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**Article**

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## OPERATIONS, INFORMATION & TECHNOLOGY | RESEARCH ARTICLE

# Performance effects of supply chain integration: The relative impacts of two competing national culture frameworks

Torsten Doering<sup>1,2\*</sup>, Jurriaan De Jong<sup>3</sup> and Nallan Suresh<sup>3</sup>

**Abstract:** The effects of supply chain integration on operational performance have been investigated in past research. However, this relationship has not been tested in the context of national culture, which forms the major objective of this study. Furthermore, a second objective is to identify the elements of national culture that have a significant moderating effect on this relationship. Following this line of inquiry, a third objective is to uniquely investigate the relative efficacy of the Hofstede and GLOBE national culture frameworks. Data from the fifth survey round of the Global Manufacturing Research Group (GMRG) from 1,017 manufacturing plants in 14 countries were utilized for hierarchical linear model (HLM) analysis. This study shows, first, that supply chain integration has a positive effect on delivery performance across national cultures. Second, this relationship was affected by two national culture dimensions: uncertainty avoidance and future orientation. It was found that investments in supply chain integration are more beneficial for societies that score high on uncertainty avoidance, and low on the future-orientation scales.

### ABOUT THE AUTHORS

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### PUBLIC INTEREST STATEMENT

Manufacturing supply chains, such as the ones for smartphones, cars, clothing, and many other products are increasingly international, spanning many cultures. Our world is more connected than ever, but national and cultural differences exist that may influence the success of integrated supply chains. The question is how to improve their effectiveness and efficiency, accounting for possible cultural traits which may significantly affect the performance of global supply chains. This study investigates which national culture dimensions have an impact on supply chain integration outcomes. In addition, a direct comparison of two widely used national culture frameworks is undertaken in this study. The results of this comparison suggest their practical applicability not only for supply chains but also for other efforts to integrate independent organizations closely across cultures.

Third, between GLOBE and Hofstede culture frameworks, the GLOBE framework proved more effective in capturing the influence of national culture in this context.

**Subjects: Operations Management; Supply Chain Management; International Business**

**Keywords: Global manufacturing; supply chain management; national culture; empirical study**

## 1. Introduction

The effects of supply chain integration (SCI) on business performance have been investigated in past research (e.g., Frohlich & Westbrook, 2001; Narasimhan & Kim, 2002; Power, 2005; Van der Vaart & van Donk, 2008). However, the relationship between SCI and performance has not been tested in the context of different national cultures, which forms the major objective of this study. Given the global, cross-cultural nature of today's supply chains, it would be of significant interest to investigate whether the positive effects of SCI are universally valid and whether there are culture-related factors that differentially affect these relationships. Accordingly, a major objective of this study is to test whether national culture moderates the relationship between SCI and operational performance.

Most firms operating today are increasingly part of dynamic, specialized and global supply chains. The complex flow of information and products across national cultures has to be managed effectively in multi-national settings in order to achieve a competitive advantage. It has been hypothesized, but not tested in past research that the effects of SCI on performance may differ depending on national contexts (Flynn, Huo, & Zhao, 2010). While many factors have been shown to affect SCI, the role of national culture has not been directly addressed (Schoenherr & Swink, 2012). SCI may be more effective in specific cultural environments which place value on aligning with partners, unified control and long-term partnerships (Braunscheidel, Suresh, & Boisnier, 2010; Cao, Huo, Li, & Zhao, 2015). An emerging body of research examines aspects of cross-cultural differences and organizational culture in relation to operational tasks. It has been found that national culture can explain behavior in international operations management, and it enables more fine-grained interpretations (e.g., Kirkman, Lowe, & Gibson, 2006; Pagell, Katz, & Sheu, 2005). The effects of national culture have been investigated in relation to practices such as lean manufacturing (Kull, Yan, Liu, & Wacker, 2014; Wiengarten, Fynes, Pagell, & de Búrca, 2011), quality management (Flynn & Saladin, 2006; Kull & Wacker, 2010), innovation (Kirkman et al., 2006), purchasing activities (Yang, Lin, Krumwiede, Stickel, & Sheu, 2013), relationship learning (Cheung, Myers, & Mentzer, 2010), and environmental investments (Power, Klassen, Kull, & Simpson, 2015). The limited amount of research to date on the influence of national culture on supply chain performance motivates this study.

To investigate the effects of national culture in operations management settings, researchers have commonly employed the Hofstede or the GLOBE frameworks. The reason for choosing either framework in past literature has been justified based on previous usage, the newness of the data, the number of researchers involved in the culture index generation process, but it has been mostly arbitrary (Brewer & Venaiik, 2011). The relative merits of these two culture frameworks are still somewhat unclear. Thus, in this study, the Hofstede and the GLOBE culture framework are employed to undertake a side-by-side comparison to investigate their efficacy in drawing inferences relative to supply chain theory and practice. The specific objectives of this study are to:

- Enhance our understanding of the influence of national culture on the performance effects of SCI investments; specifically, whether national culture moderates the relationship between SCI investments and performance.
- To identify which elements of culture have a significant moderating effect, if one exists. The specific elements of culture tested were power distance; individualism/collectivism; masculinity/assertiveness; uncertainty avoidance; and long/short-term orientation.

- Compare the relative efficacy of the Hofstede and GLOBE frameworks to capture the effects of national culture in international supply chain management.
- Draw inferences for theory and supply chain practice on culture-oriented aspects to improve global supply chain governance.

For this investigation, data from the fifth round of the Global Manufacturing Research Group (GMRG) survey were utilized. Plant-level data from 1,017 manufacturing plants in 14 countries were used for a hierarchical linear model (HLM) analysis.

This study shows, first, that SCI has a positive effect on performance, as established in past research, but also across national cultures. Second, this relationship was significantly affected by two of the five included national culture dimensions: uncertainty avoidance and future orientation. It was found that investments in supply chain integration are more beneficial for societies that score high on uncertainty avoidance, and low on future-orientation scales. Third, between GLOBE and Hofstede culture frameworks, the GLOBE framework was more effective in capturing the influence of national culture in this context. This study also addresses the research issues of effect size and practical significance in addition to commonly reported statistical significance. This is an issue of emerging interest in empirical operations management research.

The following sections present the theoretical development, the specific hypotheses, a description of the analysis using hierarchical linear models (HLM), followed by a discussion and a conclusion.

