

Standardization and International Business: Evidence from German Micro Data

vorgelegt von

JO-ANN MÜLLER, M.A.

geboren in Erfurt

von der Fakultät VII – Wirtschaft und Management

der Technischen Universität Berlin

zur Erlangung des akademischen Grades

Doktor der Wirtschaftswissenschaften

- DR. RER. EOC. -

genehmigte Dissertation

Promotionsausschuss:

Vorsitzender: Prof. Dr. Jan Kratzer

Gutachter: Prof. Dr. Knut Blind

Gutachter: Prof. Dr. Michał Grajek

Tag der wissenschaftlichen Aussprache: 20. Oktober 2017

Berlin 2018

Abstract (English)

Objective

Increasing globalization opens up market opportunities, but also results in increased competition. In order to meet the strong opposing forces for customization and cost efficiency at work at the same time, firms aim to simultaneously increase the level of product adaption and efficiency. Standardization can play a significant role for international businesses to achieve these goals.

The objective of this dissertation is to exploit unique micro data on standardization activities of German firms in order to provide empirical evidence on the role of standardization in global business. Particular attention is directed towards the drivers for the development and application of harmonized standards versus regional standards, and the importance of company standards for the governance of corporate groups.

Structure

The first part of the dissertation takes a regional perspective on standardization in global markets and examines drivers for the development and application of international standards and regional standards. At first, the focus is on factors influencing firms' decision to be involved in supranational standardization (in addition to national standardization). The subsequent chapter sheds light on the preferences of firms with respect to the application of standards on different regional levels in the specific case of trade with the United States.

The second part of the thesis applies an internal perspective by analyzing the role of company standards for the governance of corporate groups. Consolidating the insights, the study closes with an elaboration of the relationship between the application of different types of standards and subsidiary strategies.

Methods and Data

Theoretical concepts on the role of standards in global business are developed based on the existing literature and tested applying quantitative methods to firm-level data.

The major strength of this study lies in the unique data on which the empirical investigations are based. The first paper uses information on the international standardization activities of experts engaged in national standardization work at the German Institute in 2016.

Abstract (English)

Additional information was retrieved from the following data bases: Hoppenstedt, PATSTAT, OECD.Stat, and UNCTAD Trade Analysis Information System. Figures published by the Federal Statistical Office of Germany and CEN-CENELEC complete the data set.

All other chapters are based on data from the German Standardization Panel. The survey is conducted among experts actively engaged in standardization and covers the years from 2013 to 2016. The project is supported by the German Society for the Promotion of Research on Standardization and implemented by the Chair of Innovation Economics at the Technische Universität Berlin.

Results

The results of this dissertation indicate that companies employ a variety of standardization strategies in conjunction with their international business activities. The motives for and objectives of the development of formal standards and company standards differ depending on firm characteristics and business environment.

Participation in standardization processes facilitates access to international markets and can take a crucial role in a firm's knowledge seeking strategy. Additional drivers for the involvement on the international level are firm size and standardization experiences. Market regulation is negatively related to participation in international standard bodies.

The application of international standards is associated with technical interoperability, productivity increases, and cost reductions. It is an essential tool in the development of an efficiency strategy in which products are produced for the global market. The application of national standards is required in order to meet pressures for local responsiveness. In addition, national standards can provide exporters with competitive advantages abroad, which makes the mutual recognition of regional standards attractive.

Company standards play a significant role in the governance of global value-chains, particularly because they facilitate the optimization of internal processes and quality management and are relevant for the integration of subsidiaries into a global company network.

Implications

From the results of this dissertation, implications can be drawn for policy makers, researchers, as well as managers.

Abstract (English)

Economic policy should aim to address the disincentives for participation in international standardization that arise from the scarcity of resources and tensions with regulation. International negotiations on the harmonization of formal standards must take into account firm and sector-specific issues, as well as differences in the competitive and technological environment of companies.

The results indicate that internal standardization is of particular importance for creating interoperability in corporate groups. Accordingly, platform researchers should aim to differentiate between the various types of standards in order to reveal new insights on the evolution and management of platforms. The conclusion that multinational corporations employ different standardization strategies depending on their strategic focus enhances the literature on international management.

Internal and external standardization as a strategic tool for the acquisition of knowledge and the optimization of internal processes is of high relevance for all firms, irrespective of their size. Managers should also consider the positive effect of company standards on the development and governance of inter- and intra-firm relationships.

Abstract (Deutsch)

Ziel und Fragestellung

Die zunehmende Globalisierung bietet Unternehmen die Möglichkeit, neue Märkte zu erschließen, führt aber zeitgleich zu einem erhöhten Wettbewerb mit internationalen Konkurrenten. Um diesen stark gegensätzlich wirkenden Kräften zu begegnen, streben Unternehmen an, Produkte zunehmend an die lokalen Bedürfnisse ihrer globalen Kunden anzupassen, aber gleichzeitig Effizienzgewinne in der Produktion zu erzielen.

Ziel dieser Dissertation ist es, einzigartige Daten zu den Standardisierungsaktivitäten von deutschen Unternehmen zu nutzen, um empirische Evidenz für die Rolle von Standardisierung für die internationale Geschäftstätigkeit zu liefern. Ein besonderes Augenmerk gilt den Faktoren, welche die Entwicklung und Anwendung von harmonisierten Normen im Vergleich zu regionalen Normen bestimmen, sowie der Bedeutung von Werknormen für die Konzernführung.

Struktur

Der erste Teil dieser Dissertation nimmt eine regionale Sichtweise auf Standardisierung in globalen Märkten ein und analysiert die treibenden Faktoren hinter der Entwicklung und Anwendung von international harmonisierten Normen im Vergleich zu regionalen Normen. Zuerst wird der Fokus auf die Entscheidungskriterien für die Teilnahme an der Entwicklung von Europäischen und internationalen Normen zusätzlich zur Normung auf nationaler Ebene gelegt. Das darauffolgende Kapitel beleuchtet die Präferenzen von Unternehmen hinsichtlich der Anwendung von Normen auf verschiedenen regionalen Ebenen in dem spezifischen Fall von Handel mit den USA.

Im zweiten Teil der Doktorarbeit wird eine interne Perspektive auf das Thema eingenommen. Es wird die Rolle von Werknormen für die Führung und das Management von Unternehmensgruppen untersucht. Alle Erkenntnisse zusammennehmend, schließt die Studie mit einer Erarbeitung der Beziehung zwischen der Anwendung von Normen und Standards und der Strategien von multinationalen Unternehmen ab.

Methoden und Daten

Theoretische Konzepte über die Rolle von Normen und Standards für die Tätigkeiten in globalen Märkten werden von der bestehenden Literatur abgeleitet und mithilfe der quantitativen Analysen von Unternehmensdaten getestet.

Die große Stärke der Arbeit liegt in ihrer einzigartigen Datengrundlage. Das erste Papier nutzt Informationen zu den internationalen Normungsaktivitäten von Unternehmensvertretern, die im Jahr 2016 aktiv an der nationalen Normungsarbeit des Deutschen Instituts für Normung beteiligt waren. Zusätzlich wurden Informationen von den folgenden Datenbanken erhalten: Hoppenstedt, PATSTAT, OECD.Stat und UNCTAD Trade Analysis Information System. Zahlen, die vom Statistischen Bundesamt sowie CEN-CENELEC veröffentlicht wurden, vervollständigen den Datensatz.

Alle anderen Kapitel basieren auf Daten vom Deutschen Normungspanel. Die Umfrage wird unter Experten durchgeführt, die sich an Normungs- und Standardisierungsprozessen beteiligen, und umfasst die Jahre 2013 bis 2016. Das Projekt wird vom Deutschen Förderverein zur Stärkung der Forschung zu Normung und Standardisierung e.V. getragen und von dem Lehrstuhl für Innovationsökonomie an der Technischen Universität Berlin durchgeführt.

Ergebnisse

Die Ergebnisse dieser Doktorarbeit zeigen auf, dass Unternehmen eine Vielzahl von Standardisierungsstrategien im Zusammenhang mit ihren internationalen Geschäftsaktivitäten verfolgen. Die Motive und Ziele der Entwicklung von formellen Normen und Werknormen unterscheiden sich je nach Unternehmenscharakteristika und Geschäftsumfeld.

Die Teilnahme in Normungsprozessen erleichtert den Zugang zu internationalen Märkten und kann eine entscheidende Rolle in der Wissensstrategie eines Unternehmens spielen. Weitere Faktoren, welche die Normungsarbeit auf internationaler Ebene begünstigen, sind Unternehmensgröße und Normungserfahrung. Marktregulierung steht in einem Spannungsverhältnis zu der Teilnahme in internationalen Normungsorganisationen.

Die Anwendung von internationalen Normen steht in Verbindung mit technischer Interoperabilität, Produktivitätssteigerungen, und Kosteneinsparungen. Es ist ein wichtiges Instrument in der Entwicklung einer Effizienzstrategie, bei der Produkte für den globalen Markt hergestellt werden. Die Anwendung nationaler Normen ist notwendig um lokalen Bedürfnissen gerecht zu werden. Außerdem können nationale Normen Exporteuren internationale

Abstract (Deutsch)

Wettbewerbsvorteile verschaffen, was die gegenseitige Anerkennung von regionalen Normen attraktiver macht.

Werknormen spielen eine wichtige Rolle bei der Steuerung und Verwaltung von globalen Wertschöpfungsketten, insbesondere da sie die Optimierung von internen Prozessen und das Qualitätsmanagement verbessern und für die Integration von Tochterunternehmen in das globale Unternehmensnetzwerk relevant sind.

Implikationen

Von den Ergebnissen dieser Doktorarbeiten lassen sich Implikationen für Politiker, Wissenschaftler sowie Manager ableiten.

Die Wirtschaftspolitik sollte darauf abzielen, die Hemmnisse für eine Teilnahme in der internationalen Normungsarbeit zu adressieren, die sich aufgrund von Ressourcenknappheit und dem Spannungsverhältnis mit internationaler Regulierung ergeben. Internationale Verhandlungen über die Harmonisierung von formellen Normen sollten die unternehmens- und industriespezifische Probleme sowie Unterschiede hinsichtlich der Wettbewerbssituation und dem technologischen Umfeld von Unternehmen berücksichtigen.

Die Ergebnisse implizieren, dass Werknormung von besonderer Wichtigkeit für die Realisierung von technischer Interoperabilität in Unternehmensgruppen ist. Demzufolge sollten Wissenschaftler darauf abzielen, zwischen verschiedenen Standardarten zu unterscheiden, um neue Einblicke in die Evolution und das Management von Plattformen zu erhalten. Die Schlussfolgerung, dass multinationale Unternehmen unterschiedliche Standardisierungsstrategien in Abhängigkeit von ihrem strategischen Fokus verfolgen, leistet einen Beitrag zu der Forschung im Bereich internationales Management.

Interne und externe Standardisierung als strategisches Instrument für die Aneignung von Wissen und die Optimierung von internen Prozessen ist für alle Unternehmen unabhängig von ihrer Größe von hoher Relevanz. Manager sollten außerdem die positiven Effekte von Werknormung bezüglich der Entwicklung und Steuerung von internen und externen Beziehungen berücksichtigen.

