
27 leader.

28 Building on Ohmae’s insights, Rugman and Verbeke note that regional  
29 FDI by MNCs follow multilateral trade regimes such as the North  
30 American Free Trade Agreement (NAFTA), the Association of Southeast  
31 Asian Nations (ASEAN) and the European Union (EU) (Rugman, 2005;  
32 Rugman & Verbeke, 2004, 2005). Researchers have highlighted the  
33 relevance of countries’ membership in key transnational organizations such  
34 as the Organisation for Economic Co-operation and Development (OECD)  
35 (Buckley & Ghauri, 2004; Dunning, 2001; Gatignon & Kimberly, 2004).  
36 On the other hand, an emerging literature in political economy suggests  
37 that regional FDI follows a more complex regional grouping based on  
38 multilateral regimes *and* bi-lateral investment treat arrangements (Simmons,  
39 Elkins, & Guzman, 2006). Thus, regional trading blocs and economic

1 arrangements might benefit from refinement based on additional bilateral  
2 dyads and arrangements.

3

5 *Regional Grouping Schemes Based on Culture*

7 The most common regional criteria used by scholars grouping countries  
8 accordingly focus on cultural dimensions related to the personal attitudes  
9 and beliefs.<sup>1</sup> Perhaps the prominent application of cultural dimensions  
10 to group countries together for explanation of MNC behavior comes from  
11 Hofstede (2001 [1980]). He first surveyed IBM employees in the 1970s to  
12 derive cultural dimensions related to 53 countries. Relying on a statistical  
13 technique (hierarchical clustering) for the cultural dimensions he uncovers in  
14 his studies (power distance, uncertainty avoidance, masculinity/femininity  
15 and individualism/collectivism), Hofstede ended up defining a 12-group  
16 regional structure (Hofstede, 2001 [1980], p. 62).

17 Hofstede's indices have provided the basis for subsequent empirical  
18 studies that have documented similarity (dissimilarity) between MNC  
19 investment and competitive behaviors within (between) regions defined by  
20 different factors and clusters (see Kirkman, Lowe, & Gibson, 2006 for a  
21 complete review of the consequences of Hofstede's framework). Later,  
22 Ronen and Shenkar (1985) offered their own scheme, partially using the  
23 work of Hofstede, where 45 countries were grouped into nine cultural  
24 clusters, while Furnham, Kirkcaldy, and Lynn (1994) offered their own  
25 scheme of 41 five cultural clusters. More recently, the World Values Survey  
26 (Abramson & Inglehart, 1995), is finding more use in IB research. The  
27 so-called GLOBE project represents yet another stream flowing from  
28 Hofstede (House, Javidan, Hanges, & Dorfman, 2002). Gupta, Hanges, and  
29 Dorfman (2002) have used GLOBE project data in discriminant analyses to  
30 identify 7 regional groups for 61 countries involved in the GLOBE project,  
31 while Brodbeck and a large team of researchers in European countries  
32 (Brodbeck et al., 2000) and Lenartowicz and Johnson (2003) in Latin  
33 America have used GLOBE project data to identify intra-regional grouping  
34 schemes relevant to MNC behavior.

35

37 *Regional Grouping Schemes Based on Institutions*

39 Yet another approach to using cultural dimensions relies less on aggregate  
40 indices and more on specific cultural traits such as language, religion, law,

1 politics and media. This approach comprises both culture defined by  
individual attitudes and beliefs and culture-as-institutions, that is, the  
3 collective legal, political and social arrangements that spring from such  
attitudes and beliefs and together guide basic rules of economic exchange  
5 (North, 1990). Language and religion are particularly important cultural  
components, such as in work by Chetty, Eriksson, and Lindbergh  
7 (forthcoming), Dow and Karunaratna (2006) and Leung, Bhagat, Buchan,  
Erez, and Gibson (2005).

9 This approach contrasts with regional groupings based explaining MNC  
FDI and lending based on similar levels of economic development  
11 (Dunning, 1998, 2001), based on similar levels of corruption, bureaucratic  
efficiency, media and voice, respect for law (Globerman & Shapiro, 2003;  
13 Kaufmann, Kraay, & Zoido-Lobaton (1999); La Porta, Lopez-de-Silanes,  
Shleifer, & Vishny, 1999). La Porta and his colleagues, for example,  
15 document that countries with Anglo-American common law traditions  
providing stronger investor and creditor protections draw more foreign  
17 investment, have deeper and broader debt markets compared to countries  
with French civil law traditions. Aguilera and Cuervo-Cazurra (2004) note  
19 that their findings support the idea that countries with more protective  
(of minority shareholder rights) legal systems tend to develop stronger and  
21 better-enforced codes of good corporate governance. On the other hand,  
Berkowitz, Pistor, and Richard (2003) show that many results obtained by  
23 La Porta and his colleagues vary once more refined country groupings are  
defined. Berkowitz and colleagues distinguish between common and civil  
25 law countries where the legal system was imposed by force or developed  
organically. Countries where legal system developed organically, whether  
27 civil or common law in nature, provide more protection than in countries  
where the system was forcibly “imported.”

29

### 31 *Regional Grouping Schemes Based on Geography*

33 Physical proximity and contiguity present the most straightforward  
dimensions for creating regional grouping schemes. Here, shared geography  
35 overlaps with and contributes to other similarities along dimensions  
previously surveyed above. Dividing the world into continental groupings  
37 such as Europe, Asia, America, Africa and Oceania often appears in IB  
research. Kwok and Tadesse (2006) choose continental groupings to study  
39 the free market-orientation of financial systems in 41 countries. Similarly,  
Katrishen and Scordis (1998) find that the continent from which MNC

1 insurers are domiciled is significantly linked to MNC insurer likelihood of  
 2 achieving economies of scale. Geringer, Beamish, and daCosta (1989) also  
 3 control by continent of origin when assessing performance of 200 MNCs  
 4 with differing levels of diversification and internationalization. Vaaler and  
 5 McNamara (2004) find that continental regional specialization by major  
 6 credit rating agencies significantly and substantially changes their sovereign  
 7 risk assessments in the late 1980s and 1990s.