## **2. Background literature**

This literature review is divided into two parts. The first part considers SCI, its conceptualization and how it affects various outcome measures. The second part reviews and contrasts the Hofstede and GLOBE national culture frameworks.

### **2.1. Supply chain integration**

Current definitions of SCI include the notions of collaboration, and internal and external relationships at strategical, tactical or operational levels of integration. In addition, typically a distinction is made between information and physical flows (Power, 2005). The scope of SCI has been described regarding the integration of a focal firm's internal processes and external integration with its suppliers and customers. A common definition is the degree to which a manufacturer strategically collaborates with its supply chain partners and collaboratively manages intra- and inter-organization processes (Flynn et al., 2010). Other definitions express that collaboration is needed to achieve integration, that SCI necessitates and invokes unified control, and that it aims to reach synchronization (Barratt & Oliveira, 2001). Chen, Daugherty, and Roath (2009) imply that integration can be achieved through collaboration, commitment, and coordination with another firm's functional areas and operationalization of internal and external process integrations. Leuschner, Rogers, and Charvet (2013) describe SCI in their recent meta-analysis as the scope and strength of linkages in supply chain processes across firms.

The conceptualization of the SCI construct has taken on many forms in the empirical literature, the level of analysis tends to vary, contingencies such as relationship power may or may not be included, and potential interactions are generally omitted (Autry, Rose, & Bell, 2014). Some authors have structured SCI through the three dimensions: information integration; coordination and resource sharing; and organizational links (Alfalla-Luque, Medina-Lopez, & Dey, 2013; Lee, 2000). An alternative model distinguishes attitudes, practices, and patterns as the three different types of integration (Van der Vaart & van Donk, 2008).

## 2.2. National culture

Most definitions of culture contain characteristics such as shared meaning, objective and subjective elements, produced and reproduced by interconnected individuals, and transmission across generations (Kroeber & Kluckhohn, 1952; Triandis, 1972). Meaningful dimensions of culture were developed to allow empirically justified interpretations. A seminal example from this stage of research are the Hofstede cultural dimensions (Matsumoto & Yoo, 2006). In some studies, culture is investigated as a mediator to explain and understand differences in the use and effectiveness of practices (Lytle, Brett, Barsness, Tinsley, & Janssens, 1995). In recent studies, culture has been used in complex and rich interpretations, such as archetypes of subnational culture, configuring unique and universal characteristics largely independent of geographic boundaries (Richter et al., 2016; Venaik & Midgley, 2015).

In this study, we apply the Hofstede model as a baseline, currently consisting of six dimensions, and align it with the nine dimensions of the GLOBE framework. We omit the Hofstede dimension Indulgence versus Restraint, since it is conceptually irrelevant for SCI, and since there is no GLOBE dimension that can be associated. An overview of the five remaining Hofstede dimensions, which will be used for a direct comparison in our model, is provided in Table 1.

### 2.2.1. Hofstede model

The data for Hofstede's (1980) highly cited research stem from a survey of 117,000 IBM employees, acquired between 1967 and 1973 during Hofstede's tenure at the company. The scores are reported on a scale between 0 and 100. The initial four indicators of cultural values were power distance, uncertainty avoidance, individualism, and masculinity. Later, a fifth dimension, long-term orientation, and subsequently a sixth dimension, indulgence versus restraint were added (Hofstede et al., 2010). The first dimension, *Power Distance (HPDI)* is a measure of perception of equally distributed status and power. *Individualism versus Collectivism (HIDV)* describes how individuals within a society are integrated into groups. *Masculinity versus femininity (HMAS)* describes how a society emphasizes traditional masculine values such as competitiveness, ambition, assertiveness, achievement in contrast to traditional feminine values such as nurturing, helping others, valuing relationships over money and quality of life (Hofstede, 1980). The *Uncertainty Avoidance index (HUAI)* expresses a society's tolerance for uncertainty and ambiguity. The term *Long-Term Orientation (HLTO)* is found in the teachings of Confucius. However, the dimension also applies to countries without a Confucian heritage. Long-term orientation is expressed through using

**Table 1. Overview of cultural dimensions**

Hofstede Model (Hofstede, Hofstede, & Minkov, 2010)	GLOBE Project (House, Hanges, Javidan, Dorfman, & Gupta, 2004)
<b>Power Distance:</b> "the extent to which the less powerful members of institutions and organizations within a country expect and accept that power is distributed unequally."	<b>Power Distance:</b> "The degree to which members of a collective expect power to be distributed equally."
<b>Individualism vs. Collectivism:</b> "Individualism pertains to societies in which the ties between individuals are loose..."	<b>Institutional Collectivism:</b> "The degree to which ... practices encourage and reward collective distribution of resources and collective action."
<b>Masculinity:</b> "...gender roles are clearly distinct: men are supposed to be assertive, tough, and focused on material success..."	<b>Assertiveness:</b> "The degree to which individuals are assertive, confrontational, and aggressive in their relationship with others."
<b>Uncertainty Avoidance:</b> "The extent to which the members of a culture feel threatened by ambiguous or unknown situations."	<b>Uncertainty Avoidance:</b> "The extent to which ... relies on social norms, rules, and procedures to alleviate unpredictability of future events."
<b>Long vs. Short Term Orientation:</b> "... fostering of virtues oriented toward future rewards—in particular, perseverance and thrift."	<b>Future Orientation:</b> "The extent to which individuals engage in future-oriented behaviors such as delaying gratification, planning, and investing in the future."

resources sparingly, through perseverance, learning, honesty, and importance of long-term profits. The sixth and last dimension *Indulgence versus Restraint* originates from a construct called subjective well-being and from a dimension that was discovered within the World Values Survey (WVS). Hofstede defines indulgence as the tendency to allow relatively free gratification of basic and natural human desires related to enjoying life (Hofstede et al., 2010). Indulgence versus Restraint misses a logical connection to supply chain integration and is therefore omitted.