Submission Record

Information as of August 15, 2017

The essay “Drivers of Companies’ Participation in Supranational Standardization” is co-authored by Knut Blind. It was presented at the TU Berlin CIF in 2017 and at the EURAS Conference 2017 in Berlin, Germany.

The essay “Beyond the Standard Practice: How to Remove Trade Barriers Arising from Standards within TTIP” is co-authored by Knut Blind. It was presented at the TU Berlin CIF in 2015, at the EURAS conference 2015 in Copenhagen, Denmark, and at the EARIE Conference 2015 in Munich. It is currently under review by Journal of Policy Modelling.

The essay “Why Corporate Groups Care about Company Standards: An Empirical Analysis of the Motives to Standardize” was presented at the TU Berlin CIF in 2016, at the EURAS Conference 2016 in Montpellier, France, and at the Workshop Innovation in Emerging Economies 2017 in Berlin, Germany.

The essay “Subsidiary Strategy and Importance of Standards: Reinterpreting the Integration-Responsiveness Framework” was presented at the TU Berlin CIF in 2016, at the Workshop on ‘Standardisation Management’ 2016 in Guimarães, Portugal, and at the VfS Annual Conference 2016 in Augsburg, Germany. It is currently under review by the Journal of Business Research.

Table of Contents

Abstract (English)	ii
Abstract (Deutsch)	v
Submission Record.....	viii
Table of Contents	ix
Acronyms	xii
List of Tables.....	xiii
List of Figures	1
1. Introduction	1
1.1. Definitions and Concepts	1
1.1.1. Definition of Standards	1
1.1.2. Direct Investment and Global Value-chains	2
1.2. Overview	3
1.3. Results and Implications	5
1.4. References	9
2. Drivers of Companies' Participation in Supranational Standardization.....	12
2.1. Introduction	13
2.2. Drivers for Participation in Standardization Processes	14
2.3. Empirical Analysis	17
2.3.1. Data and Variable Description	17
2.3.2. Empirical Model and Results	22
2.4. Discussion and Conclusion	26
2.5. References	28
2.6. Appendix	31
3. Beyond the Standard Practice: How to Remove Trade Barriers Arising from Standards within TTIP	32
3.1. Introduction	33
3.2. Theoretical Considerations.....	35
3.2.1. Benefits and Costs of Harmonized Standards	35

3.2.2.	Creating Competitiveness Vis-à-Vis Global Rivals	37
3.2.3.	Influencing International Standardization Processes.....	38
3.2.4.	The Role of Firm Size and Industry	39
3.2.5.	Importance of Informal Consortia Standards	40
3.3.	Empirical Analysis	42
3.3.1.	Data and Variable Description	42
3.3.2.	Empirical Model and Results	44
3.3.3.	Robustness Checks	48
3.3.4.	Limitations and Future Research.....	49
3.4.	Summary and Policy Conclusions.....	51
3.5.	References	53
3.6.	Appendix	57
4.	Why Corporate Groups Care about Company Standards: An Empirical Analysis of the Motives to Standardize.....	59
4.1.	Introduction	60
4.2.	Motives for the Application of Company Standards.....	61
4.2.1.	External Perspective on the Application of Company Standards.....	62
4.2.2.	Internal Perspective on the Application of Company Standards.....	62
4.3.	Empirical Analysis	65
4.3.1.	Data and Variable Description	65
4.3.2.	Empirical Model and Results	68
4.4.	Conclusion.....	74
4.5.	References	76
4.6.	Appendix	81
5.	Subsidiary Strategy and Importance of Standards: Reinterpreting the Integration- Responsiveness Framework	82
5.1.	Introduction	83
5.2.	Conceptual Framework	84
5.2.1.	The Integration-Responsiveness Framework	84
5.2.2.	Types of Standards and Their Role in MNEs.....	87
5.2.3.	The Relationship between Subsidiary Strategy and the Application of Standards .	90
5.3.	Empirical Analysis	92
5.3.1.	Data and Variable Description	93
5.3.2.	Grouping of Subsidiaries by Importance of Standards.....	93

5.3.3.	Export Intensity and Subsidiary Strategy	98
5.3.4.	Motives to Apply Standards	99
5.4.	Discussion and Conclusion	101
5.5.	References	103
5.6.	Appendix	108
6.	Conclusion.....	110
6.1.	Main Results.....	111
6.2.	Implications	113
6.2.1.	Implications for Economic Policy.....	113
6.2.2.	Implications for Research Policy	113
6.2.3.	Implications for Management	114
6.3.	Limitations and Future Research.....	115
6.4.	References	115

Acronyms

CEN	European Committee for Standardization
CENELEC	European Committee for Electrotechnical Standardization
CIS	Community Innovation Survey
CPRP	Chemical, pharmaceutical, rubber, and plastic products
DIN	German Institute for Standardization
DKE	German Commission for Electrical, Electronic & Information Technologies
EPO	European Patent Office
ETSI	European Telecommunications Standards Institute
EU	European Union
EWS	Energy and water supplies, Oil
FDI	Foreign direct investment
GSP	German Standardization Panel
HMT	High and medium technology
HS	Harmonized Standards
ICS	Information and communication services
IEC	International Electrotechnical Commission
IRF	Integration-responsiveness framework
ISO	International Organization for Standardization
ITU	International Telecommunication Union
MNE	Multinational enterprise
NTM	Non-tariff measure
OJEU	Official Journal of the European Union
R&D	Research and development
SUR	Seemingly unrelated regressions
TBT	Technical barriers to trade
TRAINS	Trade Analysis Information System
TTIP	Transatlantic Trade and Investment Partnership
US	United States of America

List of Tables

Table 2.1: Specifications of the dependent variables	17
Table 2.2: Definition and descriptive statistics of all independent variables	19
Table 2.3: Descriptive statistics of the main explanatory variables by industry	20
Table 2.4: Group mean values of independent variables and t-test statistics	22
Table 2.5: Logistic regressions for additional participation in supranational standardization	25
Table 2.6: Model statistics	26
Table 2.7 Logit regressions excluding outliers	31
Table 3.1: Proposed pros and cons of the three harmonization solutions	41
Table 3.2: Means of explanatory variables by groups and t-test statistics	43
Table 3.3: Multivariate probit model for preferences about harmonization solutions	47
Table 3.4: Comparison of model statistics	49
Table 3.5: Univariate and bivariate probit models for preferences about harmonization solutions	50
Table 3.6: Multivariate probit model for preferences about harmonization solutions including labeling requirements	57
Table 4.1: Application of company standards by form of business organization	66
Table 4.2: Mean values of independent variables by form of business organization.....	67
Table 4.3: Model statistics	70
Table 4.4: Proportional and partial proportional odds models	71
Table 4.5: Partial proportional odds model (SV) differentiating between national and international corporate groups.....	72
Table 4.6: Multivariate probit regressions for the motives to apply company standards.....	74
Table 4.7: Pairwise correlations of variables measured by Spearman's rho (*significant at 1%).	81
Table 5.1: Organizational Characteristics of Multinational, Global, International and Transnational Companies	86
Table 5.2: Application of the IRF to standards	92

Table 5.3: Number of observations assigned to clusters in four and five cluster solution.....	94
Table 5.4: Descriptive statistics for clusters identified by means of K-means algorithm.....	95
Table 5.5: Difference in the importance of formal standards and company standards for business success factors by clusters and t-test statistics.	100
Table 5.6: Optimal number of clusters - Ward's Method and Duda-Hart index	108
Table 5.7: Industry distribution and descriptive statistics for subsidiaries with export data.....	109

List of Figures

Figure 3.1: Average assessment of different solutions for the harmonization of formal standards in the context of TTIP	34
Figure 3.2: World Competitiveness Ranking – 5-year comparison	57
Figure 4.1: Effects of company standards on intra and inter-firm relations.....	64
Figure 4.2: Average impact of company standards on business success factors by form of business organization	66
Figure 5.1: Comparison of industry shares by clusters between Ghoshal and Nohria (1993) (left) and own results (right)	97
Figure 5.2: Framework of the relationship between subsidiary strategies and application of standards.....	101

1. Introduction

The focus of this dissertation is on the role of standardization in the governance of global business activities. The emphasis is on formal standardization at standards bodies on different regional levels and internal standardization by individual companies as strategic tools to enhance exports and direct investment. The following chapter provides an explanation of terms and definitions on which this study is based.

1.1. Definitions and Concepts

1.1.1. Definition of Standards

A standard is a “document, that provides, for common and repeated use, rules, guidelines, or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context (...)” (DIN EN 45020).

According to DIN 820-3 standards can be classified, depending on their purpose, into service, fitness for purpose, supply, measurement, planning, testing, quality, safety, material, process, and comprehensibility standards. Depending on who develops and uses them, one can distinguish between formal standards, informal consortia standards, de-facto standards, company standards, as well as specifications and technical rules.

This dissertation focuses on formal standards and company standards.

Formal Standards

Formal standards are “established by consensus and approved by a recognized body” (DIN EN 45020) and recommend rules and guidelines. Formal standardization is recognized to have a high level of legitimation due to its well-established processes. The use of formal standards can become mandatory for the company if they are cited in a law or contracts. In this study, the development of formal standards is also referred to as external standardization.

Formal standards are established on the national, European, and international level. In Germany, national formal standards are developed by national institutes such as the German Institute for Standardization (DIN) or the German Commission for Electrical, Electronic & Information Technologies (DKE). DKE is the German national organization responsible for developing standards and safety specifications in electrical engineering, electronics, and information technology. DIN is the acknowledged national standards body representing German interests at all levels, including the European and international standards organizations.

Introduction

National standards are non-tariff measures (NTMs)¹ that can act as an impediment to trade and investment. According to United Nations (2015), standards can primarily be classified as technical barriers to trade (TBT).

On the European level, standards are drawn up by the three officially acknowledged European standards organizations: the European Committee for Standardization (CEN), the European Committee for Electrotechnical Standardization (CENELEC) and the European Telecommunications Standards Institute (ETSI). Each country in Europe is represented within CEN and CENELEC by one member body. This work is supported by a working committee designated as the “mirror committee” to the relevant European body. This committee determines the German position on a particular subject and sends delegates to the European committees to represent this position and participate in the consensus-building process.

Likewise, the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC) are private organizations on the international level, whose members are the national standards organizations. Another international body that sets rules is the International Telecommunication Union (ITU). International standards can provide the basis for free trade agreements to dismantle non-tariff barriers to trade (OECD, 2016).

Company Standards

A company standard is developed by a firm to meet its own needs and requirements (Düsterbeck et al., 1995). They are generally not open to the public (Blind, 2004) and more specific to the firm than formal standards. Company standards are adopted by companies themselves and can be used in business relationships, for example with subsidiaries or suppliers. In the following, the development of company standards is also referred to as internal standardization.

1.1.2. Direct Investment and Global Value-chains

Increasing globalization has triggered the “slicing up of the value-chains” (Krugman, 1995) and the development of production networks known as global value-chains. Fragmentation means that different stages of the production process are spread across the globe (Deardorff, 2001) and intermediates are shipped between countries from one production stage to the next. The global value-chain comprises all steps required to create a product which is sold to the customers. Different companies can specialize on core competencies and certain stages of the value-chain.

