GUEST EDITORIAL

Restriction of variance interaction effects and their importance for international business research

Jose M. Cortina¹, Tine Köhler²
and Bo Bernhard Nielsen³

¹Department of Psychology, George Mason University, Fairfax, USA; ²Department of Management and Marketing, International Business Group, University of Melbourne, Parkville, Australia; ³University of Sydney Business School, Discipline of International Business, University of Sydney, Sydney, Australia

Correspondence:

BB Nielsen, University of Sydney Business School, Discipline of International Business, University of Sydney, Sydney, NSW 2006, Australia.
Tel: +61 2-9351-6586

Abstract

A recent *Journal of International Business Studies* editorial on interaction effects within and across levels highlighted the importance of and difficulty associated with justifying and reporting of such interaction effects. The purpose of this editorial is to describe a type of interaction hypothesis that is very common in international business (IB) research: the restricted variance (RV) hypothesis. Specifically, we describe the nature of an RV interaction and its evidentiary requirements. We also offer several IB examples involving interactions that could have been supported with RV arguments. Our hope is that IB researchers can use this paper to bolster their arguments for interaction hypotheses by explaining them in terms of RV.

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RESTRICTION OF VARIANCE INTERACTION EFFECTS AND THEIR IMPORTANCE FOR INTERNATIONAL BUSINESS RESEARCH

As international business (IB) research matures, it is only natural that we should seek more nuanced explanations of phenomena of interest. *JIBS* authors often seek to place boundary conditions on additive effects by introducing interactive effects via moderators. While there are myriad papers that walk us through methods for testing all sorts of interactions, far less guidance is available regarding the conceptualization and defense of such effects. The recent editorial by Andersson, Cuervo-Cazurra, and Nielsen (2014) provides precisely these kinds of instructions to help authors prepare their submissions to *JIBS*.

Their instructive discussion and specific recommendations as to how to theorize and justify interactions within and across levels of analysis drew attention from scholars from other disciplines who pointed out another type of interaction effect, the *restricted variance* (RV) interaction, that requires its own sort of justification and testing. As we outline below, RV interactions are particularly relevant to IB research, especially for commonly hypothesized

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cross-level relationships between variables. This follow-up editorial serves as a complement to the editorial by Andersson et al. (2014) and seeks to explain the *what*, *why* and *how* of the RV interaction.

WHAT IS THE RV INTERACTION?

In an RV interaction, the effect of a predictor variable X on a dependent variable Y depends on the level of moderator variable Z *because the variance of X or Y changes as a function of Z* . If, for example, Y has very little variance when Z is high, then the slope representing the relationship between X and Y (or between anything else and Y) will be lower when Z is high. Because Y doesn't vary much when Z is high, then it cannot co-vary much with X . We will offer some detailed IB examples shortly. For the time being, the reader is encouraged to think of the variance restricting properties of strength of host market institutions on foreign direct investment, or of government ownership on willingness to invest in volatile foreign markets. At certain levels of these moderating variables, low values of FDI or willingness to invest are relatively rare. Because these variables have less variance under these conditions, they have less covariance with other variables. This is the essence of the RV interaction.

RV interactions are most commonly connected to the situational strength arguments of Mischel (1973, 1977). Mischel argued that the relationship between personality and behavior depends on the strength of the situation. In situations with well-defined and monitored norms for behavior (e.g., funerals), people tend to behave in the same fashion regardless of personality. In less well-defined situations (e.g., sitting alone in one's office writing a description of a proposed *JIBS* submission), behavior varies as a function of personality. In the weak situation, there is variance in behavior, and that variance can be explained by personality, among other things. For a general conceptual discussion of situational constraints, we direct authors to Peters and O'Connor (1980); for descriptions of different types of constraining moderators and their use in organizational science research we point to Meyer, Dalal, and Hermida (2010).

Figures 1 and 2 provide a very simple illustration of the effect of variance differences between strong situations and weak situations.

Both figures (and their corresponding data) reflect the relationship between the personality trait extraversion and loquacity (i.e., chattiness). The data for Figure 1 are intended to contain a full range of values

Figure 1 The relationship between extraversion and chattiness at a party: Unrestricted variance on the dependent variable for 10 people.

Figure 2 The relationship between extraversion and chattiness at a funeral: RV on the dependent variable for 10 people.

on both variables and represent the extraversion–loquacity relationship in a weak situation, that is, one in which there are few norms for behavior.