### 2.2.2. GLOBE project

Since its inception in the mid-1990s and now in its third phase, the Global Leadership and Organizational Behavior Effectiveness (GLOBE) project was made possible through involvement of a global group of more than 200 researchers, with the goal to assess how cultural drivers influence economic competitiveness (Dorfman, Javidan, Hanges, Dastmalchian, & House, 2012). Phase one of the project covered 62 national societies. This phase involved focus groups and a survey of 17000 managers representing 951 organizations. The GLOBE study includes nine dimensions and was designed to replicate and expand on Hofstede's framework. Each cultural characteristic is measured via two scoring systems at the country-level through practices scores ("as is") and through value scores ("should be"). Only the value scores of GLOBE are utilized in this study, as is common in the Operations Management literature (Kull et al., 2014). The following provides an overview of the GLOBE dimensions:

High power distance (GLPD) societies are separated into classes where power is used as a mechanism to provide social order, and to limit access to resources, skills, capabilities, and information (House et al., 2004). The GLOBE project distinguishes between two individualism/collectivism (GLIC) dimensions. In-group collectivism measures how society values loyalty, identity, and pride in families and organizations. Institutional collectivism, used in this study, expresses how society encourages and values collective action (House et al., 2004). The third dimension assertiveness (GLAS) parallels the masculinity versus femininity dimension in the Hofstede model. Assertive societies value dominance, competition, taking the initiative, and think of others as being opportunistic. House et al. (2004) suggest that organizations in high uncertainty avoidance (GLUA) cultures have a more formalized and analytical decision-making process. In contrast, organizations in low uncertainty avoidance cultures are more likely to rely on intuition and the word of others they trust, instead of formal processes. Future orientation (GLFU) describes how members of society believe in strategic planning, developing and investing in their future, and that current actions will have a delayed impact. Four GLOBE dimensions are excluded from this study because they do not conceptually align with Hofstede's cultural framework and can therefore not be directly compared: gender egalitarianism (GLGE), in-group collectivism (GLIG), performance orientation (GLPO) and humane orientation (GLHO).

### 3. Research hypotheses

The performance impact of SCI has been well documented. For a critical review of this literature, the reader is referred to the works of Van der Vaart and van Donk (2008), Leuschner et al. (2013), Mackelprang, Robinson, Bernardes, and Webb (2014) and Autry et al. (2014). However, the moderating impact of national culture on the effectiveness of SCI has yet to be investigated. As a guiding principle for the theoretical development, we recognize that the source for informal constraints is linked to national culture, as the cultural filter can provide continuity and can shape perception, values, and behavior which affect human actions (North, 1990). Institutional theory accepts that decisions made under the same institutional norms will tend to converge (DiMaggio & Powell, 1983; Scott, 2001). Applied to our context, institutional theory could help to explain how external forces lead to the implementation of best practices, such as SCI, in alignment with a firm's unique characteristics and requirements. SCI can only be useful if key supply chain partners are able to and willing to cooperate and share long-term goals, therewith solidifying the moderating role of the external environment that companies operate in (Pagell, Wiengarten, & Fynes, 2013).

External upstream and downstream integration is based on collaboration and coordination between firms. It has been shown that information sharing, joint planning, decision-making, forecasting, and replenishment helps to improve supply chain competitiveness (Autry et al., 2014). Depending on the national context, transaction costs can be reduced, resources and knowledge can be shared, leading to better operational performance, responsiveness and ultimately better financial performance (Frohlich & Westbrook, 2001; Rosenzweig, Roth, & Dean, 2003). We retest this relationship in our sample as a baseline for analysis in an international environment:

**H1:** External SCI investments are positively associated with performance.

Previous studies have called to include culture in international research to explain patterns of SCI and performance (Flynn et al., 2010). By doing this, we also compare the efficacy of the GLOBE and Hofstede indices based on our sample. It has been shown that magnitude and direction of effects can change, by applying ostensibly similar GLOBE or Hofstede dimensions (Brewer & Venaik, 2011). It also became evident that the predictive power of the Hofstede indices grew weaker over time (Taras, Steel, & Kirkman, 2012). The Hofstede indices were based on data from mainly non-managerial respondents at IBM, collected about 40 years ago. In contrast, the GLOBE project data are more recent, was collected by a large and diverse group of researchers, and includes mostly managerial respondents. The following hypotheses will be tested with both cultural frameworks.

Power distance measures the degree of inequality in society. The three Hofstede measures for power distance (HPDI) include “afraid to express disagreement with managers” and perception of, or preference for a superior’s decision-making style, such as autocratic or consultative for example (Hofstede et al., 2010). The corresponding GLOBE dimension (GLPD) subsumes that only a few people have access to resources, skills, capabilities, and information. Recent research has found that the effectiveness of external integration is based on internal integration (Chen et al., 2009; Flynn et al., 2010). Internal integration, in turn, relies on information exchange and periodic meetings (Narasimhan & Kim, 2002); hence we posit:

**H2:** High Power Distance impedes the effectiveness of SCI investments.

Past research shows that the individualism/collectivism dimension is possibly the only dimension that has an impact on the implementation of quality practices in an international context (Netland, Mediavilla, & Errasti, 2013). Collectivist societies further the integration of individuals into cohesive groups with loyal members. Collectivists value training opportunities, use of skills and good physical working conditions according to the measurement items in Hofstede’s framework (HIDV). GLOBE’s institutional collectivism dimension (GLIC) expresses how society encourages and values collective action. Power, Schoenherr, and Samson (2010) have shown in an international context that investments in operations structure and infrastructure were more effective in a collectivist culture. Hence we posit:

**H3:** High Individualism impedes the effectiveness of SCI investments.

Hofstede measures the feminine spectrum (HMAS) through “good working relationships,” “cooperation with each other,” and employment security. The corresponding GLOBE dimension assertiveness (GLAS), reflects whether people are assertive, aggressive and tough in relationships. A predominantly feminine culture, based on closer analysis of Hofstede and GLOBE measurement instruments, should be more suitable to support cooperative relationships (House et al., 2004):

**H4:** High Masculinity impedes the effectiveness of SCI investments.

Uncertainty Avoidance measures the intolerance to ambiguity in society. Respondents in countries which score high on this dimension want rules to be respected, seek a long-term career and feel on average more stressed at work according to Hofstede (HUII). The GLOBE project

dimension (GLUA) measures uncertainty avoidance at the societal and organizational level (used here). Cultures with high scores tend to formalize relationships and procedures, are orderly and risk-averse (House et al., 2004). Deeper integration is one of the means to reduce uncertainty in a supply chain (Wong, Boon-Itt, & Wong, 2011). Hence we posit:

**H5:** Low Uncertainty Avoidance impedes the effectiveness of SCI investments.

SCI, supported by a long-term orientation culture should show an increase in competitive performance through positive reinforcement (Cao et al., 2015). Engaging in a long-term relationship and proximity leads to dedicated linkages and improved performance (Cannon, Doney, Mullen, & Petersen, 2010; Dyer & Singh, 1998). Long-term orientation has also been shown to positively impact inter-firm communication and supply chain performance (Paulraj, Lado, & Chen, 2008). Hofstede's definition (HLTO) refers to fostering the virtues toward future rewards, in particular, perseverance and thrift. Future Orientation in the GLOBE model (GLFU) relates to long-term strategic orientation, adaptive organizations and long-term success (House et al., 2004). Higher scores indicate greater future orientation. Integration projects can be complex and require collective action. Hence we posit:

**H6:** Low Long-Term Orientation impedes the effectiveness of SCI investments.

The effect of control variables to improve statistical power through reduced standard errors is particularly desirable for cross-level interactions in multilevel models (Mathieu, Aguinis, Culpepper, & Chen, 2012). On the plant-level, company size and degree of international ownership have been suggested for culture-as-moderator studies (Kull & Wacker, 2010; Popli, Akbar, Kumar, & Gaur, 2016). On the country-level, we include gross domestic product per capita (Kull et al., 2014; Naor, Linderman, & Schroeder, 2010).

#### **4. Research methodology**

The data for this research stem from the fifth round of the Global Manufacturing Research Group (GMRG) survey, collected between 2012 and 2014. The survey measures have been established by an international group of researchers and were back-translated to ensure content validity across samples (Tsui, Nifadkar, & Ou, 2007; Whybark, Wacker, & Sheu, 2009). The unit of analysis is the plant. One or more key managers are involved in completing each questionnaire.

##### **4.1. Operationalization of measures**

Measurement items for our independent and dependent plant level variables are in separate sections of the questionnaire, which attenuates the impact of common method variance (Chang, Van Witteloostuijn, & Eden, 2010). The measurement items from the core module of the GMRG V survey and corresponding constructs are shown in Table 2. Harman's one-factor analysis accounted for 31.1% of the variance and is thus below the threshold of 50%, which would indicate excessive common method variance (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). A subsequent CFA test for common method variance, which assigned all measurement items to one factor, resulted in unacceptable fit indices  $\chi^2(20) = 1918.199$ , RMSEA (90% CI) = 0.314 (0.302, 0.326), CFI = 0.479 (Sanchez & Brock, 1996).

The outcome variable in this study is delivery performance, measured with three items from the GMRG survey (Table 2). A joint performance measure was avoided as competitive priorities can often have intrinsic trade-offs among them, particularly between cost and flexibility measures (Boyer & Lewis, 2002). Delivery performance is appropriate since it can be understood as a consequence or catch-all of operational performance.

We used all measurement items of the plant-level components (Table 2) and assessed them through principal component analysis and Varimax rotation with Kaiser normalization. The eigenvalues of the orthogonally rotated components are 2.4, 2.3, 1.7 and 1.1, explaining a total of 75%



**Table 2. CFA constructs and loadings**

Construct	Standard loading	Standard error	R <sup>2</sup>
<b>Integration: <math>\alpha = 0.83</math>, AVE = 0.71</b>			
Please indicate the extent of investment (money, time and/or people) in the following areas in the last two years.			
Customer process integration	0.876	n/a	0.77
Supplier process integration	0.806	0.078	0.65
<b>Delivery performance: <math>\alpha = 0.88</math>, AVE = 0.71</b>			
Please indicate your plants performance compared to your major competitor(s).			
Delivery speed	0.850	n/a	0.72
Delivery reliability	0.902	0.033	0.81
Response to changes in delivery due date	0.770	0.033	0.59

of the variance. All loadings of variables on factors are higher than 0.71. Furthermore, this solution is interpretable and coincides with the constructs of performance, integration and the controls being measured (Tabachnick & Fidell, 2012). All plant-level components exhibit high internal consistency (Table 2). A confirmatory factor analysis of the two performance constructs and the predictor integration demonstrates good fit and convergent validity,  $\chi^2_{(17)} = 37.527$ , RMSEA(90% CI) = 0.035 (0.020, 0.051), SRMR = 0.023, CFI = 0.994, TLI = 0.991 (Hu & Bentler, 1999). The  $\chi^2$  ratio is slightly larger than 2, which is quite acceptable considering the other fit indicators (Brown, 2006). All factor loadings exceed 0.5 and have t-values in excess of 1.96. Discriminant validity was confirmed through constrained CFA models for every possible pair of latent constructs, in which every pair of constructs was fixed to 1.0. The  $\chi^2$  difference to the unconstrained model demonstrated discriminant validity (Bagozzi, Yi, & Phillips, 1991). The average variance extracted (AVE) for each construct was greater than the squared correlation between constructs (Fornell & Larcker, 1981). The preceding results confirm reliability, convergent and discriminant validity. Hence, we can submit the summated scores of the measurement items to a multilevel analysis.

Measurement invariance of the pooled sample ensures that meaning and interpretation of measures and constructs are the same across countries. We employed the G-theory (Malhotra & Sharma, 2008). The results with a generalizability coefficient of 0.9 allow us to continue with the analysis by using one pooled sample (Sharma & Weathers, 2003; Wiengarten, Pagell, Ahmed, & Gimenez, 2014). Sample statistics, including the represented countries and plant-level data, are presented in Table 3. Most Hofstede scores were taken from the literature (Hofstede et al., 2010). The data for Nigeria and Ukraine had to be obtained from Hofstede's training company website ([geert-hofstede.com/countries.html](http://geert-hofstede.com/countries.html)). The Hofstede scores and the GLOBE project scores are included in Appendix A (House et al., 2004).

The initial sample included a total of 1068 cases from 14 countries. After removal of cases with missing data, a final sample of 1017 plants remained. The overall portion of missing values was smaller than 5% and thus non-critical considering the sample size (Tabachnick & Fidell, 2012).

The countries in the sample cover five of the seven continents with quite different national environments. Half of the countries are classified as advanced economies by the International Monetary Fund (Australia, Croatia, Germany, Ireland, South Korea, Taiwan, USA) and the other half as emerging economies (China, Hungary, India, Nigeria, Poland, Ukraine, Vietnam).

A correlation table of all country-level variables can be found in Appendix B. GDP data represents actual 2014 values in US dollar as published by the International Monetary Fund (IMF, 2014).