¹ Berden et al. (2009) define non-tariff measures as ‘all non-price and non-quantity restrictions on trade in goods, services and investment, at federal and state level. This includes border measures (customs procedures, etc.), as well as behind-the-border measures flowing from domestic laws, regulations and practices’.

The costs of market transactions as compared to internal transactions determines whether it is more beneficial to perform different stages of the value-chain in-house or by subcontractors (Coase, 1937). Inter-firm relationships are beneficial if products and processes are characterized by a high degree of market compatibility and low amount of company-specific knowledge. If technologies and business practices that are transferred between value-chain activities convey knowledge that is valuable to the firm, companies will seek to keep such assets within the boundaries of the firm (Gereffi et al., 2005).

The focus of this study is on the role of standards in corporate groups. A corporate group is a set of legally separate firms which are subject to common control by the parent firm. Corporate groups have to be differentiated from sets of firms that enter into strategic alliances, and from single firms. Groups that exclusively comprises firms located in the home country are referred to as national corporate groups. If 10% or more of the voting power is acquired in a business enterprise in another country, this is referred to as foreign direct investment (FDI) (OECD, 2016).

Multinational enterprises (MNEs) assign different strategic roles to their subsidiaries, depending on the aim of investment (Prahalad and Doz, 1987). The main objectives of FDI are access to markets (market seeking), access to resources (resource seeking), and cost reductions (efficiency seeking) (Dunning, 1993).

1.2. Overview

Worldwide economic, financial, and cultural integration requires companies to take a global perspective. Because market opportunities and growth potentials are immense in global markets, so is competition. In order to adapt to the rapid globalization, firms develop complex strategies including exporting, outsourcing and direct investment. Standards can act as non-tariff barriers to trade and investment, but can also facilitate global business (Swann, 2010).

On the one hand, the application of national standards can create competitive advantages abroad, and thereby improve firms' export performance (e.g. Swann et al., 1996; Blind, 2004; Moenius, 2006). On the other hand, national standards can act as barriers to trade, because the adoption of products to local requirements incurs extra costs for exporting (Chen et al., 2006). Accordingly, the reduction of trade barriers through harmonization of standards can enhance trade and investment, in particular by facilitating compatibility between products and reducing information asymmetries (Swann, 2000). For example, Clougherty and Grajek (2008) show that the diffusion of international standards in developing countries enhances exports and FDI from developed countries. Affected companies have the opportunity to increase profits, and consumers in both countries would benefit from higher employment associated with trade liberalization.

Consumers will not only gain from higher incomes due to a boost in employment but also from lower prices and increased product variety (e.g. Krugman and Obstfeld, 2008; Feenstra and Taylor, 2008).

For the case of trade between the European Union (EU) and the United States of America (US), the European Commission estimates potential gains from trade liberalization to be 120 billion Euro for the EU economy, 90 billion Euro for the US economy and 100 billion Euro for the rest of the world (Joseph et al., 2013). Other studies take a critical look at existing literature and predict negative effects in the form of losses to net exports, and especially intra-industry trade (e.g. Swann et al., 1996; Capaldo, 2014).

The alternative harmonization solutions within The Transatlantic Trade and Investment Partnership (TTIP) have different implications for firms. While the application of common standards creates direct and indirect network externalities, high implementation cost and a reduction in variety can have a negative impact on firms' profits. Companies might instead prefer the mutual recognition of regional standards, especially if those are associated with competitive advantages (Swann et al., 1996; Blind, 2001; Moenius, 2006).

Firms can pursue various strategic objectives with the development of standards on different regional levels. The literature on the motives for participation in formal standardization is limited (Choi et al., 2011). Blind and Mangelsdorf (2016) conclude that firms expect to gain access to markets and knowledge, to influence the development process, to shape the regulatory framework, and to solve specific problems.

In addition, standardization plays a significant role in the development of product platforms (Gawer and Cusumano, 2013; Festing and Eidems, 2011). Dispersed international operations create complex internal interfaces that require targeted control and strategic coordination. A conglomeration of firms from different businesses not only expands the product portfolio but creates a need to integrate different corporate cultures and management systems. Integrating value-chain activities worldwide and coordinating internal interfaces creates high managing, monitoring, and transaction costs. In particular for multinational corporations that establish subsidiaries abroad, challenges arise from different operating conditions in different countries. Integration will be profitable only if internal interfaces are optimally coordinated, advantages fully utilized and assets kept within the boundaries of the firm. One way for corporate groups to meet their special need for internal consistency is the application of standards (Fortanier et al., 2011).

The significant role of standards in value-chain governance is undisputed in the economic literature (e.g. Gereffi and Lee, 2012; Kaplinsky, 2010; Gereffi et al., 2005; Gibbon and Ponte, 2005; Nadvi and Wältring, 2004). Studies exist on the link between foreign direct investment and

international management system standards (e.g. Guler et. al, 2012; Smith, 2009), and the importance of internal guidelines and routines in globally dispersed firms is not new by any means either (see e.g. Dunning, 2001; Dowell et al., 2000; Christmann, 2004; Jaffee and Masakure, 2005). International management system standards, as well as company standards are highly relevant for supply-chain governance (Großmann and von Gruben, 2014). The motives for the application of company standards are optimization of internal processes, improvement of performance, and differentiation (Großmann et al., 2016). Company standards thereby foster the development of a high-performance enterprise network (Festing und Eidems, 2011; Forntanier et al. 2011; Dowell et al., 2000).

However, most of the existing studies are based on case studies that focus on certain industries and lack precise definitions of and differentiation between various types of standards. No quantitative analyses exist on the drivers for firms' participation in supranational standardization, the perceptions of firms regarding alternatives to harmonize standards within TTIP, and the motives to apply company standards and their special role in corporate groups.

It is common belief within the international management literature that MNE subsidiaries take different roles within the group. The various strategies imply differences between subsidiaries regarding the adaption to market-specific requirements, the allocation of resources, the control over the design of products and processes, and the dependencies with headquarters and other group members. The relationship between firms' strategic focus and the importance of different types of standards has, to date, been neglected by standardization researchers.

This dissertation aims to provide a deeper understanding of the role of standardization in global business by answering the open questions. The major strength of this dissertation lies in the application of econometric methods to unique data from the German Standardization Panel (GSP), allowing for a quantitative analysis of the standardization activities of German firms. The first part of the study takes a regional perspective and analyzes the drivers for the development and application of internationally harmonized standards and regional standards. Following the implication of the existing literature that standards are particularly important to corporate groups, the second part focusses on the role of standards for the governance of internal value-chains, with a focus on multinational corporations. The study provides new theoretical as well as empirical insights.

1.3. Results and Implications

The second chapter of this dissertation expands the limited literature on the motives to engage in formal standardization processes by analyzing the relevance of industry and firm

specific factors for the likelihood to participate in supranational in addition to national standard setting organizations. Logistic regression models are applied to data on companies active in German standardization committees. Industry-level measures on export volumes, patent stocks, market regulations and concentrations, and firm-level patent data were matched from open access data bases.

The analysis provides empirical support for the findings of previous studies and generates new insights relevant for both standardization policy and management. Firstly, the large pool of industry knowledge outside of Germany is a significant driver for participation in supranational standardization. The results confirm the perception that standardization is a ‘knowledge-seeking’ strategy for companies. Secondly, the export volume of the industry measuring market access motives is positively related to participation in European and international standardization (as compared to participation exclusively on the national level). Market access is not sufficient in explaining additional participation among firms already engaged in supranational standardization. Furthermore, the data provides no indication that large firms with high market power in Germany form standardization cartels by excluding less powerful competitors from international standardization or that the regulatory regime in Europe, established under The New Approach, is related to a firm’s likelihood to undertake European standardization activities. On the international level, regulation of international export markets is negatively related to participation in international standard bodies. The findings possibly reflect that firms expect to have little influence on international regulation through standardization. In this case, disincentives for standardization could be reduced by implementing a complementary relationship as within The New Approach to improve companies’ ability to shape the regulatory environment for their products and services. In addition, the results imply that small and medium-sized firms face obstacles in raising sufficient resources to participate in standardization. Policy makers and representatives of the standards institutes are needed to find effective solutions to enhance the interplay between regulation and standardization, and to increase the involvement of small and medium-sized firms in the development processes.

After examining the drivers for the development of international standards, the third chapter focusses on factors that influence firms’ preferences about the application of international versus regional standards in the specific case of trade with the United States. Data on the assessment of different harmonization solutions within TTIP is available from the GSP conducted in 2013. The application of international standards is the option German firms prefer most to reduce barriers to export to and invest in the US. A more detailed analysis based on multivariate probit regression reveals, however, that this solution does not fit all firms best. Overall, three dimensions determining firms’ preferences regarding the various harmonization solutions are

identified: 1) company-specific factors, 2) the competitive environment, and 3) the technological environment.

The application of international standards is perceived as a good solution, in particular if formal standards facilitate market access, technical interoperability, productivity increases, and reductions in diversification costs. Firms that expect a positive impact of formal standards on competitive advantages prefer mutual recognition, indicating that those competitive advantages result from the application of regional standards. Companies operating in fast-moving industries advocate for this option, possibly because they believe that the acceptance of existing standards integrates markets more quickly. Even though negotiating standards bilaterally seemingly combines the advantages of international standards and mutual recognition, German firms on average reject the development of new EU-US standards as an alternative to international standards or mutual recognition. This is in particular true if well-established European or international standards already exist. The results imply that trade facilitating initiatives should, in addition to sector-specific issues, address differences in the competitive and technological environment of the most affected firms.

The following chapter takes an internal perspective on the role of standards in global business by considering company standards as a strategic tool for the governance of corporate groups. This study adds to the existing literature by providing empirical evidence of the motives to apply company standards and their special role in corporate groups.

Controlling for size, standardization and innovation activities, and industry, the empirical analysis confirms that German corporate groups utilize more company standards than single companies. The main motives for internal standardization are quality improvements, productivity increases and cost reductions, legal security, and technical interoperability. Differences between corporate groups and single firms exist with respect to the impact of company standards on the realization of technical interoperability and the fulfillment of market entry conditions. The results underline the special role of internal standardization for the development and management of internal platforms and the conformity of products and processes with local entry requirements when operating in different business environments.

The implications of this study are of considerable importance to value-chain managers, who should consider the effects of company standards on the governance of inter- and intra-firm relationships. The application of high corporate quality and environmental standards creates positive externalities, providing a rationale for government support for internal standardization. The results of the study suggest that support should be targeted to small and medium-sized enterprises that are not only less likely than large firms to apply company standards but also assess

the impact of company standards on improvements in quality and competitiveness significantly lower.

In chapter five, the integration-responsiveness framework (IRF), according to which subsidiaries of multinational enterprises are assigned different strategic roles depending on the business environment they operate in, is applied to standards in order to develop a theoretical concept about the relationship between subsidiary strategies and the importance of different types of standards. The concept is supported by data about the standardization activities of MNE subsidiaries in Germany. The results of the explorative analysis confirm the hypothesis that subsidiaries of multinational corporations can be grouped according to the relevance of different types of standards. The groups show characteristics consistent with the typology of multinationals provided by the IRF. Therefore, the results allow to draw conclusions on the relationship between the application of standards and subsidiary strategies.