8 The United Nation's Statistics Division may offer more fine-grained  
 9 partition of these geographic regions (UN, 2007). The UN scheme breaks up  
 10 countries into 19 regions (i.e., Australia and New Zealand, Caribbean,  
 11 Central America, Eastern Africa, Eastern Asia, Eastern Europe, Melanesia,  
 12 Middle Africa, Northern Africa, Northern America, Northern Europe,  
 13 South America, South-Central Asia, South-Eastern Asia, Southern Africa,  
 14 Southern Europe, Western Africa, Western Asia, Western Europe). Flores  
 15 and Aguilera (2007) use this scheme to explain US MNC country location  
 16 decisions in 1980 and 2000.

17

19

### 20 *Use, Validity and Reliability Issues in Recent IB Empirical Research*

21

22 Our review of the empirical literature related to regional effects in IB and  
 23 related fields reveal clear differences regarding dimensions for grouping  
 24 countries and explaining MNC behavior and performance within and across  
 25 such groupings. No doubt this often follows from the eclecticism of IB  
 26 research interests, theoretical perspectives and empirical analytical methods.  
 27 Even so, some such dimensions are provided without any ex ante theoretical  
 28 grounding, thus undermining concept, construct and measurement validity.  
 29 Even where ex ante theoretical grounding is provided, we note in many cases  
 30 that alternative schemes based on similar theories and methods yield  
 31 different results, thus impairing reliability claims as well.

32 For example, Ronen and Shenkar (1985) refine Hofstede's regional  
 33 clusters with differing results regarding MNC executive attitudes, while  
 34 Simmons et al. (2006) suggest that refinement of regional trading blocs  
 35 based on assessment of bilateral investment treaties may change previous  
 36 results based on multilateral trade agreements alone. And more fine-grained  
 37 regional grouping schemes based on legal system differences reported by  
 38 Berkowitz et al. (2003) yield different insights on the extent of investor and  
 39 creditor protection for MNCs compared to more coarse-grained measures  
 and groupings proposed by La Porta and his colleagues.



1           **A NEW EX POST APPROACH TO ASSESSING**  
 3           **REGIONAL GROUP VALIDITY AND RELIABILITY:**  
               **SIMULATED ANNEALING**

5           *Ex Post Approaches to Assessing Regional Grouping Schemes*

7 We take such findings as the departure point for our own alternative  
 9 approach to evaluation of regional grouping schemes. Rather than attack  
 11 the theoretical validity and reliability of prominent regional grouping  
 13 schemes reliant on economic, cultural, institutional and other dimensions ex  
 15 ante, we propose an alternative ex post evaluative technique based on  
 17 iterative refinement and re-estimation using a simulated annealing  
 19 approach. However, the regional scheme is structured, the ex post question  
 21 to be posed is whether and how much such a scheme is subject to change  
 after reasonable refinement. Schemes that are vulnerable to substantial  
 change have weaker validity and reliability than schemes exhibiting less  
 change. Evidence of robustness after submission to this ex post evaluation  
 responds to criticisms noted above with empirical evidence demonstrating  
 the stability of key grouping assumptions grounded in whatever theory IB  
 researchers choose initially to justify their regional grouping scheme.

Consider, for example, an empirical model of MNC country location  
 defined as follows:

$$\begin{aligned}
 \text{MNC subsidiary}_{ijmt} = & \alpha_0 + \sum_{k=1}^{k=l} \text{Country factors}_{it} + \sum_{n=1}^{n=p} \text{MNC factors}_{jt} \\
 & + \sum_{q=1}^{q=r} \text{Year factors}_t + \sum_{s=1}^{s=u} \text{Regional dummies}_m + \varepsilon_{ijmt} \quad (1)
 \end{aligned}$$

In (1), the dependent variable is a 0-1 indicator equal to 1 when MNC  $j$  has  
 a subsidiary operation in country  $i$  part of region  $m$  in year  $t$ . We explain the  
 likelihood of MNC location of a subsidiary operation based on country  
 factors  $i$  ( $k=1-l$ ), MNC factors  $j$  ( $n=1-p$ ) and time (year) factors  
 $t$  ( $q=1-r$ ). In addition, we define a regional grouping scheme in the form of  
 fixed regional dummies  $m$  ( $s=1-u$ ). The structure of this regional grouping  
 scheme is presumably grounded ex ante in theory related to the significance  
 of economic, cultural, institutional and/or geographic factors. Logistic or  
 Probit estimation of this model provides insight on the impact of regional  
 grouping based on evaluation of the regional dummies for their individual  
 and collective significance and practical impact.

1 Our approach implies re-estimation of (1) after iterative ex post  
refinement of the initial regional grouping schemes. This implication raises  
3 new challenges related to the extent of this refinement. In concept,  
alternative regional groupings are limited only by the number of countries  
5 and potential country combinations. It is unfeasible to search all of these  
possible alternative schemes. A partial search seeking to refine the grouping  
7 scheme based on some simple optimization criterion may reduce search  
time, yet challenges still persist. Consider, for example, a search to refine  
9 some initial regional grouping scheme based on minimization of the  
regression equation's unexplained variance, that is, the error sum of squares  
11 (ESS) generated by logistic estimation. If the number of alternative grouping  
schemes with refinement is still large, simple minimization using conven-  
13 tional algorithms such as Newton Raphson or Davidson-Fletcher-Powell is  
likely to move greedily to a local minimum but search no further. Thus, we  
15 may end search and refinement of initial regional grouping scheme  
prematurely, thus leaving the global minimum ESS unidentified and the  
17 researcher unsure as to the stability of initial results.

19

#### *Ex Post Evaluation Based on Simulated Annealing*

21

An alternative "simulated annealing" search algorithm improves on these  
23 and other "hill-climbing" heuristics. Usually the cooling process for molten  
metal is used to detail how this procedure works. On those processes where  
25 the temperature of the metal is continuously reduced, after a slow cooling  
(annealing), the metal arrives to a minimum energy state. Innate random  
27 variations in energy allow the annealed system to escape local energy  
minima. Even though this technique is not flawless in finding the global  
29 minimum, it tends to achieve an ending point closer to the global minimum  
than do conventional algorithms (Alrefaei & Andradóttir, 1999; Goffe et al.,  
31 1994). Perhaps the best-known application of simulated annealing is to the  
"traveling salesman" problem, where the goal is to find the minimum trip  
33 distance connecting several cities. Academic applications of this technique  
range from optimal land use and irrigation design (Aerts & Heuvelink, 2002)  
35 to micro-circuit design (Kirkpatrick, Gelatt, & Vecchi, 1983). Within the  
management realm, Han (1994) uses simulated annealing for optimal  
37 information filing, while Carley and Svoboda (1996) model optimal  
organizational adaptation to environmental shocks. Semmler and Gong  
39 (1996) optimize the size of industry groupings in analyses of real business  
cycle parameters, while Fox et al. (1997) use simulated annealing to refine

1 business membership in standard industry classes and assess the impact of  
 3 such intra-industry strategic groups on business performance in the US  
 during the 1970s.