**Table 3. Sample statistics**

#	Country	Percent	Number of Employees	Percent	Mean	SD	Min.	Max.
1	Australia	7	≤ 50	24%				
2	China	10	51–250	45%				
3	Croatia	11	251–500	13%				
4	Germany	4	501–2500	13%				
5	Hungary	4	>2500	5%				
6	India	5						
7	Ireland	3						
8	Korea (S)	8						
9	Nigeria	5						
10	Poland	7						
11	Taiwan	4	Size	817.13	4913.5	2	133000	
12	USA	16	International	18.78	35.51	0	100	
13	Ukraine	5	Delivery Performance	5.22	1.08	1	7	
14	Vietnam	13	Integration	4.44	1.4	1	7	

Centering of predictor variables in multilevel models is vital to the interpretation of intercept and slope parameters (Enders & Tofghi, 2007). The main emphasis in this study is on cross-level interactions. Therefore, we used group-mean centering for all plant-level variables to remove between-cluster variation and to obtain unbiased estimates (Raudenbush & Bryk, 2002). All country-level variables are grand-mean centered to allow for straightforward interpretation of the differently scaled measures.

We tested for multicollinearity before the analysis. Appendix B shows the correlations of all country-level variables. The highest VIF between the utilized Hofstede scores was 4.07 and thus below the typical thresholds of five or ten (Cohen, Cohen, West, & Aiken, 2003). The highest VIF between GLOBE scores was 1.7, showing that multicollinearity concerns are not likely.

## 5. Analyses and results

The common three-step procedure of analyzing and fitting a hierarchical linear model (HLM) will be applied, including the interpretation of fixed and random effects and relevant metrics such as the intra-class correlation coefficients and effect sizes (Raudenbush & Bryk, 2002). All parameters were estimated with the full maximum likelihood approach in HLM 7 to enable comparison of model fit with different sets of variables. The general recommendation is to estimate multiple cross-level interaction effects in one model, as done in this study (Aguinis, Gottfredson, & Culpepper, 2013).

### 5.1. Fully unconditional model

The fully unconditional model (FUM) includes the dependent variable  $Performance_{ij}$ , with values for each plant  $i$  in country  $j$ . This null model does not have any predictors. The grand mean intercept  $\gamma_{00}$  remains constant across all countries, its error term  $u_{0j}$  can vary and defines the deviation of each country mean. This deviation of intercepts between countries  $u_{0j}$  is expressed through the variance  $\tau_{00}$  and stands for the mean performance differences between countries in the sample. The remaining within-country variance of  $r_{ij}$  is measured through  $\sigma^2$ . Both variance components together represent the total variance.

The average delivery performance across all countries is 5.2,  $p < 0.01$  (Table 4). We confirmed the existence of sufficient variance in performance between countries ( $\tau_{00}$ ) to justify the use of a hierarchical model. The degree of homogeneity within a country can be expressed through the intra-class correlation coefficient ( $ICC = \tau_{00}/[\tau_{00} + \sigma^2]$ ). A near zero ICC would suggest using a regular single level linear regression model. The total variance within companies is  $\sigma^2 = 1.102$  (delivery performance), and the variance between companies is  $\tau_{00} = 0.073$  ( $\chi^2_{(13)} = 70.66$ ,  $p < 0.01$ ). Since there are significant differences in the performance level between countries, we can continue and calculate the ICC. The null model has an ICC of 6.2%, which is a reasonable value for this type of data (Kull & Wacker, 2010). As can be seen in Kreft and de Leeuw (1998), the possible inflation of the type I error can exceed 30% for groups with more than 50 firms even assuming a relatively low ICC of 5%, when using a non-hierarchical regression model.

#### 5.1.1. Partially conditional model

The partially conditional model (PCM) includes the plant-level main predictor, investment in SCI (Integration), and two control variables:

$$\text{Combined: } Performance_{ij} = \gamma_{00} + \gamma_{10} * (Integration_{ij}) + \gamma_{20} * (Size_{ij}) \\ + \gamma_{30} * (International_{ij}) + u_{0j} + u_{1j} * (Integration_{ij}) + r_{ij}$$

The main effect for SCI is significant with  $\gamma_{10} = 0.183$ ,  $p < 0.01$ . An increase of one point in SCI ( $sd = 1.4$ ) is on average related to a 0.183 increase in performance. The random effect of the level of SCI is significant in the delivery model  $\tau_{11} = 0.006$  ( $\chi^2_{(13)} = 23.4$ ,  $p < 0.05$ ), indicating a difference in their relationship across countries.

**Table 4. HLM results**

	FUM	PCM		FCM (Hofstede)		FCM (GLOBE)
<i>Plant-Level</i>						
Grand Intercept ( $\gamma_{00}$ )	5.221***	5.221***		5.219***		5.219***
Integration ( $\gamma_{10}$ )		0.183***		0.176***		0.171***
Size ( $\gamma_{20}$ )		0.000		0.000		0.000
International ( $\gamma_{30}$ )		-0.000		-0.000		-0.000
<i>Country-Level</i>						
			GDP ( $\gamma_{01}$ )	-0.000	GDP ( $\gamma_{01}$ )	-0.000
			HPDI ( $\gamma_{11}$ )	0.001	GLPD( $\gamma_{11}$ )	0.092
			HIDV ( $\gamma_{12}$ )	-0.001	GLIC ( $\gamma_{12}$ )	-0.073
			HMAS ( $\gamma_{13}$ )	-0.000	GLAS ( $\gamma_{13}$ )	-0.044
			HUAI ( $\gamma_{14}$ )	-0.001	GLUA ( $\gamma_{14}$ )	0.148**
			HLTO ( $\gamma_{15}$ )	0.002	GLFU ( $\gamma_{15}$ )	-0.239**
<i>Variance</i>						
$\sigma^2$	1.102	1.040		1.040		1.035
$\tau_{00}$	0.073***	0.074***		0.059***		0.059***
$\tau_{11}$		0.006**		0.000*		0.000
<i>Deviance</i>						
	3006.3	2955.1		2945.4		2941.4
Number of parameters	3	8		14		14
<i>Reliability</i>						
$\beta_0$	0.794	0.806		0.769		0.770
$\beta_1$		0.360		0.035		0.020

Significance levels: \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ ; Full maximum likelihood estimation.