The data for Figure 2 were created by compressing the values of the dependent variable upwards and are meant to represent the extraversion–loquacity relationship in a situation with strong norms for behavior, such as a funeral. The reader will notice that the rank order of the subjects on the dependent variable remains the same, as does the range of values on the predictor variable. Nevertheless, the compression, or variance restriction, on the dependent variable serves to reduce the slope representing the relationship between personality and behavior. And indeed, even with this very small sample, the personality–situation interaction is significant at 0.01, that is, at the 1% level.

The distinction between RV interactions and traditional interactions is a useful one. The *raison d'être* of the Andersson et al. (2014) editorial was that interactions can be difficult to justify without thorough explanation of underlying theoretical mechanisms. RV arguments allow one to specify in an intuitive way why a relationship between an independent variable *X* and a dependent variable *Y* varies across situational contexts by more clearly identifying the mechanisms that drive the variability in the independent variable–dependent variable relationship.

IMPORTANCE AND PREVALENCE OF RV INTERACTION EFFECTS IN IB RESEARCH

Many of the interactions hypothesized in published IB research can be considered RV interactions. While published IB research does not usually make RV arguments, the way that authors of these papers approach the rationale for their hypothesized interaction effects is often consistent with, and perhaps better explained as RV interactions. To get an idea for how common RV interactions might be in research published in *JIBS*, we went through all of the articles *JIBS* published in 2014 in order to identify those that hypothesized and tested interaction effects. Out of 21 papers that hypothesized and tested interaction effects, we determined that 11 (53%) in fact described RV interaction effects. However, just to be clear, none of these papers made an explicit case for a RV interaction or provided a specific test for RV.

Providing a few specific examples for typical RV interaction effects in published IB research should allow us to demonstrate their commonality. IB research frequently hypothesizes the moderating effect of contextual variables such as market regulation, strength of existing legal structures, and government ownership. Typical arguments are that a given relationship between an independent variable

X and the dependent variable *Y* exists in countries with little market regulation or weak legal structures, but not in countries with strong market regulation or strong legal structures.

For example, Lu, Liu, Wright, and Filatotchev (2014) argue that prior experience with the target market is beneficial for FDI, going on to propose that when host countries have strong market-supporting institutions, these institutions can act as a sort of substitute for prior experience. Market-supporting institutions can create links to customers and business partners, and they can help navigate the local market landscape. As such, when there are strong institutions in the host market, the predictive power of prior international experience with regard to FDI entry becomes weaker. This is, in essence, an RV argument. Strength of host market institutions acts as a “strong situation” that suppresses the variance of FDI. Where there are weak host institutions, there is a great deal of variance in FDI, and this variance can be explained by prior experience with that market. Where there are strong institutions, FDI is (relatively) uniformly high, and this restricted dependent variable is less strongly predicted by experience, or by most anything else. Other scholars (e.g., Jory & Ngo, 2014) make the related argument that foreign direct investment is more positively related to profit in countries with weak legal structures as investors can find more creative ways of reducing their operating costs in such countries as compared to countries with strong legal structures that limit the options that foreign companies might have.

Another common example revolves around the moderating effect of government ownership. For example, Pan, Teng, Supapol, Lu, Huang, and Wang (2014) argue that perceptions of favorability of the institutional environment predict whether or not a company decides to acquire or invest in companies in a volatile foreign market. This relationship, however, should be moderated by government ownership such that companies that are government owned are backed up by the government and hence their risk tolerance in general is higher. As a result, perceptions of favorability of the institutional environment are less relevant – if things go wrong when they enter a volatile market, their government will intervene or bail them out. Therefore, the degree to which perceived favorability predicts decision to enter a volatile foreign market is weaker for government-owned companies than it is for non-government-owned companies, simply because there are fewer negative consequences associated with an unfavorable environment.

RV EFFECTS IN CROSS-LEVEL MODELS

Andersson et al. (2014) also make the important distinction between within-level and cross-level interactions and highlight the particular importance of multilevel models in IB research. RV interactions are, if anything, more common in cross-level models than in within-level models.

Consider the following example of a cross-level RV interaction. Foreign companies are likely to vary in the extent to which they invest in state-owned enterprises (SOEs) vs non-SOEs. A moderating factor here could be the country in which the acquisition target is located. In countries in which legal structures and employment laws are weak and financial markets are underdeveloped, there might be a stronger positive relationship between investment in SOE targets and company performance (e.g., Jory & Ngo, 2014). In these countries, companies that acquire SOEs have more opportunities to influence the target firms and to improve their performance. On the flipside, in more developed countries where the legal structures, employment laws, and financial markets are strong, they create a much more rigid structure in which a company has to operate. Hence, the potential opportunities and gains are fewer and as a result, buying an SOE in a more developed market has fewer positive outcomes in terms of operating performance and stock price.