To explain how the annealing algorithm functions in our application,  
 5 consider an initial partitioning of countries into regional groups based on  
 (1):  $\{P_s\} = (p_{s=1}, p_{s=2}, \dots, p_{s=u})$ . Here,  $p_s$  represents the  $s^{\text{th}}$  regional group  
 7 composed of  $n$  countries. Coefficients are estimated for this initial partition.  
 Next, a new partition  $[P_s']$  is made by varying the group structure of the  
 9 whole set of countries. The variation may be of two types:

- 11 1. It may be a random exchange of two countries from different regional  
 groups,  $p$ .
- 13 2. It may be a random perturbation changing the size of a given region,  
 $p_s$ , resulting in a change in the number of countries  $n$  in the region from  
 15  $x \geq 3$  to  $x - c \geq 3$  where  $c$  is some integer.

After re-estimation, if the new ESS' is less than the old ESS, the new  
 17 regional group structure,  $\{P_s'\}$ , structure replaces the old regional group  
 structure,  $\{P_s\}$  and the algorithm moves downhill. If the new ESS' is greater  
 19 than or equal to the old ESS, then acceptance is stochastic. A criterion  
 developed by Metropolis, Rosenbluth, Rosenbluth, Teller, and Teller (1953)  
 21 decides on acceptance of an uphill move. Thermodynamics analogies also  
 motivated the Metropolis criterion. The value:

$$\text{Metropolis} = e^{-(\text{ESS}' - \text{ESS})/T}$$

25 is estimated and compared to Metropolis', a uniformly distributed random  
 27 number ranging from [0,1]. If Metropolis is greater than Metropolis', the  
 new structure is accepted,  $\{P_s\}$  is updated to  $\{P_s'\}$ , and the algorithm moves  
 29 uphill. Otherwise,  $\{P_s'\}$  is rejected and the search for alternative regional  
 grouping schemes minimizing unexplained variance in (1) continues.

31 From eq. (1), obviously two factors decrease the likelihood of an uphill  
 move: lower 'temperature' ( $T$ ) and larger differences in the function's value.  
 33 After several iterations, the temperature is reduced in steps and the  
 annealing process continues. As temperature is lowered, large moves uphill  
 35 are discouraged and the algorithm favors smaller refinements leading  
 toward the global minimum. The annealing schedule, that is, the initial  
 37 temperature and the size of stepwise decreases, is ad hoc and requires  
 experimentation. Successful annealing depends on the schedule and size of  
 39 perturbations to the system considered at each iteration. The smaller the  
 extent of a perturbation, the more likely the search will efficiently find the

1 global minimum. The random choice of the initial regional group scheme  
 3 will also influence the efficiency of the annealing process. The algorithm  
 5 stops when some preset criterion is met. In general, the algorithm finishes  
 7 during the final step in cooling after the rate of change in the ESS term fails  
 9 to meet some preset rate of change related to the CPU speed of the  
 11 computer doing the various calculations.

13 We apply these simulated annealing parameters to develop an executable  
 15 program, which follows the pseudo-code detailed below:

- 17 1. Define empirical model (1).
- 19 2. Read data into (1).
- 21 3. Run a logistic regression with an original regional grouping scheme.
- 23 4. Randomly select a regional group. Count the number of countries in it.
- 25 5. If there are six or more countries in the group, then randomly choose  
 27 between changing group based on break up into two groups or  
 29 randomly swap a country from that group with another group  
 randomly chosen.
6. If there are fewer than six countries in the group, then randomly swap  
 one country from group with another group randomly chosen.
7. Run the logistic regression with new group structure.
8. Compare new ESS' with previous ESS and apply Metropolis criterion to  
 accept or reject change in group structure.
9. Repeat steps 3–8 at least 50 times at the given temperature. Stop  
 iterations at given temperature and decrease temperature based on  
 random stopping criterion.
10. Repeat step 9 until final temperature decrease in annealing schedule is  
 accomplished and overall stopping criterion is met.
11. Print final group structure, final logistic regression coefficient estimates  
 and  $p$ -values, final pseudo  $R^2$  and final ESS.

Once annealing is completed, we are in a position to assess the robustness of  
 the original regional grouping scheme based on three criteria: (1) percentage  
 change in the number of regional groups  $((u_{\text{end}} - u_{\text{beginning}})/u_{\text{beginning}}$  where  
 $u$  is the number of regional groups before (beginning) and after (end)  
 annealing); (2) percentage change in overall MNC FDI model explanation  
 (pseudo  $R^2_{\text{end}} - \text{pseudo } R^2_{\text{beginning}} / \text{pseudo } R^2_{\text{beginning}}$  where pseudo  $R^2$  is the  
 coefficient of variation before and after annealing and (3) percentage change  
 in MNC FDI model coefficients  $((w_{\text{beginning}} - w_{\text{end}})/w_{\text{end}}$  where the difference  
 in  $w$  is the number of non-group terms retaining the original coefficient sign  
 and significance after annealing). We can multiply each of these three  
 measures by 100 to obtain percentages of change. A regional grouping

1 scheme is less (more) robust ex post to the extent that each of these three  
percentages exceeds (verges on) 0%.