Neither control variable, company size or percentage of international ownership is significant. Both control variables are modeled as fixed from this stage onward in the interest of parsimoniousness. As a note, the fixed effects estimated with full maximum likelihood are almost identical to those with robust standard errors provided by HLM 7. This is an indication that distributional assumptions are not violated.

The intercept variance  $\tau_{00} = 0.074$  ( $\chi^2_{(13)} = 74.86$ ,  $p < 0.01$ ) is significant. This variance represents the in-between country variation of average performance scores. The plant-level intercept ( $\beta_{0j}$ ) is an unadjusted mean. The fixed effect  $\gamma_{00}$  can be interpreted as the average performance across all plants, in other words, the expected performance of a plant  $i$  within country  $j$  with an average level of investment in country  $j$ . The plant-level equation with group-mean centered predictors can be expressed in combined form:  $\text{Performance}_{ij} = \beta_{0j} + \beta_{1j} * (\text{Integration}_{ij} - \text{Integration}_{-j}) + \beta_{2j} * (\text{Size}_{ij} - \text{Size}_{-j}) + \beta_{3j} * (\text{International}_{ij} - \text{International}_{-j}) + r_{ij}$ .

The percentage of within-country variance explained by the main predictor, investment in SCI and two plant-level control variables as a proportion of total variance is  $(1.102 - 1.040) / 1.102 = 5.6\%$ . The deviance for the partially conditional model is significantly different from the deviance for the fully unconditional model, denoting that the PCM explains significantly more variance. The test statistic is  $\chi^2_{(5)} = 51.2$ ,  $p < 0.01$ .

### 5.2. Fully conditional model with hofstede dimensions

The fully conditional model (FCM) builds on the culture-as-a-moderator approach, which has frequently been used in OM literature (Gelfand, Erez, & Aycan, 2007; Kull et al., 2014; Power et al., 2015). At this stage, we compare the moderating effects of the five Hofstede dimensions of national culture to the effects of the five corresponding GLOBE dimensions. The cross-level interactions are designed to explain the variation of the relationships between the predictor Integration and the outcome Performance. The model with Hofstede dimensions:

$$\text{Plant : Performance}_{ij} = \beta_{0j} + \beta_{1j} * (\text{Integration}_{ij}) + \beta_{2j} * (\text{Size}_{ij}) + \beta_{3j} * (\text{International}_{ij}) + r_{ij}$$

$$\text{Country : } \beta_{0j} = \gamma_{00} + \gamma_{01} * (\text{GDP}_j) + u_{0j}$$

$$\begin{aligned} \beta_{1j} = & \gamma_{10} + \gamma_{11} * (\text{HPDI}_j) + \gamma_{12} * (\text{HIDV}_j) + \gamma_{13} * (\text{HMAS}_j) + \gamma_{14} * (\text{HUAI}_j) \\ & + \gamma_{15} * (\text{HLTO}_j) + u_{1j} \end{aligned}$$

$$\beta_{2j} = \gamma_{20}$$

$$\beta_{3j} = \gamma_{30}$$

$$\begin{aligned} \text{Combined : Performance}_{ij} = & \gamma_{00} + \gamma_{01} * (\text{GDP}_j) + \gamma_{10} * (\text{Integration}_{ij}) \\ & + \gamma_{11} * (\text{HPDI}_j) * (\text{Integration}_{ij}) + \gamma_{12} * (\text{HIDV}_j) * (\text{Integration}_{ij}) \\ & + \gamma_{13} * (\text{HMAS}_j) * (\text{Integration}_{ij}) + \gamma_{14} * (\text{HUAI}_j) * (\text{Integration}_{ij}) \\ & + \gamma_{15} * (\text{HLTO}_j) * (\text{Integration}_{ij}) + \gamma_{20} * (\text{Size}_{ij}) \\ & + \gamma_{30} * (\text{International}_{ij}) + u_{0j} + u_{1j} * (\text{Integration}_{ij}) + r_{ij} \end{aligned}$$

There are no significant relationships between average performance and the control variable GDP  $\gamma_{01} = -0.000$ ,  $p > 0.1$ . The gross domestic product per capita does not explain the average performance level within a country. None of the five Hofstede culture dimensions have a statistically significant impact on the relationship between integration and performance.

The change in intercept variance for performance ( $\tau_{00}$ ) is 20.3%. Both of these variance components remain significant, which indicates that the non-significant control variable GDP cannot fully explain the mean performance differences between countries. The relative change in slope variance for performance ( $\tau_{11}$ ) is 94.5%. The variance component for performance ( $\tau_{11}$ ) remains significant, meaning that there are still differences, albeit small, in the slopes between countries. Compared to the partially conditional model, the difference in deviance is not significant  $\chi^2_{(6)} = 9.7$ ,  $p > 0.1$ .

### 5.3. Fully conditional model (FCM) with GLOBE dimensions

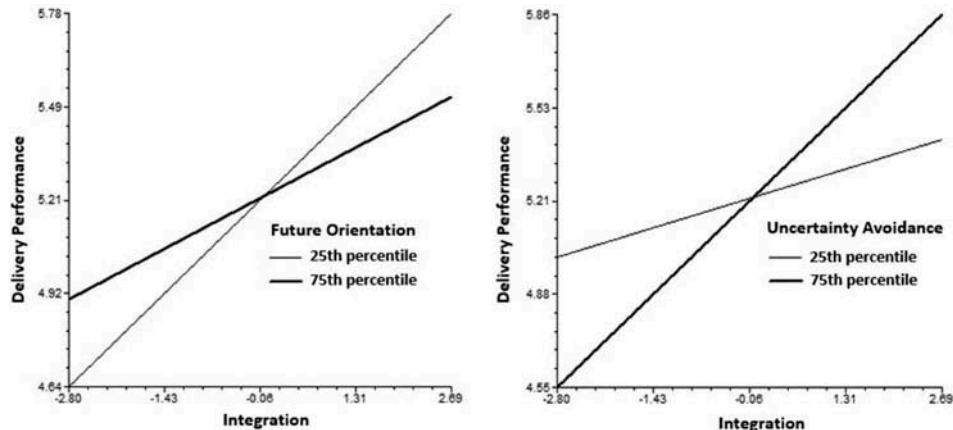
There are no significant relationships between average performance and the control variable GDP ( $\gamma_{01} = -0.000$ ,  $p > 0.1$ ) (Table 4). Two of the five GLOBE national culture dimensions have an impact on the relationship between Integration and Performance. Uncertainty avoidance (GLUA) is statistically significant and moderates the relationship between Integration and Performance,  $\gamma_{14} = 0.148$ ,  $p < 0.05$ . Future orientation (GLFU) is statistically significant and moderates the relationship between integration and performance  $\gamma_{15} = -0.239$ ,  $p < 0.05$ . The moderation effects of the two GLOBE dimensions can be seen in Figure 1. The horizontal axis represents  $\pm$  two standard deviations of the group centered variable integration; the vertical axis represents delivery performance in relation to the 25<sup>th</sup> and 75<sup>th</sup> percentiles of both cultural dimensions. Exemplary simple slope equations for an integration score of  $-2.8$  (Figure 1, right graph, low integration) are below.