The governance of global value-chains can be facilitated by the application of international management system standards and company standards. They act as a tool to implement common organizational practices and company-specific requirements, thereby boosting the integration of subsidiaries worldwide. In addition, the application of international formal standards is essential for efficiency strategies in which products are produced for the global market.

In order to meet specific needs of buyers in different countries, efficiency-seeking corporations might need to adopt a flexible approach that still maximizes cost efficiency. The transnational strategy includes modularization through standardization of internal interfaces. As a result of the development of company standards, firms pursuing this strategy can achieve differentiation from competitors and adaption of products to local standards while efficiency gains can still be achieved. If subsidiaries are granted autonomy because of a high need for local adaption, company standards are of minor importance compared to formal standards.

The application of national standards that are internationally respected can create competitive advantages abroad if foreign companies do not have access to the standard and complementary resources, or do not have the necessary know-how to implement it. In this case, export of successful products and duplication of their production when exporting is very costly is a beneficial strategy to serve global markets.

The study provides new insights for the understanding of the modes and effects of establishing multinational organizations and improves the predictability of such complex activities. It adds a new dimension to the typology of multinational corporations and takes a further step towards overcoming the “lack of conceptual clarity” of the IRF (Roth & Morrison, 1990: 545) by identifying additional variables related to subsidiary strategy.

In summary, using a unique data set that allows to addresses problems of many prior studies, this dissertation provides empirical evidence on the drivers for developing and applying internationally harmonized standards (as compared to regional standards) as well as company standards. New insights are gained on the role of company standards in corporate groups and the relationship between subsidiary strategy and application of standards.

1.4. References

- Berden K., Francois J., Thelle M., Wymenga P., Tamminen S. (2009). Non-tariff Measures in EU-US Trade and Investment – An Economic Analysis. Study for the European Commission, Directorate-General for Trade, Ecorys, Rotterdam, Netherlands. Available at: <http://goo.gl/HPSDZf>.
- Blind K. (2001). The Impacts of Innovation and Standards on Trade of Measurement and Testing Products: Empirical Results of Switzerland's Bilateral Trade Flows with Germany, France and the United Kingdom. *Information Economics and Policy*, 13(4), pp. 439-460.
- Blind K. (2004). The Economics of Standards. Theory, Evidence, Policy. Cheltenham, UK, Northampton, MA, USA: Edward Elgar.
- Blind K., Mangelsdorf A. (2016). Motives to Standardize: Empirical Evidence from Germany. *Technovation*, 48-49, pp. 13-24.
- Capaldo J. (2014). The Trans-Atlantic Trade and Investment Partnership: European Disintegration, Unemployment and Instability. *Global Development And Environment Institute Working Papers*, No. 14-03, Tufts University, Medford, MA, USA.
- Chen M.X., Otsuki T., Wilson J.S. (2006). Do Standards Matter for Export Success? *World Bank Policy Research Working Papers*, No. 3809, World Bank, Washington, D.C., USA.
- Choi D.G., Lee H., Sung T. (2011). Research profiling for 'standardization and innovation'. *Scientometrics*, 88(1), pp. 259–278.
- Christmann P. (2004). Multinational companies and the natural environment: determinants of global environmental policy standardization. *Academy of Management Journal*, 47, pp. 747–760.
- Clougherty J.A., Grajek M. (2008). The impact of ISO 9000 Diffusion on Trade and FDI: A New Institutional Analysis. *Journal of International Business Studies*, 39(4), pp. 613-633.
- Coase R.H. (1937). The nature of the firm. *Economica*, 4(16), pp. 386-405.
- Deardorff A.V. (2001). Fragmentation in Simple Trade Models. *The North American Journal of Economics and Finance*, 12(2), pp. 121–137.
- DIN EN 45020 (2007). Berlin, Germany: Beuth Verlag GmbH.

- DIN 820–3 (2014). Berlin, Germany: Beuth Verlag GmbH.
- Dowell G., Hart S., Yeung B. (2000). Do Corporate Global Environmental Standards Create or Destroy Market Value? *Management Science*, 46 (8), pp. 1059–1074.
- Dunning J.H. (1993). Multinational Enterprises and the Global Economy. Harlow, UK: Addison-Wesley.
- Dunning J.H. (2001). The electric (OLI) paradigm of international production: Past, present and future. *International Journal of the Economics of Business*, 8(2), pp. 173-190.
- Düsterbeck B., Hesser W., Inklaar A., Vischner J. (1995). An introduction to standards and standardization. In Deutsches Institut für Normung e.V. (DIN) (Ed.), DIN Normungskunde, 36, pp. 99–138. Berlin, Germany: Beuth Verlag.
- Feenstra, R. C. and Taylor, A. M. (2008). International Economics. Basingstoke, UK: Palgrave-Macmillan.
- Festing M., Eidems J. (2011). A process perspective on transnational HRM systems — a dynamic capability-based analysis. *Human Resource Management Review*, 21, pp. 162–73.
- Fortanier F., Kolk A., Pinkse J. (2011). Harmonization in CSR reporting. *Management International Review*, 51, pp. 665–696.
- Gawer A., Cusumano M.A. (2013). Industry Platforms and Ecosystem Innovation. *Journal of Product Innovation Management*, 31 (3), pp. 417-433.
- Gereffi G., Humphrey J., Sturgeon T. (2005). The governance of global value-chains. *Review of International Political Economy*, 12 (1), pp. 78–104.
- Gereffi G., Lee J. (2012). Why the World Suddenly Cares About Global Supply Chains. *Journal of Supply Chain Management*, 48(3), pp. 24–32.
- Gibbon P., Ponte S. (2005). Trading Down: Africa, Value-chains and the Global Economy. Philadelphia, PA, USA: Temple University Press.
- Großmann A.-M.C, Gruben P.-V. von (2014). The Role of Company Standards in Supply Chains – The Case of The German Automotive Industry. In T. Blecker (Ed.), Innovative Methods in Logistics and Supply Chain Management: Current Issues and Emerging Practices, pp. 99-121. Berlin, Germany: epubli GmbH.
- Großmann A.-M.C., Gruben P.-V. von, Lazina L.K. (2016). Strategic Development and Implementation of Company Standards. In Jakobs K. (Ed.), Effective Standardization Management in Corporate Settings, pp. 77–104. Hershey, PA, USA: IGI Global.
- Guler I., Guillén M.F., Macpherson J.M. (2002). Global competition, institutions, and the diffusion of organizational practices: the international spread of ISO 9000 quality certificates. *Administrative Science Quarterly*, 47, pp. 207–232.
- Jaffee S., Masakure O. (2005). Strategic use of private standards to enhance international

- competitiveness: vegetable exports from Kenya and elsewhere. *Food Policy*, 30, pp. 316–333.
- Joseph F., Manchin M., Norberg H., Pindyuk O., Tomberger P. (2013). Reducing Trans-Atlantic Barriers to Trade and Investment: An Economic Assessment. Final Project Report. Centre for Economic Policy Research (CEPR), London, UK. Available at: goo.gl/ttRFxd.
- Kaplinsky R. (2010). The Role of Standards in Global Value-chains. *Policy Research Working Papers*, No. 5396, World Bank, Washington, D.C., USA.
- Krugman, P. (1995). Growing World Trade: Causes and Consequences. *Brookings Papers on Economic Activity*, 25(1), pp. 327-362.
- Krugman P. R., Obstfeld M. (2008) International Economics: Theory and Policy (7th ed.). Upper Saddle River; NJ, USA: Prentice Hall.
- Moenius J. (2006). International Standardization as a Strategic Tool: Do National Standards Hinder or Promote Trade in Electrical Products. IEC – Geneva, Switzerland, mimeograph.
- Nadvi K., Wältring F. (2004). Making sense of global standards. In H. Schmitz (ed.), *Local Enterprises in the Global Economy*. Cheltenham, UK: Edward Elgar.
- OECD (2016). OECD Factbook 2015-2016: Economic, Environmental and Social Statistics. Paris, France: OECD Publishing.
- Prahalad C.K., Doz Y. (1987). *The Multinational Mission: Balancing Local Demands and Global Vision*. New York, USA: Free Press.
- Roth K., Morrison A.J. (1990). An empirical analysis of the Integration-Responsiveness framework in global industries. *Journal of International Business Studies*, 21, pp. 541–564.
- Swann G. P. (2000). The Economics of Standardisation. Final Report for Standards and Technical Regulations Directorate Department of Trade and Industry, 11 December. Available at <https://goo.gl/cwBXW6>.
- Swann G.P. (2010). International Standards and Trade: A Review of the Empirical Literature. *OECD Trade Policy Papers*, No. 97, OECD Publishing, Paris, France.
- Swann G. P., Temple P. and Shurmer M. (1996). Standards and Trade Performance: the UK Experience. *The Economic Journal*, 106(438): pp. 1297-1313.
- Smith G. (2009). Interaction of public and private standards in the food chain. *OECD Food, Agriculture and Fisheries Papers*, No. 15, OECD Publishing, Paris, France.
- United Nations (2015). International classification of non-tariff measures. United Nations Conference on Trade and Development, UNCTAD/DITC/TAB/2012/2/Rev.1.

2. Drivers of Companies' Participation in Supranational Standardization

***Abstract:** Companies follow various motivations to participate in standardization. This study expands the limited literature by using information about companies active in German standardization committees to test the relevance of industry and firm specific factors. The volume of exports and the pool of industry knowledge outside of Germany positively influence companies' involvement in supranational standardization. While no relationship can be established between the European regulatory regime and the likelihood to standardize, the number of regulatory barriers outside of Europe is negatively related to international standardization. Finally, market power has no significant impact on companies' supranational standardization activities, but the availability of resources and duration of participation are robust explanatory factors. Despite the data limitations, the findings reveal interesting insights for standardization management and policy making.*

2.1. Introduction

Several studies confirm the economic significance of formal standards because of their impact on growth and international business (e.g. Swann, 2010a, 2010b, 2000; Blind and Jungmittag, 2008; Blind, 2004; DIN, 2000). While the application of national standards can create competitive advantages abroad (Moenius, 2006; Blind, 2001), the harmonization of standards reduces barriers to trade and thereby enhances exports and FDI. International standards provide recommendations for best practice and can complement national technical regulations. In the EU, the New Approach (New Legislative Framework) (European Commission, 2016) establishes a close relationship between regulation and standardization. Several European directives and regulations refer to harmonized European standards that are developed in consensus-based decision-making processes involving representatives from all European countries. The potential economic benefits of national and international standards for companies and consumers are substantial (Blind, 2004; Swann, 2000, 2010b). However, high implementation cost and reduced variety can result in lower profits. Smaller and less-innovative companies may particularly suffer from prevailing standards that have been established with the aim to increase costs of competitors (Salop and Sheffman, 1983). The negative effects of standards are magnified if legislation refers to standards that are the expression of interests of producers rather than consumers.

Given the major potential impacts of standards on society, it is important to understand the characteristics of the companies that influence globally diffusing standards as well as the industry-specific factors affecting firms' decision to participate in standardization processes. However, companies' motivation to participate in standardization has in contrast to patenting only recently attracted researchers' interest (Choi et al., 2011). A pioneer work is the company survey-based study by Blind and Mangelsdorf (2016) that uses the subjective assessments of managers responsible for standardization to determine the various types of strategic interests to join standard-setting organizations. It is the first empirical study that develops a taxonomy of drivers for companies' involvement in standardization. The authors identify the following five motives to standardize: access to markets and knowledge, influence on regulation, promotion of company interest, and problem solution.