## ILLUSTRATION OF OUR EX POST APPROACH

### *Data Sources, Sampling and Empirical Model for Illustration*

We illustrate this ex post approach to evaluating different regional grouping schemes based on US MNC data used in Flores and Aguilera (2007). They examine the country location of 100 largest US MNCs in 1980 and 2000 based on total sales. Consistent with (1) above, the dependent variable, MNC Subsidiary, is a 0-1 variable taking the value of 1 if the MNC has a subsidiary in the country in the year of observation. These data are obtained from the Directory of American Firms Operating in Foreign Countries (Angel, 1991, 2001), which includes all major US firms' investments abroad. US MNC investment abroad is where "American firms have a substantial direct capital investment and have been identified by the parent firm as a wholly or partially owned subsidiary, affiliate or branch. Franchises and non-commercial enterprises or institutions, such as hospitals, schools, etc., financed or operated by American philanthropic or religious organizations are not included." (Angel, 2001, p. i) This operationalization of US foreign location choice allows us to address, at least partially, some of the criticisms of drawing on sales as an overarching measure to capture MNC activities overseas (Clark & Knowles, 2003; Clark et al., 2004; Dunning, Fujita, & Yakova, 2007). US firms in the sample cover 27 different two-digit SIC industry code from oil and gas exploration to pharmaceuticals manufacturing. The US MNCs in this sample have on average substantial direct capital investment on 22.9 countries in 1980 and 28.9 countries in 2000. The total number of substantial foreign capital investments for the 100 MNCs is 2,288 and 2,891 in 1980 and 2000, respectively, an increase of 26% over 20 years.

Again consistent with (1) we define several country-related, MNC-related and time- (year)-related variables. We include in (1) 10 country terms (with expected sign): (1) *Country Wealth* (+), which we operationalize as Gross Domestic Product in billions of current US dollars measures affluence in each year; (2) *Country Size* (+), which we operationalize as the total number of inhabitants in millions; (3) *Country Physical Infrastructure* (+), which we operationalize as the total number of phone lines per thousand inhabitants; (4) *New Country* (-), which we operationalize as a 0-1 term

1 where 1 equals a country that did not exist in 1980; (5) *Country Political*  
 3 *Institutions* (+), which we operationalize as a 0-1 term where 1 equals a  
 country judged as democratic; (6) *Country Legal System* (+), which we  
 5 operationalize as a 0-1 term where 1 equals a country with an Anglo-  
 American common law tradition; (7) *Country Language* (+), which we  
 7 operationalize as a 0-1 term where 1 equals a country where English is an  
 official language; (8) *Country Geographic Distance* (-), which we operation-  
 9 alize as distance in thousands of miles, between Washington, DC and the  
 capital of each country; (9) *Cultural Distance* (-), which we operationalize  
 based on Kogut and Singh's (1998) and (10) *Economic Development* (+),  
 11 which we operationalize as a 0-1 term where 1 equals an OECD member  
 country. Data for these terms come from the World Bank's World  
 13 Development Indicators (*Country Size, Country Physical Infrastructure,*  
*New Country*), the *CIA FactBook* (*Country Political Institutions, Country*  
 15 *Language, Country Economic Development*), Reynolds and Flores (1989)  
 (*Country Legal System*), *Great Circle Distances Between Capital Cities*  
 17 (Eden, 2006) (*Country Geographic Distance*) and International Institute of  
 Culture (*Country Cultural Distance*).

19 Again consistent with (1) we include two firm (MNC) terms: (1) *Firm Size*  
 (+), which we operationalize as the total number of employees and (2) *Firm*  
 21 *Performance* (+), which we operationalize as the total return to investors in  
 the previous 10 years. Data for these variables come from the UN Center for  
 23 Transnational Corporations (UNCTAD, 2005). Finally, we include a 0-1  
*Year* (-) dummy that equals 1 when year is 1980. We have complete data for  
 25 foreign investments by 100 US MNCs operating in 105 countries in 1980  
 and 2000, a total of 19,635 observations for foreign investments made by  
 27 this group of 100 US firms in 105 countries, total of 19,635 MNC country  
 year observations. Descriptive statistics and pair-wise correlations for this  
 29 sample are reported in Table 1.

31

### *Regional Grouping Schemes and Annealing Schedule for Ex Post* 33 *Evaluation*

35 The logistic regression model for estimating the likelihood of US MNC  
 investment in various foreign countries, we add regional dummies linked to  
 37 two regional grouping schemes: (1) four regional dummies corresponding  
 to a five-region grouping scheme based on the continental membership  
 39 of countries (America (Canada and Latin America/Caribbean), South  
 America, Europe, Africa and Asia) and (2) six regional dummies

Table 1. Descriptive Statistics for Key Variables.

Variable	Mean	s.d.	1	2	3	4	5	6	7	8	9	10	11
1. Capital investment	0.18	0.38	1.00										
2. Firm size	65 e+3	82 e+3	0.10***	1.00									
3. Firm performance	11.2	9.6	0.01	-0.02**	1.00								
4. Country language	0.34	0.47	0.01	0.00	0.00	1.00							
5. New country	0.08	0.27	-0.03***	-0.00	0.09***	-0.21***	1.00						
6. Country wealth	102.0	326.1	0.33***	-0.00	0.04***	-0.08***	0.01	1.00					
7. Country population	33.2	119.2	0.12***	-0.00	0.01*	0.00	-0.03***	0.28***	1.00				
8. Country physical infrastructure	147.0	182.6	0.32***	-0.00	0.10***	-0.03***	0.18***	0.39***	-0.06***	1.00			
9. Country political institutions	0.54	0.50	0.21***	-0.00	0.12***	0.13***	0.13***	0.17***	0.01	0.39***	1.00		
10. Country legal institutions	0.34	0.47	0.12***	-0.00	0.02**	0.61***	-0.13***	0.08***	0.04***	0.07***	0.28***	1.00	
11. Country geographic distance	5.53	2.16	-0.08***	0.00	-0.00	0.26***	-0.06***	-0.05***	0.11***	-0.20***	-0.16***	0.23***	1.00
12. Country cultural distance	2.81	1.33	-0.14***	0.00	0.00	-0.05***	-0.11***	-0.12***	0.00	-0.35***	-0.04***	-0.10***	-0.04***

\*  $p < 0.05$ .

\*\*  $p < 0.01$ .

\*\*\*  $p < 0.001$ .