$$\text{Delivery Performance} = \gamma_{00} + \gamma_{10} * (\text{Integration}) + \gamma_{14} * (\text{GLUA}) * (\text{Integration})$$

$$25^{\text{th}} \text{ percentile : } 5.219 + 0.171 * -2.80 + 0.148 * -0.643 * -2.80 = 5.01$$

$$75^{\text{th}} \text{ percentile : } 5.219 + 0.171 * -2.80 + 0.148 * 0.457 * -2.80 = 4.55$$

**Figure 1. Moderation effect of GLOBE dimensions.**



The reduction in intercept variance ( $\tau_{00}$ ) is 20.3%. The variance component remains significant, indicating that GDP cannot fully explain the mean performance differences between countries. The relative change in slope variance ( $\tau_{11}$ ) is 97.0%. This effect size is scale independent and signifies the cross-level interactions' explanatory power (Aguinis et al., 2013). After introducing the GLOBE variables, the variance component is no longer significant, indicating that there are no differences in the slopes between countries anymore.

Compared to the PCM, the difference in deviance is significant ( $\chi^2_{(6)} = 13.7, p < 0.05$ ).

The focal effects in this study are cross-level interactions between cultural dimensions and integration. For a *post-hoc power analysis*, the ML Power Tool and the following parameters were used:  $n_i = 73, n_j = 14, ICC1 = 0.062, \gamma_{00} = 0.0065, \gamma_{0x} = 0.379, \gamma_{0w} = 0.091, \gamma_{0xw} = 0.05, \gamma_{10} = 0.236, \gamma_{11} = 0.086, \tau_{00} = 0.074, \tau_{11} = 0.006, \sigma^2 = 1.040, \alpha = 0.05$ , and 1000 replications. The resulting statistical power for the GLOBE dimension of uncertainty avoidance is estimated to be 0.45, and for future orientation 0.30. These values are calculated with standardized measures, group mean centered plant-level variables and grand-mean centered country-level variables, and are comparatively low yet common for this type of study (Mathieu et al., 2012).

## 6. Discussion

In a global sample of manufacturing plants, SCI with customers and suppliers has a positive impact on performance (Hypothesis 1). There are significant differences in average performance between countries as shown by the significant random intercept ( $\tau_{11}$ ). As far as the influence of national culture, the relationship between SCI and performance was affected by the GLOBE dimensions of uncertainty avoidance and future orientation (Hypotheses 5 and 6). After introducing the GLOBE national culture dimensions, the random effect in the integration—performance relationship slope between countries was not significant anymore, indicating that the GLOBE scores explained the differences in efficiency between countries.

Good reporting practice includes the assessment of practical significance in addition to statistical significance (Aguinis et al., 2010). A comparison of the significant uncertainty avoidance (GLUA) interaction between the 1<sup>st</sup> and 3<sup>rd</sup> quartile, results in a 0.46-point difference in performance when the integration investment is two standard deviations below or above average. Investments in external integration seem to be relatively more beneficial for plants in countries with high uncertainty avoidance. The cultural dimension of future orientation (GLFU) has a negative and even stronger coefficient estimate ( $\gamma_{15}$ ) in our model, meaning that plants in countries with a low future orientation score derive a greater benefit from

investments in integration. However, regarding practical significance, the difference in performance when the integration investment is two standard deviations below or above average is only 0.26 points. *Ceteris paribus*, uncertainty avoidance has a stronger impact than future orientation on the effectiveness of investments in SCI. Surprisingly, these results show that integration investments in countries with a long-term culture are less efficient. Some countries in our sample that score high on this dimension are Hungary, Nigeria, and South Korea (see Appendix A). It is possible that firms in these countries have already taken steps to integrate with other firms, or they could be more inflexible and resistant to change, or both. Countries that score high on the uncertainty avoidance dimension are Nigeria, Taiwan, and China. Investing in SCI in these countries may be more efficient than in countries that can easily tolerate uncertainty. Notable is that Nigeria has high scores for uncertainty avoidance and long-term orientation, yet the coefficient estimates for the two significant GLOBE dimensions have opposite signs. This demonstrates numerically that culture is a complex phenomenon and that trade-offs may exist.

The predictive power of the GLOBE and Hofstede national culture dimensions diverges considerably in the OM context. The difference between the two major culture frameworks based on a proven operations management data set is an important secondary finding, and it demonstrates the utility of comparative research. This finding is congruent with a meta-analysis based on more than half a million observations throughout 30 years, which shows that national cultural scores are not as stable as generally assumed and that the predictive power of Hofstede scores weakened over time (Taras et al., 2012). Similarly, in a review of 180 studies, Kirkman et al. (2006) found that a relatively low amount of variance was explained by the Hofstede-based cultural scores.

Surprisingly, the correlation pattern between the five ostensibly comparable Hofstede and GLOBE dimensions in our sample reveal only insignificant relationships (Appendix B; underlined). However, several correlation coefficients among the six Hofstede dimensions are strongly significant, indicating overlapping constructs and potential estimation issues. Even though the GLOBE project features more cultural dimensions, there seems to be less conceptual overlap judged by the weak correlations based on the utilized data set. Some other correlations among the national culture frameworks are noteworthy, for example, between Hofstede's power distance (HPDI) and GLOBE's uncertainty avoidance (GLUA) index. The correlation table shows that in the latter case the two cultural frameworks are scoring decidedly different concepts in a similar fashion. The results of the comparison between the two frameworks using a large international data set suggest overall that the GLOBE national culture dimensions may be more effective in capturing the effects of national culture in an international supply chain setting.