The present study applies the insights on the strategic motives of firms to participate in standards development to a higher aggregate level. The analysis attempts to offer empirical validation of the previous findings on the drivers for participation in standardization on different regional levels using industry specific indicators. It thereby extends the horizon of the study by Blind and Mangelsdorf (2016), which focuses on the electrotechnical and mechanical engineering

sectors in Germany – industries operating under special framework conditions. Based on industry-level data from nine different sectors, this study empirically investigates the drivers of participation in European and international standardization processes. The remainder of this paper is organized as follows. The next section provides an overview of the existing literature on the motives for standardization and develops the theoretical concept. Section 3 introduces the empirical analysis and reports the results. The final part of the paper discusses the limitations of the analysis and summarizes the findings.

2.2. Drivers for Participation in Standardization Processes

Blind and Mangelsdorf (2016) identify five motives to standardize: access to markets and knowledge, influence on regulation, promotion of company interest, and problem solution.

Market Access

In the literature about strategic alliances (e.g. Blind and Mangelsdorf 2013, 2016), access to markets is identified as a motive to join strategic alliances that facilitate entry into foreign markets (Beeby and Booth, 2000). This is especially true for firms active in network industries, like telecommunication, transportation, and computer software and hardware that try to set common compatibility standards in order to achieve access to international markets. Increasing the compatibility of products with complementary products allows firms to exploit direct and indirect network externalities. Empirical studies (e.g. Blind, 2006; Blind and Mangelsdorf, 2013; Wakke et al., 2015) reveal that companies active in exporting are more likely to join standardization activities, because strategically important decisions, such as the development of standards related to market access, occur at the supranational level. Accordingly, the relationship between supranational standardization activities and trade volume is expected to be positive.

Knowledge Acquisition

While strategic alliances are already accepted as an efficient mechanism for transferring and exchanging knowledge among firms (Kogut, 1988; Hamel, 1991; Buckley et al., 2009; Grant and Baden-Fuller, 2004), this characteristic has only recently been attributed to standardization. Narayanana and Chen (2012), for example, identify knowledge acquisition as one of the companies' motives to join standard-setting organizations. Through the standardization process, companies can supplement their own research and development (R&D) with access to the technological developments of other firms and benefit from unintended knowledge spillovers (Blind, 2006). Participation in strategic alliances allows firms to access other firms' technological

know-how, which reduces the time to develop new products and introduce them to market (Delcamp and Leiponen, 2014). Hawkins (1999) identifies standardization consortia as a strategy for companies to pool their knowledge. In addition, the participation of research institutes and universities in standard-setting leads to the integration of up-to-date scientific and technological knowledge in the standards' specification (Blind and Gauch, 2009), and thereby increases knowledge gains from standardization. Blind and Mangelsdorf (2013, 2016) find empirical evidence for this line of argument. The incentives for participation in standardization in order to gain access to industry knowledge increase with the size of the knowledge pool. However, the use of this strategy also depends on the availability of alternative mechanisms for knowledge cooperation, such as direct bilateral collaboration or joint ventures. Participation in standardization might endanger a company's competitive advantage if a competitor's solution is preferred or too much proprietary information is unintentionally revealed during standard-setting processes. Accordingly, more innovative firms might have less incentives to be involved in standardization work at standard bodies.

Influence on Regulation

Firms participating in standardization are also interested in influencing the regulatory framework conditions, which is known as regulatory capture (Laffont and Tirole, 1991). This is especially true for firms in Europe producing under New Approach Directives. The New Approach in the European Union, subsequently developed further to the New Legislative Framework (European Commission, 2016), delegates responsibilities for setting market rules to private institutions such as European standardization organizations. Whereas 'essential requirements' like the protection of health, safety, and the environment are defined in European Directives, firms in European standards bodies are required to define technical specifications in 'harmonized standards' that meet the requirements of these New Approach Directives (Egan, 2002). Firms participating in consensus-based decision-making processes in standard bodies have incentives to define technical specifications that are favorable for both their own profits and the whole industry. Blind et al. (2017), for example, reveal some kind of regulatory capture related to standardization in already settled markets. Consequently, the availability of harmonized European standards in an industry increases opportunities and incentives for companies to get involved in European standardization and thereby shape the regulatory environment for their products and services.

No similar relationship between regulation and formal standardization exists on the international level. However, international standards may be complementary, or even substitutionary to national technical regulations if standards are used as a reference in legislation.

For example, Löhe and Blind (2015) present the case of international standards for data security in the cloud implemented as legal regulation in South Korea. Accordingly, designing industry-friendly requirements represents an incentive to participate in international standard-setting.

Promotion of Company Interest

In rather fragmented sectors with numerous smaller stakeholders involved in standardization, both consensus-building and promotion of own interests become very difficult. In contrast, a smaller number of players in heavily concentrated industries could be a better precondition to reach consensus and efficiently reflect company-specific interests. Market concentration, thus, is expected to be positively correlated with participation in standardization.

Due to higher availability of resources, company size plays an important role for companies' involvement in standardization in general (Blind 2006, Blind and Mangelsdorf 2013, Wakke et al. 2015), and in particular for the time-consuming and costly European and international activities.

Another driver to join standardization processes arises from the company's size in relation to its competitive environment. Large companies operating in very competitive industries might use their influence on the regulatory framework to reduce the competitive pressure, e.g. by building market barriers through the development of standards that raise competitors' costs (Salop and Scheffman, 1987). Accordingly, large companies in less concentrated industries that exert high market power are expected to be more active than large companies in more concentrated industries. They are also expected to be more active than small companies in more fragmented environments, for which standardization can help to reduce technological and market risks resulting from a highly competitive environment. Small companies in highly concentrated markets are expected to have the lowest likelihood of participating in supranational standardization.

Problem Solution

The factor 'technical solution' refers to the interest of firms to solve company- and industry-specific technical problems. Solving technical problems within standardization processes constitutes a strategic decision by firms that is hard to measure by means of industry-level variables. However, since this motive is likely to drive participation on all regional levels to the same extent, it is excluded from the following analysis.

2.3. Empirical Analysis

2.3.1. Data and Variable Description

The empirical analysis is based on data about participation in European and international standardization committees of experts engaged in standardization work at DIN in 2016. The data set contains 5,710 experts representing 3,130 companies in production industries. 62% of the companies are involved only in German standardization processes, 16% are engaged on the national and European level, 13% on the national and international level and 10% participate in committees on all regional levels. Two specifications of the binary dependent variables measure additional participation in European or international standardization (see Table 2.1). The first specification compares firms that are active only on the national level with those participating in standardization on the national and one of the supranational levels. Group E1 and group I1 thus include companies with a stronger national or regional focus. The second specification considers differences among firms with greater exposure to international markets by comparing companies involved on the national and European level (group I2), or the national and international level (group E2) with those engaged on all regional levels.

Table 2.1: Specifications of the dependent variables

	European participation		International participation	
	Group E1 (N = 2,448)	Group E2 (N = 682)	Group I1 (N = 2,324)	Group I2 (N = 806)
	N vs. N+E	N+I vs. N+E+I	N vs. N+I	N+E vs. N+E+I
Description	0 if participation only on the national level (n = 1,933; 79 %)	0 if participation on the national and international level (n = 391; 57 %)	0 if participation only on the national level (n = 1,933; 83 %)	0 if participation on the national and European level (n = 515; 64 %)
	1 if participation on the national and European level (n = 515; 21 %)	1 if participation on all regional levels (n = 291; 43 %)	1 if participation on the national and international level (n = 391; 17 %)	1 if participation on all regional levels (n = 291; 36 %)

The data set also provides information about the number of employees, industry, and first year of participation. Firm-level patent stocks were matched from the PATSTAT database (European Patent Office, 2017). The 3,130 firms in the sample on average employ 2,742 persons, initially participated in standardization committees in 2010, and hold 109 patents (see Table 2.2). The data allows differentiation between nine sectors. Nearly 30% of the companies in the sample operate in mechanical engineering, 20% in electrical and medical engineering. The primary and

food sector and the energy and water supply, and oil (EWS) sector are least represented in the sample.

The main challenge of this study is to identify possible sources for industry-level data on the drivers for participation in standardization as identified by Blind and Mangelsdorf (2016). Table 2.2 reports definitions, sources, and descriptive statistics of all independent variables considered to explain the likelihood of a firm to be additionally involved in supranational standard-setting.

Industry-level data measuring access to markets and knowledge was obtained from the OECD.Stat database. Market access on the European and international level is captured by the share of an industry's intra- and extra-EU trade in total trade.² Intra-EU exports of the nine industries altogether account for 35% of Germany's total trade, extra-EU exports for 32% of Germany's total trade. Table 2.3 indicates that the highest share of intra-EU trade in total trade is observed for the automotive industry, followed by manufacturing of chemical, pharmaceutical, rubber, and plastic products (CPRP). Infrastructure and construction firms show the lowest trade volumes. On the international level, the automotive engineering and mechanical engineering industries export most of their production while the lowest shares of extra-EU trade in total trade result for the construction and primary and food sectors.

The stocks of granted patents at the European Patent Office (EPO) on the European and international level by areas of technology³ indicate the knowledge pools companies can access outside of the national borders. The share of granted patents on a certain regional level in world patents, therefore, serves as an indicator for the potential to acquire knowledge on the respective regional level in that industry ('knowledge-seeking'). The aggregated number of patents granted to firms located in EU27 countries (excluding Germany) in 2014 on average account for 30% of total patents granted at the EPO, non-EU for 48%. The figures reported in Table 2.3 reveal that almost 50% of the patents in the construction industry are granted to firms in the EU27-countries, only 20% are granted to firms located in the non-EU28 countries. The majority of patents in electrical and medical engineering and CPRP is held by companies located outside of the EU.

² Data on trade volume is available on 2-digit level of ISIC Rev. 4 industry classification. The aggregates according to the industry classes as reported in Table 2.3 are the weighted averages of trade shares across subindustries.

³ Data on patent grants is available for IPCV8 classification of technologies and was summed up to 2-digit level of NACE Rev. 2 following the correspondence tables provided by Eurostat (Van Looy et al. 2015).