1 corresponding to a seven-region grouping scheme based on Vaaler and  
 3 McNamara's (2004) research on sovereign risk rating around the world  
 5 (North America-Caribbean, Latin America, Western Europe, Central and  
 7 Eastern Europe, Africa-Middle East, Asia and Oceania). We omit North  
 9 America from the continental regional grouping scheme, and omit Western  
 Europe from the regional grouping scheme based on Vaaler and McNamara  
 (2004). Once we estimated our base model for each of the two regional  
 schemes, we submit them for iterative re-estimation and simulated annealing  
 according to the following schedule:

11	Initial temperature	100
	Temperature reduction factor	0.98
13	Ending temperature	0.05
	Maximum steps	100
15	Minimum number of iterations/step required	50
	Maximum number of iterations/step permitted	25,000
17	Actual total number of iterations	16,445 (continental), 17,172 (Vaaler & McNamara)
19	Running time on workstation computer	8 h
21		

### 23 *Results before and after Annealing*

25 Results from initial logistic estimation based on both regional grouping  
 27 schemes are presented in Tables 2–4. Case A results follow from the  
 continental regional scheme while Case B results follow from the Vaaler and  
 McNamara regional scheme. We first examine results in Table 2, that is, the  
 29 “Beginning” country, firm and year coefficients for Case A and Case B.  
 These coefficients yield intuitive results. For the Case A continental scheme,  
 31 11 of the 13 country, firm and year coefficients have the predicted sign and  
 10 of the 11 are significant at commonly accepted (10% or better) levels. For  
 33 the Case B Vaaler and McNamara scheme, 10 of the 13 coefficients have the  
 predicted sign and all 10 are significant at commonly accepted levels. US  
 35 MNCs are more likely to locate FDI in countries abroad if they are more  
 profitable and larger MNCs, if it is in 2000 rather than 1980, and if the host  
 37 country has the following characteristics: greater wealth and size, better  
 infrastructure, is not newly independent, has more democratic political  
 39 institutions, a common law legal system, less cultural distance from the US  
 and a higher level of economic development.



**Table 2.** Logistic Regression Coefficients: Cases A & B.

Control Variables	Case A: Continent Regional Scheme <sup>a</sup>		Case B: Vaaler and McNamara (2004) Regional Scheme <sup>a</sup>	
	Beginning	End	Beginning	End
Firm performance	-0.0016***	-0.0026***	-0.0017***	-0.0018***
Firm size	4.51E-06***	5.19E-06***	4.59E-06***	5.17E-06***
Country wealth (GDP)	0.0016***	0.0002***	0.0016***	0.0009***
Country size (population)	0.0011***	0.0047***	0.0009***	0.0024***
Country physical infrastructure	0.0011***	0.0022***	0.0015619***	0.0031***
New country dummy	-0.2070*	1.1949	0.5805 <sup>§</sup>	1.6686
Country political institutions	0.6521 <sup>§</sup>	0.4019*	0.5980 <sup>§</sup>	0.4800 <sup>§</sup>
Country legal institutions	0.4404 <sup>§</sup>	0.7296 <sup>§</sup>	0.5122 <sup>§</sup>	0.7738 <sup>§</sup>
Country language	-0.1670*	-0.5708 <sup>§</sup>	-0.1668*	-1.0466
Country distance to US	0.2536*	0.1890*	0.2641*	0.3434*
Country cultural distance to US	-0.1034**	-0.0096**	-0.0975*	0.0223**
Country economic development	1.1443	3.2142	0.4098 <sup>§</sup>	0.8343 <sup>§</sup>
Year dummy	-0.1811*	-0.2154*	-0.2854*	-0.4910 <sup>§</sup>
Constant	-4.7119	-4.3437	-3.9916	-8.0417
Pseudo R <sup>2</sup> (%)	31.32	37.92	31.90	37.02
ESS	2,428	2,195	2,407	2,227
N	19,635	19,635	19,635	19,635

<sup>a</sup>See Appendix A for a complete description of regional schemes and the countries.

<sup>§</sup>p < 0.10.

\*p < 0.05.

\*\*p < 0.01.

\*\*\*p < 0.001.

What about the explanatory power of each regional grouping scheme at initial estimation? Here, we see clear contrasts in Tables 3 and 4. With Case A's continental scheme, we see that two regions, Africa and Asia are significantly less likely to receive US MNC FDI, and we note that these four continental dummies as a whole add significant additional explanation to the logistic regression. On the other hand, with Case B's Vaaler and McNamara scheme, we find no significant regional dummies at the beginning. Were we to stop here, we might conclude that a simple continental scheme emphasizing geography and physical distance adds significantly and practically to overall explanation of MNC FDI patterns over time.

But submission of these two schemes to iterative refinement and re-estimation based on simulated annealing leads to a different view.

**Table 3.** Logistic Regression Coefficients for Case A: Beginning and End of Annealing Process.

Regional Dummies	Case A: Continent Regional Scheme <sup>a</sup>	
	Beginning	End
Africa dummy	-0.6476 <sup>§</sup>	
America dummy	1.7423	
Asia dummy	-0.5030 <sup>§</sup>	
Europe dummy	-1.0066	
Sub-region Africa 1 dummy		-1.9232
Sub-region America 1 dummy		2.2707
Sub-region Asia 1 dummy		-4.7510
Sub-region Oceania dummy		-2.7916
Sub-region Europe 1 dummy		-2.326
Sub-region America 2 dummy		-0.8007 <sup>§</sup>
Sub-region Africa 2 dummy		-2.9281
Sub-region Europe 2 dummy		0.5654 <sup>§</sup>
Sub-region Asia 2 dummy		-1.107
Sub-region Africa 3 dummy		-1.518
Sub-region America 4 dummy		1.4897
Sub-region Africa 4 dummy		0.8054 <sup>§</sup>
Sub-region Asia 3 dummy		-3.6295

<sup>a</sup>See Appendix A for a complete description of regional schemes and the countries.

<sup>§</sup> $p < 0.10$ .

\* $p < 0.05$ .

\*\* $p < 0.01$ .

\*\*\* $p < 0.001$ .

AU :1

We set minimization of the ESS as our annealing criterion and follow the schedule noted above. This way, the algorithm searches for additional model explanation through iterative refinement of each grouping scheme. We track that search in Fig. 1. Two panels in Fig. 1 illustrate along the  $x$ -axis the number of iterations, that is, attempted refinements in grouping scheme, over the 100 temperature steps in the algorithm. Along the  $y$ -axis, we note changes in overall model explanation using a pseudo- $R^2$  measure commonly reported with logistic regression.