## 7. Conclusions and future research

This empirical investigation contributes to the literature on cross-cultural operations management studies. The relationship between external supply chain integration and delivery performance was confirmed, but cannot be deemed universal. We further show that SCI, performance, and national culture are interrelated through a structured comparison. As the first and main theoretical contribution to literature, this study indicates that the national culture dimensions of future orientation and uncertainty avoidance moderate the effectiveness of international SCI. The practical impact of uncertainty avoidance is larger, even though its coefficient estimate is smaller than that of future orientation, highlighting the need to look beyond statistical significance. This finding has important managerial implications when facing investment decisions for a portfolio of countries. The priority should be to invest in countries with high uncertainty avoidance to improve return on investment. The second step should be to consider external integration investments in countries with low future orientation according to these results based largely on small and medium enterprises. A secondary contribution to the literature emerges from the comparison between the Hofstede and the GLOBE national culture frameworks. Building on a meta-analytic study (Taras et al., 2012), we provide large-sample empirical support and show through hierarchical linear modeling and correlation table statistics

that the GLOBE framework has greater efficacy in capturing the effects of national culture in international supply chain management.

Given the survey structure and dimensions, constraints of this study include the limited number of countries and the lack of data on SCI best practices in the dataset for a deeper examination of findings.

The results of the study suggest, contrary to expectations that SCI may be of greater utility for low-future-orientation contexts, which should be further investigated in future research. A possible explanation for this surprising result could be related to the limitations of a cross-sectional study, which does not consider already implemented external integration improvements in countries with a strategic long-term planning culture. A potential resistance to change in long-term oriented cultures could be another reason.

While most studies aim to document differences, this viewpoint may obstruct the identification of similarities which may be just as important (Matsumoto & van de Vijver, 2010). In an attempt to overcome this shortcoming and to validate future results, configurational methods may enrich analysis through the identification of a profile of conditions (Venaik & Midgley, 2015). The link to organizational culture and its relative impact could help to enhance this type of analysis, but makes it also more complex and may introduce methodological challenges through commonly found high correlation among organizational culture dimensions. A helpful extension would be to investigate the broader practices-integration-performance link, to understand the use of best practices between countries. Hence, the next analytical step should be to consider collaboration and coordination practices, to obtain a deeper understanding of externally integrated relationships and to understand the impact of managerial actions.

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### Appendix A. Hofstede and GLOBE Cultural Scores

	Hofstede					GLOBE				
	HPDI	HIDV	HMAS	HUAI	HLTO	GLPD	GLIC	GLFU	GLUA	GLAS
Australia	38	90	61	51	21	2.78	4.4	5.15	3.98	3.81
China	80	20	66	30	87	3.1	4.56	4.73	5.28	5.44
Croatia	73	33	40	80	58	2.57	4.38	5.42	4.99	4.59
Germany	35	67	66	65	83	2.54	4.82	4.85	3.32	3.09
Hungary	46	80	88	82	58	2.49	4.5	5.7	4.66	3.35
India	77	48	56	40	51	2.64	4.71	5.6	4.73	4.76
Ireland	28	70	68	35	24	2.71	4.59	5.22	4.02	3.99
Nigeria	80*	30*	60*	55*	13	2.69	5.03	6.04	5.6	3.23
Poland	68	60	64	93	38	3.12	4.22	5.2	4.71	3.9
S Korea	60	18	39	85	100	2.55	3.9	5.69	4.67	3.75
Taiwan	58	17	45	69	93	3.09	5.15	5.2	5.31	3.28
USA	40	91	62	46	26	2.85	4.17	5.31	4	4.32
Ukraine	92*	25*	27*	95*	86	2.62^	3.89^	5.48^	5.07^	2.83^
Vietnam	70	20	40	30	57	3.24	4.43	5.5	4.63	4.81

^ Values from Russia.

Appendix B. Correlation Table of Country-Level Variables

	HPDI	HIDV	HMAS	HUAI	HLTO	HIVR	GDP	GLPD	GLIC	GLIG	GLFU	GLPO	GLHO	GLGE	GLUA	GLAS
<b>HPDI</b>	1															
<b>HIDV</b>	<u>-.743**</u>	1														
<b>HMAS</b>	<u>-.545*</u>	<u>.677**</u>	1													
<b>HUAI</b>	0.186	-0.082	-0.231	1												
<b>HLTO</b>	0.281	-.601*	-0.409	0.336	1											
<b>HIVR</b>	-0.49	0.416	0.299	-0.384	<u>-.723**</u>	1										
<b>GDP</b>	<u>-.893**</u>	<u>.700**</u>	0.31	-0.164	-0.291	<u>.551*</u>	1									
<b>GLPD</b>	<u>0.183</u>	-0.266	-0.104	-0.375	-0.021	0.006	-0.17	1								
<b>GLIC</b>	-0.123	<u>-0.069</u>	0.339	-0.386	-0.13	0.416	-0.049	0.141	1							
<b>GLIG</b>	-0.192	0.461	-0.036	0.446	-0.467	0.282	0.354	-0.263	-0.394	1						
<b>GLFU</b>	0.314	-0.174	-0.177	0.233	<u>-0.26</u>	0.152	-0.42	-0.365	-0.067	0.184	1					
<b>GLPO</b>	-0.135	0.449	0.401	-0.069	<u>-.665**</u>	0.422	0.086	-0.153	0.387	0.323	0.074	1				
<b>GLHO</b>	0.021	0.071	0.072	0.055	-0.381	<u>.580*</u>	0.079	-0.37	0.039	0.186	.541*	0.049	1			
<b>GLGE</b>	-0.741**	<u>.822**</u>	0.323	-0.068	-0.592*	0.448	<u>.723**</u>	-0.377	-0.092	0.519	-0.054	0.522	0.011	1		
<b>GLUA</b>	<u>.807**</u>	-0.724**	-0.327	0.158	0.18	-0.186	-0.791**	0.241	0.152	-0.086	0.417	-0.081	0.118	-0.775**	1	
<b>GLAS</b>	0.18	-0.127	<u>0.032</u>	<u>-.627*</u>	-0.078	-0.177	-0.168	0.438	-0.07	-0.357	-0.268	0.068	-0.501	-0.114	0.091	1

\*  $p < 0.05$ ; \*\*  $p < 0.01$  (Pearson two-tailed); All bold variables are part of the model.  
 Note: Correlations of comparable Hofstede and GLOBE dimensions in the sample are underlined.



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