Table 2.2: Definition and descriptive statistics of all independent variables

Variable	Description	Source	Unit	N	Mean	Sd	Min	Max
inEUtrade	Access to European markets: share of German intra-EU trade in total trade by industry, 2013	OECD data	industry level	3,130	0.041	0.020	0.001	0.096
exEUtrade	Access to international markets: share of German extra-EU trade in total trade by industry, 2013		industry level	3,130	0.041	0.027	0.001	0.120
relEU27pat	Access to European knowledge: EU27 patent grants (excl. Germany) divided by world patent grants by industry, 2014		industry level	3,130	0.293	0.069	0.234	0.492
relRowpat	Access to international knowledge: International patent grants (excl. EU28) divided by world patent grants by industry, 2014		industry level	3,130	0.477	0.106	0.201	0.600
HScited	Influence on European regulation: Number of HS cited in the OJEU by business domain, 2015	CEN-CENELEC	industry level	3,130	413.8	300.1	0	812
NTMworld	Influence on international regulation: Number of NTMs imposed by World (excl. EU) on Germany by industry, March	UNCTAD TRAINS	industry level	2,925	116.9	262.0	13	1,303
power	Market power: dummy for firms with more than 250 employees in industries with below-average market concentration		firm level	3,130	0.155	0.362	0	1
CR6	Concentration rate (CR6): weighted average of share in sales of six largest companies in Germany, 2014	Destatis report	industry level	3,130	26.32	19.56	7.474	85.20
lnempl	Log number of employees	DIN	firm level	3,130	5.252	2.003	0	13.32
patents	Patent stock of the firm			3,130	109	1,318	0	42,286
yrentry	First year of participation in standardization			3,130	2010	4.212	2002	2016

On the European level, the variable measuring influence on regulation is the number of harmonized standards (HS) cited or intended for citation in the Official Journal of the European Union (OJEU) in different business domains (CEN and CENELEC, 2017). The existence of HS relates to the application of the New Approach (Borraz, 2007), as standards specify the details of European regulations and directives, and thereby provides firms with the opportunity to shape the European regulatory framework within the NLF. The highest number of HS cited or intended for citation in the OJEU exists in mechanical engineering, followed by the consumer goods and construction industries. No HS are reported in the field of 'metal and steel production'.

Table 2.3: Descriptive statistics of the main explanatory variables by industry

Industry description		N	Access to markets	Influence on regulation	Access to knowledge	Market concentration
Primary sector, food products, tobacco	E	130	0.03	0	0.40	11.58
	I		0.007	1303	0.48	
Consumer goods	E	218	0.03	554	0.32	16.30
	I		0.02	98	0.44	
CPRP	E	358	0.06	67	0.23	30.79
	I		0.05	197	0.59	
Metal and steel production and processing	E	401	0.04	0	0.32	14.99
	I		0.02	79	0.38	
Electronics, electrical and medical engineering	E	615	0.04	401	0.25	34.64
	I		0.04	40	0.60	
Mechanical engineering	E	869	0.04	812	0.26	14.00
	I		0.06	21	0.47	
Automotive engineering	E	182	0.10	329	0.26	67.84
	I		0.12	13	0.42	
EWS, oil	E	152	0.02	262	0.38	85.2
	I		0.01	25	0.48	
Construction	E	205	0.001	480	0.49	7.47
	I		0.001		0.20	

On the international level, the number of NTMs imposed by non-EU countries and affecting Germany serves as a proxy for the degree of international market regulation faced by German companies. Detailed information on various types of NTMs based on official regulations differentiated by product classes (HS 2-digit) is available from the updated UNCTAD Trade Analysis Information System (TRAINS) database (United Nations, 2005). The market regulation variable includes sanitary and phytosanitary measures, TBTs, pre-shipment inspections,

contingent trade-protective measures, price control measures, quantity control measures, and export-related measures imposed on Germany by 38 countries. Because absolute values deviate substantially between industries, world aggregates are weighted by the share of the respective industry in German extra-EU trade. German firms on average face 117 NTMs when operating in non-EU countries. The primary and food and CPRP sectors show the highest degrees of market regulation, indicated by the number of NTMs. The lowest number of NTMs is observed for the automotive engineering industry.

The fourth driver, promotion of company interest, captures companies' potentials to influence standardization processes. Firms with high market power are expected to invest in standardization activities to pursue their own interest. This factor is captured relating the firm's potential power to the power of other actors in the same industry. More precisely, market power is assumed to be reflected by the relative size of a firm in its environment since large firms operating in markets with many small competitors can exert more influence than large firms in highly concentrated markets, or than small firm. The Federal Statistical Office of Germany (2016) published concentration rates of industries measuring the share in sales of the six largest companies in each sector⁴ in Germany in 2014. The data implies that the industries EWS and automotive engineering are the most concentrated sectors in Germany. The lowest shares in sales of the six largest companies are reported for the primary and food sector and mechanical engineering. The measure for market power is a binary variable indicating large firms operating in markets with below-average concentration levels. According to this measure, 16% of the firms in the sample have significant market power in Germany.

Descriptive statistics of the independent variables by categories of the dependent variables are depicted in Table 2.4. The lowest average levels of industry trade result for the group of firms that participate in national standardization only (N). Firms that in addition participate in European standard bodies (N+E) operate in industries that on average export most within the EU. The highest share of extra-EU in world industry trade is reported for firms that are involved in national and international standardization (N+I), the lowest for those only engaged nationally.

Companies that only participate in national standard organizations more often operate in industries with a high relative stock of patents granted in EU27 countries. Firms that additionally attend international committees (N+I) show the lowest stock of knowledge on the European level, but the highest on the international level. They furthermore show the greatest degree of industry concentration in Germany but face the lowest number of NTMS imposed by non-EU countries.

⁴ Data on market concentration is available on 2-digit WZ08 industry classification. The aggregates according to the industry classes as reported in Table 2.3 are weighted averages using share of sales of the respective subindustry.

Table 2.4: Group mean values of independent variables and t-test statistics

Variable	Group E1			Group E2		
	N	N+E	p-value	N+I	N+E+I	p-value
Observations	1,933	515		391	291	
inEUtrade	0.039	0.043	0.000	0.046	0.046	0.743
relEU27pat	0.299	0.292	0.031	0.269	0.279	0.013
HSscited	413.6	417.9	0.783	412.4	409.2	0.888
power	0.141	0.171	0.101	0.156	0.223	0.028
CR6	25.52	24.34	0.203	30.84	29.10	0.255
lnempl	4.923	5.262	0.000	5.776	6.721	0.000
patents	28.96	68.83	0.099	151.9	654.9	0.039
yrentry	2010	2009	0.000	2009	2008	0.000

Variable	Group I1			Group I2		
	N	N+I	p-value	N+E	N+E+I	p-value
Observations	1,933	391		515	291	
exEUtrade	0.038	0.049	0.000	0.043	0.047	0.058
relRowpat	0.469	0.509	0.031	0.471	0.498	0.000
NTMworld	115.2	75.05	0.000	145.5	135.0	0.643
power	0.141	0.156	0.431	0.171	0.223	0.076
CR6	25.52	30.84	0.000	24.34	29.10	0.001
lnempl	4.923	5.778	0.000	5.262	6.721	0.000
patents	28.96	151.9	0.004	68.83	654.9	0.016
yrentry	2010	2009	0.000	2009	2008	0.000

The highest average number of harmonized standards and the largest number of international export barriers results for companies participating in national and European standardization (N+E). Firms that participate on all regional levels are on average the most powerful, most experienced in standardization, and report the highest numbers of patents and employees. The opposite is true for the group of firms exclusively active on the national level.

2.3.2. Empirical Model and Results

Logistic regression is applied to estimate the impact of various factors on participation in supranational standardization measured by binary variables.

Following Hosmer et al. (2013), the probability that the binary response variable, Y , equals one is:

$$\pi(x) = Pr[Y = 1|x] = \frac{e^{x'\beta}}{1 + e^{x'\beta}} \quad 1)$$

where x' is the vector of covariates, and β is the vector of coefficients. The logit transformation is given by:

$$g(x) = \ln \left[\frac{\pi(x)}{1 - \pi(x)} \right] = x'\beta + \varepsilon \quad 2)$$

Parameters are estimated using maximum likelihood estimation, which maximizes the likelihood function that is defined as follows:

$$l(\beta) = \prod_{i=1}^n \pi(x_i)^{y_i} [1 - \pi(x_i)]^{1-y_i} \quad 3)$$

The results for the different specifications of the dependent variables are reported in Table 2.5. The first specification analyzes drivers for participation in supranational standardization in addition to national standardization: Companies involved exclusively in national standardization are compared to companies active either in national and European standard-setting organizations (column I of Table 2.5) or in national and international standard bodies (columns III and V of Table 2.5). Columns II, IV, and VI report the estimation results for additional participation in European and international standardization among companies with a more international focus. More precisely, companies engaged in standardization work at at least one supranational standard-setting organization are compared with firms active on all regional levels.

In addition to the measures for the four factors influencing firms' participation in standardization identified by Blind and Mangelsdorf (2016), further control variables are included in the regression model. Firm patent stock captures the impact of the innovativeness of a firm and its absorptive capacity (Cohen and Levinthal, 1990). The number of employees indicates the availability of resources, the year of first participation expresses a firm's experience with standardization.

In order to test the robustness of the results for participation in international standardization towards outliers, column V and VI exclude 130 companies operating in the primary and food sectors, where the number of NTMs imposed on Germany is far larger than that of other sectors. This exclusion does not affect estimation results. Likewise, excluding observations that were identified as outliers by plotting deviance residuals against the estimated logistic probability (Sarkar et al., 2011) does not influence the results (see Table 2.7 in the Appendix). Table 2.6 illustrates that model statistics imply that the models fit the data well. All models pass the Pearson χ^2 goodness-of-fit test and the link test, but the statistics indicate

problems regarding the specification for Model 2. The results, therefore, have to be interpreted with caution. Classification analysis reveals that regressions for additional participation in international standardization versus only national standardization perform especially well in correctly classifying the observations. Model 2 again performs most poorly. Finally, pairwise correlations provide no indication for multicollinearity.

The estimation results for the drivers of firms' participation in supranational standardization in Germany suggest that companies in industries with a relatively large share of German intra-EU trade are more likely to be involved in European standardization (in addition to national standardization) than exclusively in national standardization. The same relation can be observed on the international level. The results imply that exporting within the EU increases the likelihood to participate in European standardization (in addition to national-level standardization) compared to national standardization alone. However, the analysis does not allow conclusions about the direction of causality.

Among the firms that participate in at least one of the supranational standard bodies, market access is not confirmed to be a significant driver for additional participation. In other words, export volume is an explanatory factor for participation in supranational standardization only when compared to participation exclusively on the national level.

No significant relationship can be confirmed between the number of harmonized standards in an industry and additional participation in European standardization. In contrast, the variable measuring the level of international regulation is negatively related to the involvement in standardization processes on the international level. This implies that firms facing lower levels of industry-level regulation outside of Europe are more likely to participate in international standardization committees. High regulatory barriers in product markets might distract companies from being active in standardization because they expect to have little influence on regulatory framework conditions by shaping international standards. The alternative, but less likely explanation is that the level of regulation is high in those industries because the participation in international standardization is low. However, based on this analysis, no conclusions can be drawn about the direction of causality.

In line with the hypothesis on 'knowledge-seeking', the results indicate that the likelihood of being engaged in both European and international standardization is higher when the knowledge pool in that industry is more developed. The results confirm the perception that standardization is used as a tool to absorb knowledge if companies are geographically dispersed.