With Case A's continental scheme, the annealing schedule results in 16,455 iterations over 100 steps while Case B's Vaaler and McNamara scheme results in 17,172 over 100 steps. The number of iterations per step ranges from the minimum of 50 to more than 1,000. Either the ESS is reduced or because of stochastic criterion permitting acceptance where ESS

**Table 4.** Logistic Regression Coefficients for Case B: Beginning and End of Annealing Process.

Regional Dummies	Case B: Vaaler and McNamara (2004) Regional Scheme <sup>a</sup>	
	Beginning	End
Africa-Middle East dummy	-1.3906	
Asia dummy	-1.0863	
Central-Eastern Europe dummy	-1.8068	
Latin America dummy	0.99588	
North American-Caribbean dummy	1.1123	
Oceania dummy	-1.3398	
Sub-region Africa-Middle East 1 dummy		3.4168
Sub-region Asia 1 dummy		2.1287
Sub-region Central-Eastern Europe 1 dummy		1.7506
Sub-region Latin America 1 dummy		4.7575
Sub-region North America-Caribbean 1 dummy		4.8575
Sub-region not Considered dummy		1.7539
Sub-region West Europe 1 dummy		3.386
Sub-region Central-Eastern Europe 2 dummy		-0.1685*
Sub-region West Europe 2 dummy		2.5836
Sub-region Africa-Middle East 2 dummy		0.2197*
Sub-region Africa-Middle East 3 dummy		2.3684
Sub-region Africa-Middle East 4 dummy		3.9958
Sub-region Latin America 2 dummy		3.3994
Sub-region West Europe 2 dummy		1.5181

<sup>a</sup>See Appendix A for a complete description of regional schemes and the countries.

<sup>§</sup> $p < 0.10$ .

\* $p < 0.05$ .

\*\* $p < 0.01$ .

\*\*\* $p < 0.001$ .

is not reduced (i.e., Metropolis criterion), we note more than 10,000 changes in both regional grouping schemes over the entire schedule that took approximately 8h to implement on a state-of-the-art workstation computer.<sup>2</sup>

We note the similar patterns of change in both panels of Fig. 1. With Case A's continental scheme, a seemingly random search for refinements to minimize ESS is rewarded approximately 75% of the way through the annealing schedule. At approximately 11,000 iterations, we start an increase in the pseudo- $R^2$  indicating refinement of group structure yielding greater explanation of variation in the likelihood of US MNCE country FDI.

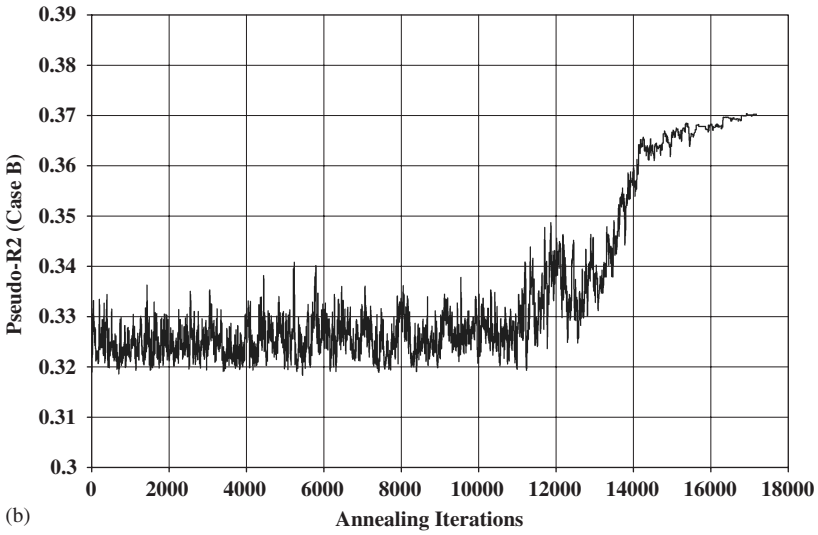
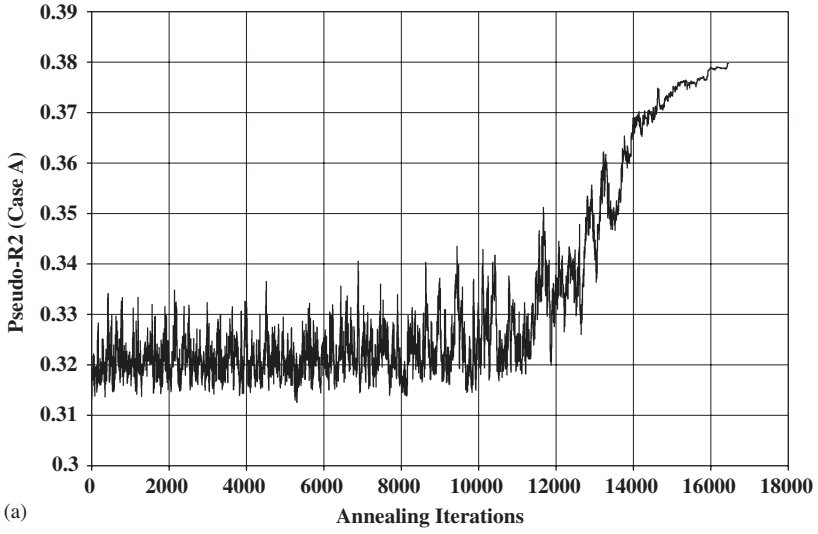


Fig. 1. Logistic Regression's Pseudo- $R^2$  versus Annealing Iterations. (a) Case A: Continents Regional Scheme, (b) Case B: Vaaler and McNamara (2004) Regional Scheme.

1 The rate of increase begins to level off at approximately 15,000 iterations,  
 3 near the final steps in the annealing schedule where stochastic jumps based  
 on the Metropolis criterion are quite unlikely. From 11,000 iterations to the  
 5 end of the annealing schedule at 16,445 iterations, pseudo- $R^2$  increases from  
 0.32 to 0.38. We observe a  $((0.38-0.32)/0.32)$  18.75% increase in model  
 explanation from the very beginning to the end of simulated annealing.