Once again, the reason for the interaction is that, when the moderator takes values that correspond to high situation strength, one of the variables in the model is constrained such that part of its range is infeasible. As a result, the relationship between that variable and the other variable is weaker than it is when the moderator takes a value that corresponds to low strength. It should be noted that assessing interaction effects that are cross-level in nature requires additional theoretical justification and the use multilevel modeling (see Aguinis, Gottfredson, & Culpepper, 2013; Meyer et al., 2010; Peterson, Arregle, & Martin, 2012, for guidance on justifying and testing cross-level hypotheses).

HOW TO JUSTIFY AND DISCUSS RV INTERACTIONS

The key to justifying such models lies in explaining why values of the restricted variable that are commonplace when the situation is weak are unlikely when the situation is strong. Applying this to some of the examples mentioned above, authors interested in differential effects of predictor variables for

FDI could begin with an argument for why low FDI values, which, like high FDI values, are common for host countries with weak institutions, are unlikely for host countries with strong institutions. Because there is less variance in the dependent variable at this (strong) level of the moderator, there will be less covariance between FDI (dependent variable) and, in this case, prior experience (independent variable).

Similarly, authors interested in why foreign companies have a larger potential for profit in less developed markets could incorporate a discussion of why companies in developed markets have a smaller range of opportunities for development. For example, strong employment laws would mean that companies cannot substantially reduce wages or lay off employees as a response to higher competition in the market. These legal structures and financial market regulations are likely to apply to all companies and all company owners equally, and hence there is little variance between them. As a result, foreign investor influence will have a smaller impact on SOEs in developed markets than in underdeveloped markets.

It should be noted that the RV arguments need not supplant the existing ones. Rather, the RV argument serves to crystallize the traditional argument. The RV argument for a given relationship is also easily extrapolated to other relationships involving the variable whose variance is restricted given that slopes connecting this variable to *any* other variable will be shallower when the restriction exists. Consider once again the Lu et al. (2014) example. Prior experience is less predictive of FDI when host countries have strong market supporting institutions because such institutions tend to make low FDI values unlikely (i.e., RV). But this RV limits the predictive power not only of prior experience but of other predictors as well.

In order for an RV interaction to be clearly labeled as such, authors need to make an argument not only about the differential strength of the relationship between the IV and the DV at different levels of the moderator variable, but also more particularly about the effect that the moderator variable has on the variance in either the independent variable or the dependent variable, resulting in weaker prediction in the strong condition. We recommend that authors adhere to the following steps when justifying and wording an RV interaction hypothesis:

1. As per Andersson et al. (2014), provide a rationale and hypothesis for the overall main effect between the independent variable and the

- dependent variable (except in the case of the complete crossover interaction, of course).
2. Explain how the strong condition of the moderator variable restricts variance in either the independent variable or dependent variable. That is, explain how certain values of the independent variable or the dependent variable are unlikely in the strong condition.
 3. Explain that this RV in the independent variable or dependent variable at the strong level of the moderator results in a weaker relationship between the independent variable and the dependent variable. Conversely, because variance is not restricted in the weak condition, there is more opportunity for covariance. The corresponding hypothesis needs to have two parts. The first part is similar to common interaction effect hypotheses and states that the relationship between the independent variable and the dependent variable is moderated by the moderator. However, the second part of the hypothesis needs to clearly lay out that the moderation effect is such that at strong levels of the moderator the variance of the independent variable or dependent variable is restricted such that certain values of the variable become less likely, and that for this reason, the slope of the regression line is flatter than is the case at weak levels of the moderator. Using one of the examples mentioned above, an RV interaction hypothesis could be explained in the following way:

Example of hypothesis logic: The relationship between FDI and profit is moderated by the strength of existing legal structures in the country. Strong legal structures are more prescriptive regarding business conduct and only allow companies very limited creativity in finding ways to increase their profit (e.g., through the reduction of various operating costs such as wages, resources, taxes, or licenses). In countries with weak legal structures, on the other hand, investors can find more creative ways of reducing their operating costs. As such, strong legal structures restrict the variance in the dependent variable (i.e., profit).

Example of associated hypothesis: In contrast to countries with weak legal structures, countries with strong legal structures display RV in profits, which in turn restrict the potential covariance between profit and FDI. Consequently, the relationship between FDI and profit will be

weaker when legal structures are strong than when legal structures are weak.