Table 2.5: Logistic regressions for additional participation in supranational standardization

Variables	I Group E1	II Group E2	III Group I1	IV Group I2	V Group I1	VI Group I2
Market access	19.83*** (4.11)	1.48 (5.43)	10.23*** (2.45)	-1.09 (3.41)	10.18*** (2.46)	-2.12 (3.47)
Knowledge seeking (pat_reg)	2.44** (1.14)	4.31** (1.98)	3.70*** (0.77)	4.33*** (1.09)	4.04*** (0.82)	5.85*** (1.28)
Regulation	0.00 (0.00)	0.00 (0.00)	-0.001* (0.00)	-0.00 (0.00)	-0.002* (0.00)	-0.004** (0.00)
Market power	-0.10 (0.17)	-0.17 (0.29)	0.02 (0.19)	0.18 (0.24)	-0.07 (0.21)	0.04 (0.28)
Patents firm (pat_firm)	0.00 (0.00)	0.00 (0.00)	0.0005** (0.00)	0.00 (0.00)	0.0005** (0.00)	0.00 (0.00)
Market concentration (CR 6)	-0.01*** (0.00)	-0.01** (0.01)	0.00 (0.00)	0.00 (0.01)	0.00 (0.00)	0.00 (0.01)
Size	0.09*** (0.03)	0.23*** (0.05)	0.20*** (0.03)	0.33*** (0.05)	0.21*** (0.03)	0.37*** (0.05)
Year of entry	-0.05*** (0.01)	-0.05*** (0.02)	-0.05*** (0.01)	-0.05*** (0.02)	-0.05*** (0.01)	-0.05** (0.02)
Constant	105.5*** (24.03)	104.3*** (38.82)	96.7*** (27.09)	97.7** (39.5)	90.1*** (28.1)	85.2** (41.35)
Observations	2,448	682	2,150	775	2,067	728

Note: Standard errors in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

The fourth factor, market power, does not significantly affect the likelihood of participating in European or international standardization. In contrast, the number of employees is a highly robust predictor, confirming the conclusion of many other studies that size is relevant regarding the ability to raise resources for participation in standardization. The results suggest that European standardization bodies' governance works efficiently because no evidence is provided that large firms with high market power form standardization cartels by excluding less powerful competitors. However, the absence of correlative effects possibly results from a lack of data on industry market concentration in Europe and worldwide. If market power in Germany does not translate into market power in European and international markets, domestic market power is not expected to affect participation on higher regional levels.

While the stock of patents owned by a company does not significantly influence the likelihood of involvement in standard-setting processes on the European level, it is a significant driver for companies' additional participation in international standardization (as compared to

participation exclusively in national standardization). This result does not apply to international firms already involved in European standardization.

On the European level, market concentration is negatively correlated with the likelihood of participating in standardization. The effect is mainly driven by the lower likelihood of infrastructure firms, like water or energy suppliers that were or still are national monopolies, to be involved in European standardization bodies. The concentration rate of the industry in Germany is not related to firms' participation in international standardization.

Finally, as expected, the likelihood to standardize increases with standardization experience on the national level. Apparently, experience in national standardization is a prerequisite for becoming active on the European or international level. The result is robust towards the truncation of entry before 2002, for which it is unclear whether those companies are not included in the dataset at all or are subsumed in the 2002 category. We considered two possible ways to check for robustness: 1) excluding this category entirely, and 2) replacing the continuous variable with a tripartite, categorical one indicating participation since less than six years, six to ten years, and 10 to 15 years. In all specifications, the positive effect is highly significant.

Table 2.6: Model statistics

Variables	1	2	3	4	5	6
Wald Chi-Square statistic	70.58	55.40	142.67	109.24	135.26	115.48
Prob > chi2	0.000	0.000	0.000	0.000	0.000	0.000
Goodness-of-fit test	0.38	0.34	0.18	0.36	0.16	0.24
Correctly classified	78.9 %	64.4 %	82.1 %	70.5 %	81.9 %	71.4 %
Linktest	passed	not passed	passed	passed	passed	passed
McFadden's R2	0.03	0.06	0.07	0.11	0.07	0.12

2.4. Discussion and Conclusion

While model statistics imply that the models fit the data well, low pseudo-R2 values indicate that the factors considered in the models do not fully explain variation in participation in supranational standardization between firms, especially on the European level. There are various potential reasons for the low explanatory power of the model specifications.

The underlying data set does not provide information on all experts involved in national committees but only those who agreed that confidential information may be shared. If not all experts are observed for the companies, firm-level variables on participation on the European and international level are potentially biased.

Due to the high level of aggregation of industries, the impact of outliers could be substantial. This problem is magnified by the lack of data on market regulation for the manufacturing sector and the number of patent grants in service industries. Even though the findings are robust towards excluding extreme values, future research based on a finer segregation of industries is required to validate the results.

Finally, the UNCTAD TRAINS NTMs database provide only limited information about market regulation in China. The NTM measure, therefore, possibly does not include the number of NTMs imposed by the second-most important export country for Germany outside of Europe. Since data on the most important trading partner, the United States of America, is available, the results are still highly relevant for understanding drivers of international standardization. With more data for China becoming available, it would be interesting to see if heterogeneous effects for regulation regarding different trading partners exist.

Despite these limitations, the presented analysis provides empirical support for some of the key drivers for supranational standardization identified in previous studies. It also generates new insights relevant for both standardization policy and management. Firstly, the export volume of the industry is positively related to the additional involvement in European or international standard bodies (as compared to participation exclusively on the national level). The direction of causality of the relationship between market access and standardization activities, however, is not clear. Market access is not sufficient in explaining additional participation among firms already engaged in supranational standardization.

Secondly, the large pool of industry knowledge outside of Germany is related to participation in supranational standardization. The results are in line with the perception that standardization is a 'knowledge seeking' strategy for companies because it allows them to acquire knowledge from standard-setting processes and complement their own know-how.

The results further suggest that participation in supranational standard bodies is not affected by market power inequalities. The availability of resources in large companies and experience in standardization increases the likelihood to standardize on the European and international level.

Finally, contrary to expectations, the established regulatory regime in Europe has no significant impact on a firm's likelihood to undertake European standardization activities, while regulation of export markets on the international level is negatively related to participation in international standard bodies. Regarding the latter, it is unclear whether high regulatory barriers in product markets prevent companies from becoming active in standardization, or whether regulatory barriers exist because firms in these sectors are less engaged in standardization. If they expect to have little influence on the regulatory framework conditions by shaping international

standards, implementation of a complementary relationship between regulation and standardization as within The New Approach could reduce the disincentives of high regulatory barriers for standardization, thereby increasing companies' ability to shape the regulatory environment for their products and services. The latter is also relevant with respect to small and medium-sized firms. While firm size is a relevant factor in raising the required resources for participation in standard-setting processes, there is no indication that large firms with high market power form standardization cartels by excluding less powerful competitors. The results thus imply that the participation of small and medium-sized firms could be encouraged through financial incentives. In this case, however, policy makers, but not standardization researchers, are needed to find effective solutions.

2.5. References

- Beeby M., Booth C. (2000). Networks and Inter-organizational Learning: A Critical Review. *The Learning Organization*, 7(2), pp. 75-88.
- Blind K. (2001). The Impacts of Innovation and Standards on Trade of Measurement and Testing Products: Empirical Results of Switzerland's Bilateral Trade Flows with Germany, France and the United Kingdom. *Information Economics and Policy*, 13(4), pp. 439-460.
- Blind K. (2004). The Economics of Standards. Theory, Evidence, Policy. Cheltenham, UK, Northampton, MA, USA: Edward Elgar.
- Blind K. (2006). Explanatory Factors for Participation in Formal Standardisation Processes: Empirical Evidence at Firm Level. *Economics of Innovation and New Technology*, 15(2), pp. 157-170.
- Blind K., Gauch S. (2009). Research and Standardisation in Nanotechnology: Evidence from Germany. *Journal of Technology Transfer*, 34(3), pp. 320-342.
- Blind K., Jungmittag A. (2008). The Impact of Patents and Standards on Macroeconomic Growth: A Panel Approach Covering Four Countries and 12 Sectors. *Journal of Productivity Analysis*, 29(1), pp. 51-60.
- Blind K., Mangelsdorf A. (2013). Alliance Formation of SMEs: Empirical Evidence from Standardization Committees. *IEEE Transactions on Engineering Management*, 60(1), pp. 148-156.
- Blind K., Mangelsdorf A. (2016). Motives to Standardize: Empirical Evidence from Germany. *Technovation*, 48-49, pp. 13-24.
- Blind K., Petersen S.S., Riillo C.A.F (2017). The Impact of Standards and Regulation on Innovation in Uncertain Markets. *Research Policy*, 46, pp. 249-264.

- Borraz O. (2007). Governing Standards: The Rise of Standardization Processes in France and in the EU. *Governance: An International Journal of Policy, Administration, and Institutions*, 20(1), pp. 57-84.
- Buckley P.J., Glaister K.W., Klijn E., Tan H. (2009). Knowledge Accession and Knowledge Acquisition in Strategic Alliances: The Impact of Supplementary and Complementary Dimensions. *British Journal of Management*, 20(4), pp. 598-609.
- CEN, CENELEC (2017). CEN-CENELEC Quarterly Statistical Pack - 2016 Q4. Available at: goo.gl/9gykeT.
- Cohen W.M., Levinthal D.A. (1990). Absorptive-capacity – A New Perspective on Learning and Innovation. *Administrative Science Quarterly*, 35(1), pp. 128–152.
- Delcamp H., Leiponen A. (2014). Innovating Standards through Informal Consortia: The Case of Wireless Telecommunications. *International Journal of Industrial Organization*, 36(C), pp. 36-47.
- DIN (2000). Economic Benefits of Standardization: Summary of Results. Berlin, Germany: Beuth Verlag GmbH.
- Egan M. (2002). Setting Standards: Strategic Advantages in International Trade. *Business Strategy Review*, 13(1), pp. 51-64.
- European Commission (2016). The 'Blue Guide' on the Implementation of EU Products Rules. *Official Journal of the European Union*, 59(C272).
- European Patent Office (2017). Data Catalog - PATSTAT Biblio and PATSTAT Legal Status. Available at: goo.gl/DKuHc5.
- Grant R.M., Baden-Fuller C. (2004). A Knowledge Accessing Theory of Strategic Alliances. *Journal of Management Studies*, 41(1), pp. 61-84.
- Hamel G. (1991). Competition for Competence and Inter-partner Learning within International Strategic Alliances. *Strategic Management Journal*, 12, pp. 83-103.
- Hawkins R. (1999). The Rise of Consortia in the Information and Communication Technology Industry: Emerging Implications for Policy. *Telecommunications Policy*, 23(2), pp. 159-173.
- Hosmer D.W., Lemeshow S., Sturdivant R.X. (2013). Applied Logistic Regression (3rd ed.). Hoboken, NJ, USA: John Wiley & Sons.
- Kogut B. (1988). Joint Ventures: Theoretical and Empirical Perspectives. *Strategic Management Journal*, 19, pp. 319-332.
- Löhe M., Blind K. (2015). Regulation and Standardization of Data Protection in Cloud Computing. *Proceedings of the 2015 ITU Kaleidoscope Academic Conference*, pp. 77-82.