7 With Case B's McNamara and Vaaler scheme, the seemingly random  
 search for refinements to minimize ESS is again rewarded approximately  
 9 75% of the way through the annealing schedule. At approximately 11,000  
 iterations, we again start an increase in the pseudo- $R^2$  indicating refinement  
 11 of group structure yielding greater explanation of variation in the likelihood  
 of US MNCE country FDI. But only 1,000 iterations or so later,  
 13 refinements to group structure decrease pseudo- $R^2$  only to see that reversed  
 again in an upward direction at approximately 12,500 iterations. The  
 15 regional grouping landscape for this scheme is apparently more rugged than  
 in the case of the simpler continental scheme. Even so, we then observe  
 17 a steady increase in model explanation that begins to level off at  
 approximately 14,000 iterations, near the final steps in the annealing  
 19 schedule where stochastic jumps based on the Metropolis criterion are less  
 unlikely. From 12,500 iterations to the end of the annealing schedule at  
 21 17,172 iterations, pseudo- $R^2$  increases from 0.325 to 0.37. From beginning  
 to end of simulated annealing, we observe a  $((0.37-0.325)/0.325)$  13.8%  
 23 increase in model explanation.

With annealing completed, we return again to Tables 2–4 for review. We  
 25 look first at the “End” coefficient estimates in Table 2. Ending firm, country  
 and year coefficients in Table 2 show little change with Case A's continental  
 27 scheme. Only 1 of the 13 terms has changed in sign or lost significance at  
 commonly accepted levels. After refinement of the initial group structure,  
 29 newly independent countries are no longer significantly less likely to have  
 US MNC FDI. This translates into a small  $[((11-10)/10) \times 100\%]$  10%  
 31 change in key coefficient estimates. Ending firm, country and year  
 coefficients with Case B's Vaaler and McNamara scheme exhibit only  
 33 slightly less robustness. After refinement of initial group structure, newly  
 independent countries are no longer significantly less likely nor are English  
 35 language-speaking countries significantly less likely to have US MNC FDI.  
 This translates into a larger  $[((10-8)/8) \times 100\%]$  25% change in key  
 37 coefficient estimates.

Tables 3 and 4 report the ending group structures after annealing.  
 39 In Table 3, Case A's continental group scheme jumps from 5 (4 dummies) to  
 14 (13 dummies) sub-continental groups with three new sub-continental

1 regions significant at commonly accepted levels compared to two at the  
 3 beginning of the analysis. As a whole, the new group dummies no  
 5 longer add significantly to overall model explanation at commonly accepted  
 7 levels. The increase in groups is  $[(14-5)/5 \times 100\%]$  180%. In Table 4,  
 9 Case B's Vaaler and McNamara group scheme increases from 7 (6 dummies)  
 to 15 (14 dummies) or an increase of  $[(15-7)/7 \times 100\%]$  143%.  
 Two of the new sub-group dummies are significant at commonly accepted  
 levels, but all of the dummies as a group are not significantly different  
 from zero.

We pull these results together for side-by-side comparison in Table 5  
 below:

Case A's continental scheme exhibits more variation in group structure  
 and model explanation but less change in key firm, country and year  
 coefficients explaining MNC FDI compared to Case B's Vaaler and  
 McNamara scheme. These results prompt more caution in our earlier  
 provisional assessment that simple continental grouping schemes may be  
 preferred to more detailed schemes incorporating geography and level of  
 economic development as in Vaaler and McNamara. The continental  
 scheme of regional dummies may provide significantly more initial  
 explanation before annealing compared to the Vaaler and McNamara  
 scheme, but the continental scheme may also be more sensitive to change in  
 regional group structure and change in overall model explanation. If, on the  
 other hand, the central research aim is to assess the robustness of key  
 coefficients, then our simulated exercise suggests additional support for use  
 of the simpler continental scheme. Even after refinement, more key  
 coefficients retain their original sign and significance compared to the  
 alternative grouping scheme based on Vaaler and McNamara. No matter  
 the research focus, our simulated annealing exercise sheds helpful ex post

**Table 5.** Side-by-Side Summary of Results after Simulated Annealing.

33 Annealing Evaluation Criteria	34 Grouping Scheme	
	35 Case A's Continental Grouping Scheme (Table A1)	36 Case B's Vaaler and McNamara Grouping Scheme (Table A2)
37 Change in group structure (%)	180	143
38 Change in key coefficients (%)	10	25
39 Change in model explanation (%)	18.75	13.8

1 analytical light on ex ante defined regional grouping schemes used  
3 previously to help explain core IB research phenomenon.

## 5 DISCUSSION AND CONCLUSIONS

### 7 *Central Results*

9 The central aim of this paper is methodological. We sought to show how  
11 empirical models of MNC FDI combined with simulated annealing, can  
13 help us to understand the impact of regional grouping schemes on a core IB  
15 research phenomenon and debate. We showed conceptually and then  
17 through empirical demonstration how regional grouping schemes grounded  
19 in intuition or theory (or both) might be subjected to ex post evaluation  
21 through a process of iterative refinement and empirical model re-estimation.  
23 We developed the general logic for this ex post evaluation method –  
25 identifying the extent of before-and-after change through simulated  
annealing – and identified three potential dimensions for applying that  
logic. Our application of this method based on Flores and Aguilera (2007)  
model and two alternative grouping schemes, yielded helpful insight  
regarding the robustness of each initial group scheme to modest refinement  
and extended search in a terrain of alternative sub-group structures with  
many local minima and maxima. Re-estimation with respectively refined  
group structure yielded additional insight on the robustness of initial model  
coefficient estimates and overall model explanation.

27 We think this ex post method for evaluating regional grouping schemes  
29 alone or in comparison represent a valuable complementary tool for  
31 researchers engaged in understanding the nature and impact of regions on  
MNC investment behavior. Our method can contribute to current debates  
over the regionalizing or globalizing nature of MNC expansion by identifying  
which regional grouping schemes are less (more) robust to reasonable refine-  
ment and thus less (more) reliable as indicators of true MNC expansion paths.