Finally, we should mention that it is sometimes easier to make enhancement of variance arguments (e.g., “free market economies provide greater discretion, resulting in more variance in ...”), but the evidentiary requirements are the same. Reasons must be given for why variance of one of the focal variables is greater in one situation than in another.

TESTING AND REPORTING RV INTERACTIONS

It should be noted that the first step in testing RV interactions is exactly the same as that for testing any other sort of interaction. The next step, however, is to show that the variance of the RV variable does indeed follow the pattern hypothesized. So, taking the example hypothesis above, the authors would begin by showing that the FDI×Legal Structures product explains variance in Profit beyond its components (i.e., the main effects). They would then show that the variance of Profit is smaller when Legal Structures are Strong (i.e., strong situation) than when they are Weak (i.e., weak situation), the reason being that low profit values are relatively uncommon when strong legal structures exist. Common tests of equality of variance include Levene’s (1960) test, which performs well for symmetric, mesokurtic distributions, and the Brown–Forsythe (1974) test, which performs better with skewed distributions.

One caveat is in order here. Andersson et al. (2014) describe the distinctions between differential prediction, which has to do with slope differences, and differential validity, which has to do with correlational differences. The phenomenon captured in an RV interaction is one of differential prediction. The compression of a variable, and therefore the reduction in its variance, does not influence standardized indices of overlap (e.g., correlations, β weights) because, by definition, such indices are based on variables with the same standard deviation (i.e., $s.d. = 1$). Instead, compression influences unstandardized indices such as regression weights and covariances. Thus, RV interaction effects are obscured in standardized coefficients and can only be seen in the unstandardized coefficients.

When reporting the results of RV interactions, we advise authors to follow the suggestions outlined in Andersson et al. (2014) with particular emphasis on explaining the substantive meaning of the interaction effect in relation to extant theory. For instance, if the effect of the moderator variable is such that

particular values of either the independent variable or dependent variable are unlikely when the moderator takes certain values, authors must take great care to interpret their results accordingly.

In RV interactions it is particularly important to report descriptive statistics regarding scale, range, means and standard deviations of variables. Moreover, interpretation of results must be based on unstandardized coefficients and considered in relation to model complexity and statistical power. For cross-level RV interactions, the reporting requirements include additional information including intraclass correlations (ICC) and variance components (for recommendations regarding reporting of cross-level interactions, please see Aguinis et al., 2013).

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CONCLUSION

The purpose of this note is to explain a particular type of interaction that is in fact quite common in research submitted to *JIBS*, the RV interaction. We have offered guidance regarding the arguments that one makes in defense of RV interaction hypotheses as well as the analyses that are required to test such hypotheses. While RV interactions may require a bit more in the way of justification, data analysis and interpretation, they are often better suited to explain IB phenomena than traditional interactions. We strongly encourage authors submitting manuscripts to *JIBS* to consider RV interactions as a way to facilitate IB theory advancement by specifying more precisely the context within which IB phenomena take place.

ABOUT THE AUTHORS

Jose M. Cortina is a Professor in the I/O Psychology program at George Mason University. He is past Editor of *Organizational Research Methods* and a former Associate Editor of the *Journal of Applied Psychology*. He was honored by the Society for Industrial and Organizational Psychology with the 2001 Distinguished Early Career Contributions Award, by the Research Methods Division of AOM with the 2004 Best Paper Award and by the ORM Editorial Board with the 2012 Best Paper Award. He was honored by GMU with a 2010 Teaching Excellence Award and by SIOP with the 2011 Distinguished Teaching Award. Dr. Cortina currently serves as Past President of SIOP.

Tine Köhler is a Senior Lecturer for International Management at the University of Melbourne, Australia. She received her PhD in Industrial and Organizational Psychology from George Mason University in Fairfax, VA, USA. Her research interests include global teamwork, the management of cross-cultural differences in norms, communication, and coordination, trust, the application of cognitive neuroscience methods to organizational research, and qualitative and quantitative research methods.

Bo Bernhard Nielsen holds a PhD in international business from Copenhagen Business School (CBS), Denmark, and is Professor of Business Strategy at the

International Business Discipline at University of Sydney. His research is at the intersection of strategy and international business with a specific focus on multilevel issues pertaining to strategic collaboration, firm internationalization, and strategic decision-making across borders. His work appears in

Journal of International Business Studies, Strategic Management Journal, Journal of Management Studies, Journal of World Business, Journal of International Management, Journal of Business Research and Long Range Planning, among others. Professor Nielsen serves as Consulting Editor for *JIBS*.

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