### 35 *Implications for IB Research and Practice*

37 Going forward, we see many implications for IB research and practice.  
39 Our method can complement not only ex ante groups defined by geography  
and/or economic development levels as in this paper, but also across  
any number of alternative dimensions. For example, we see value in

1 implementing a series of pair-wise ex post comparisons of grouping schemes:  
we might consider ex post comparative evaluation of Hofstede's (2001  
3 [1980]) versus Ronen and Shenkar's (1985) alternative grouping schemes  
based on cultural dimensions; we might consider the same for relatively  
5 simple law-related grouping schemes proposed by La Porta et al. (1998)  
versus more complex law-related schemes proposed by Berkowitz et al.  
7 (2003). Indeed, we might use simulated annealing to compare any number  
of culturally, geographically, economically and/or institutionally derived  
9 grouping schemes within and across these categories. Our comparative logic  
and measurable dimensions are sufficiently generic to permit this sort of  
11 study and gain greater insight on the value of alternatively defined schemes  
and their robustness to reasonable refinement.

13 We also see value extending such methods to other IB and related  
management phenomena of interest. The group concept is important to  
15 many fundamental issues in strategic management. As Fox and et al. (1997)  
as well as Short, Ketchen, Palmer, and Hult (2007) have demonstrated,  
17 groups of firms within an industry space may have collective qualities  
determining firm behavior and performance as apparently do groups of  
19 countries within a geographic, cultural, economic and/or institutional space.  
If so, then results from initial estimation of strategic group effects for firms  
21 will benefit from ex post iterative refinement and re-estimation based  
on simulated algorithms and evaluative logics and dimensions similar to  
23 those developed in this paper. How soon do changes in group structure  
occur and how quickly do these refinements affect key coefficients and  
25 broader model explanation? Our ex post method of evaluating groups  
based on simulated annealing can render useful research insight across  
27 firms grouped within industries, across countries grouped within regions  
and other grouping designations important to scholars in the broader  
29 management field.

31

33

## NOTES

35 1. See Earley (2006); Hofstede (2006); Javidan, House, Dorfman, Hanges, and  
deLuque (2006); Smith (2006) for current debate over culture in international business.

37 2. We wrote the program using C++ language and used a MATLAB logistic  
regression module combined with a simulated annealing algorithm based on  
39 (Press, Teukolski, Vetterling, & Flannery, 1992). Interestingly, the MATLAB logistic  
regression module proved much more time-consuming to implement than the  
annealing algorithm on our workstation platform.





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## APPENDIX A. TWO REGIONAL GROUPING SCHEMES USED IN SIMULATED ANNEALING ANALYSES

**Table A1.** Continental Regional Grouping Scheme.

Region	Countries
Africa (43)	Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Central African Republic, Chad, Congo, Democratic Republic of Congo, Djibouti, Egypt, Ethiopia, Gabon, Gambia, Ghana, Guinea, Ivory Coast, Kenya, Lesotho, Liberia, Libya, Madagascar, Malawi, Mali, Mauritius, Morocco, Mozambique, Namibia, Niger, Nigeria, Senegal, Seychelles, Sierra Leone, South Africa, Sudan, Swaziland, Tanzania, Tunisia, Uganda, Zambia, Zimbabwe

**Table A1.** (Continued)

Region	Countries
Americas (25)	Argentina, Bahamas, Bolivia, Brazil, Canada, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Surinam, Trinidad & Tobago, Uruguay, Venezuela
Asia (37)	Azerbaijan, Bahrain, Bangladesh, Brunei, Cambodia, China (PRC), Cyprus, Hong Kong, India, Indonesia, Iran, Iraq, Israel, Japan, Jordan, Kazakhstan, Kuwait, Lebanon, Macao, Malaysia, Oman, Pakistan, Philippines, Qatar, Saudi Arabia, Singapore, South Korea, Sri Lanka, Syria, Taiwan (ROC), Thailand, Turkey, Turkmenistan, United Arab Emirates, Uzbekistan, Vietnam, Yemen
Europe (37)	Albania, Austria, Belarus, Belgium, Bosnia-Herzegovina, Bulgaria, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Macedonia, Malta, Netherlands, Norway, Poland, Portugal, Romania, Russian Federation, Serbia & Montenegro, Slovakia, Slovenia, Spain, Sweden, Switzerland, Ukraine, United Kingdom
Oceania (5)	Australia, Fiji, New Caledonia, New Zealand, Papua New Guinea

Source: <http://unstats.un.org/unsd/methods/m49/m49regin.htm>

**Table A2.** Vaaler and McNamara (2004) Regional Grouping Scheme.

Region	Countries
Africa-Middle East (55)	Algeria, Angola, Azerbaijan, Bahrain, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Central African Republic, Chad, Congo, Democratic Republic of Congo, Djibouti, Egypt, Ethiopia, Gabon, Gambia, Ghana, Guinea, Iran,


*Table A2. (Continued)*

Region	Countries
	Iraq, Israel, Ivory Coast, Kenya, Kuwait, Lebanon, Lesotho, Liberia, Libya, Madagascar, Malawi, Mali, Mauritius, Morocco, Mozambique, Namibia, Niger, Nigeria, Pakistan, Qatar, Saudi Arabia, Senegal, Seychelles, Sierra Leone, South Africa, Sudan, Swaziland, Tanzania, Tunisia, Uganda, United Arab Emirates, Uzbekistan, Zambia, Zimbabwe
Asia (25)	Bangladesh, Brunei, Cambodia, China (PRC), Cyprus, Hong Kong, India, Indonesia, Japan, Jordan, Kazakhstan, Macao, Malaysia, Oman, Philippines, Singapore, South Korea, Sri Lanka, Syria, Taiwan (ROC), Thailand, Turkey, Turkmenistan, Vietnam, Yemen
Central-Eastern Europe (19)	Albania, Belarus, Bosnia-Herzegovina, Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Macedonia, Malta, Poland, Romania, Russian Federation, Serbia & Montenegro, Slovakia, Slovenia, Ukraine
Latin America (18)	Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Guyana, Honduras, Nicaragua, Panama, Paraguay, Peru, Surinam, Uruguay, Venezuela
North America-Caribbean (7)	Bahamas, Canada, Dominican Republic, Haiti, Jamaica, Mexico, Trinidad & Tobago
Western Europe (18)	Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom
Not considered (5)	Australia, Fiji, New Caledonia, New Zealand, Papua New Guinea

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