- Laffont J.-J., Tirole J. (1991). The Politics of Government Decision-Making: A Theory of Regulatory Capture. *Quarterly Journal of Economics*, 106(4), pp. 1088-1127.
- Moenius J. (2006). International Standardization as a Strategic Tool: Do National Standards Hinder or Promote Trade in Electrical Products. IEC – Geneva, Switzerland, mimeograph.
- Narayanana V.K., Chen T. (2012). Research on Technology Standards: Accomplishment and Challenges. *Research Policy*, 41, pp. 1375– 1406.
- Sarkar S.K., Midi H., Rana S. (2011). Detection of Outliers and Influential Observations in Binary Logistic Regression: An Empirical Study. *Journal of Applied Sciences*, 11, 26-35.
- Salop S.C., Scheffman D.T. (1987). Cost-Raising Strategies. *Journal of Industrial Economics*, 36, pp. 19–34.
- Federal Statistical Office of Germany (2016). Konzentrationsstatistische Daten für das Verarbeitende Gewerbe, den Bergbau und die Gewinnung von Steinen und Erden sowie für das Baugewerbe. *Fachserie*, 4, Reihe 4.2.3 - 2013/2014.
- Swann G. P. (2000). The Economics of Standardisation. Final Report for Standards and Technical Regulations Directorate Department of Trade and Industry, 11 December. Available at: <https://goo.gl/cwBXW6>.
- Swann G.M.P. (2010a). International Standards and Trade: A Review of the Empirical Literature. *OECD Trade Policy Papers*, No. 97, OECD Publishing, Paris, France.
- Swann G.M.P. (2010b). The Economics of Standardization: An Update. Report for the UK Department of Business, Innovation and Skills (BIS), Version 2.2, 27 May 2010. Available at: goo.gl/MKQYAL.
- United Nations (2005). Methodologies, Classifications, Quantification and Development Impacts of Non-tariff Barriers. United Nations Conference on Trade and Development, TD/B/COM.1/EM.27/2. Available at: goo.gl/dVz9Tg.
- Van Looy B., Vereyen C, Schmoch U. (2015). Patent Statistics: Concordance IPC V8 – NACE REV.2 (version 2.0). Report prepared in collaboration with Sogeti Luxembourg S.A. and the European Patent Office (EPO). Available at: goo.gl/lzR3bk.
- Wakke P., Blind K., De Vries H. (2015). Driving Factors for Service Providers to Participate in Standardization: Insights from the Netherlands. *Industry & Innovation*, 22 (4), pp. 299-320.

2.6. Appendix

Table 2.7 Logit regressions excluding outliers

Variables	1	2	3	4
Market access	23.27*** (4.27)	2.21 (5.65)	13.91*** (2.67)	-1.50 (3.58)
Knowledge seeking (pat_reg)	2.83** (1.16)	5.43** (2.06)	5.69*** (0.87)	5.29*** (1.14)
Regulation	0.00 (0.00)	0.00 (0.00)	-0.002*** (0.00)	0.00 (0.00)
Market power	-0.16 (0.17)	-0.34 (0.29)	0.03 (0.21)	0.20 (0.25)
Patents firm (pat_firm)	0.00 (0.00)	-0.0002* (0.00)	0.001*** (0.00)	0.00 (0.00)
Market concentration (CR 6)	-0.01*** (0.00)	-0.01*** (0.01)	0.00 (0.00)	0.00 (0.01)
Size	0.12*** (0.03)	0.33*** (0.05)	0.28*** (0.04)	0.42*** (0.05)
Year of entry	-0.06*** (0.01)	-0.08*** (0.05)	-0.06*** (0.01)	-0.06*** (0.02)
Constant	109.9*** (24.32)	148.1*** (40.12)	108.0*** (29.73)	115.6*** (41.4)
Observations	2,435	664	2,099	752

Note: Standard errors in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

3. Beyond the Standard Practice: How to Remove Trade Barriers Arising from Standards within TTIP

***Abstract:** This study explores firm-level characteristics that influence companies' preferences regarding alternatives to harmonize standards within TTIP. Trade barriers arising from standards can be reduced by implementing common standards, developed on the international level or in bilateral negotiations, or mutually recognizing existing standards. Multivariate probit models are applied to GSP data to identify factors that explain differences in the perception of various harmonization solutions by German firms. The results of the empirical analysis indicate that three dimensions are relevant in this context: 1) company-specific factors, 2) the firm's position vis-à-vis other market participants, and 3) the dynamics of the market the company operates in. German firms expect significant benefits from full harmonization of standards with the US. Mutual recognition is expected to integrate markets quickly and promote profits from product differentiation. Development of specific EU-US standards combines the advantages of international standards and mutual recognition, but is rejected as a harmonization solution within TTIP.*

3.1. Introduction

In 2013, the EU and the USA, regions that account for more than one-third of world trade, entered negotiations over a regional free trade agreement of utmost economic significance: the TTIP. The US is one of the EU's most important trading partners and vice versa. In 2016, German companies exported USD 118 billion⁵ worth of goods to the US.

Negotiations in the framework of TTIP focus on removing NTMs, such as pre-shipment inspections, export quotas, or TBTs.⁶ Germany, as a heavily export-oriented country and business location for many transnationally linked firms, is expected to profit strongly from the further integration of markets through TTIP. Affected companies would have the opportunity to increase profits, and consumers in both countries would benefit from higher employment associated with trade liberalization. Consumers will not only gain from higher incomes due to a boost in employment but also from lower prices and increased product variety (e.g. Krugman and Obstfeld, 2008; Feenstra and Taylor, 2008).

The European Commission estimates potential gains from TTIP to be 120 billion Euro for the EU economy, 90 billion Euro for the US economy and 100 billion Euro for the rest of the world (Joseph et al., 2013). Other studies take a critical look at the existing literature and predict negative effects in the form of losses to net exports, GDP, and jobs (e.g. Capaldo, 2014). Nevertheless, the majority of studies conclude that the removal of NTMs in the framework of this agreement will result in increases in real income and trade on both sides of the Atlantic (e.g. Berden et al., 2009; Plaisier et al., 2012; Joseph et al., 2013; CEPR/BIS, 2013; Felbermayr et al., 2015; Egger et al., 2015). They also point out the importance of harmonizing formal standards that define product and process requirements of producers as well as consumers.

In the context of TTIP, three different harmonization pathways have been the subject of public debate: adoption of international standards, development of specific EU-US standards, and mutual recognition of existing standards. According to ISO, an international standard is a 'document, established by consensus and approved by a recognized body, that provides, for common and repeated use, rules, guidelines, or characteristics for activities or their results, aimed at achievement of the optimum degree of order in a given context' (ISO, 2004, p. 1). The harmonization of standards can significantly contribute to eliminating NTMs (Swann, 2010), especially when negotiations are conducted on the international level and include representatives of a large number of countries. Alternatively, the two countries involved in the trade agreement

⁵ OECD Quarterly International Trade Statistics, accessed on August 12, 2017.

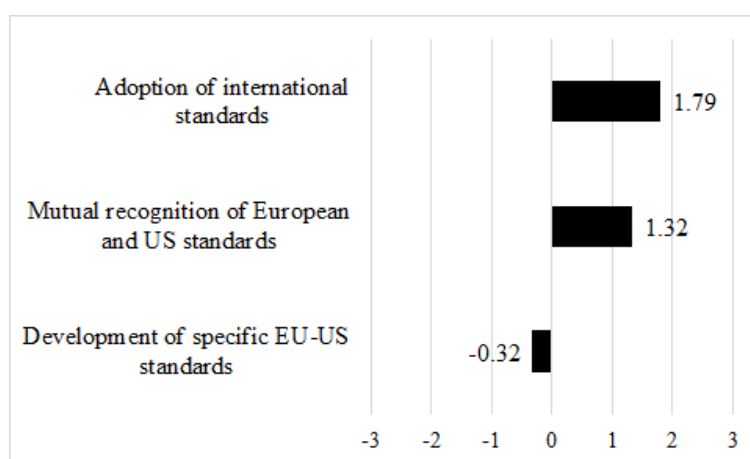
⁶ See Egan and Pelkman (2015) for a detailed description of the barriers addressed in TTIP.

could bilaterally develop uniform standards. The third approach to dismantle non-tariff trade barriers is the mutual recognition of standards (Chen and Mattoo, 2004; Baller, 2007), in particular if trade flows are low (Michalek et al., 2005). Because EU and US standards were considered equivalent, products could be freely traded even if the technical requirements set by the country of destination are not fully met (European Union, 2008).

Even though all of these options have different implications for firms and the economy, no studies analyze how to remove barriers arising from standards in the framework of TTIP. In order to fill this research gap, this study explores data from the GSP in 2013. In the special section of the questionnaire, companies were asked to assess the three harmonization solutions discussed in the context of TTIP. The results are depicted in Figure 3.1 and reveal that companies involved in standardization processes on average prefer complete harmonization through the adoption of international standards or mutual recognition of European and US standards rather than the development of bilateral standards.

It is clear that no one-size-fits-all solution exists in either the adoption of international standards or mutual recognition. TTIP negotiations will most likely result in sector-specific approaches. It is an open question whether industry affiliation is actually the only factor that influences firms' preferences about the adoption of uniform standards and mutual recognition. The study takes a step towards answering that question by exploring factors that influence firms' preferences about the various options to dismantle export barriers arising from standards.

Figure 3.1: Average assessment of different solutions for the harmonization of formal standards in the context of TTIP on a scale from -3 (very bad solution) to +3 (very good solution)



Note: Figures based on 211 observations.

As the harmonization solutions differ substantially in their implications for the standardization activities of a company, firms' preferences about the respective option might vary depending on the company's characteristics. Within the theoretical part of the exploratory

analysis, six propositions on the expected effects are derived based on a review of the existing literature, which is quite limited. The empirical test of the propositions is based on GSP data and is introduced in section 3. Multivariate probit estimation using simulated maximum likelihood is applied to control for possible correlations between a firm's preferences. The results are presented in section 4 and indicate that there is no one-size-fits-all solution for the harmonization of standards. The last section of the paper discusses the limitations of the study.

3.2. Theoretical Considerations

The overall goal of this analysis is to investigate factors influencing firms' preference with respect to the development and implementation of common standards and the mutual recognition of existing standards within the framework of TTIP.

3.2.1. Benefits and Costs of Harmonized Standards

Several factors justify the harmonization of standards across trading countries.⁷ The adoption of uniform standards pushes mutual market access, as well as the realization of technical interoperability and compatibility of products, enhancing trade of goods and services. The inclusion of representatives from different market segments into formal standardization processes fosters the acceptance of the standard. This enhances broad-scale implementation and increases economies of scale and learning curve effects (Schroder, 2011). Further cost reductions are achieved through lower input prices and reduced administrative cost (Desphande and Nazemetz, 1999). Firms with many trading partners and intensive intra-firm trade strongly profit from internationally harmonized standards, because benefits increase in the number of countries involved. If formal standards are referred to in national law, compliance with them helps to increase legal security in the home and the foreign country (Schroder, 2011).

If market transactions are based on documents that clearly define requirements and responsibilities and were established by consensus, uncertainties between business partners (and the consequent transaction costs) are reduced (Desphande and Nazemetz, 1999).

Lutz and Pezzino (2012) theoretically analyze under which conditions governments introduce full harmonization through international standards or mutual recognition of quality standards by extending a model of vertical product differentiation and trade. The authors argue that uniform standard are only binding for firms that initially apply lower standards. Those

⁷ See, for example, Swann (2010,) for a review of the empirical literature on the effects of international standards on trade and, more generally, Blind (2004) for the economic impacts of standards.

companies will incur costs for implementing standards that modify internal processes and require training of employees. Resulting losses increase with the cost differential between the countries. The World Competitiveness Ranking 2017 published by the IMD World Competitiveness Center is reported in the Appendix and shows that differences in competitiveness between the US and Germany are rather low. This indicates that losses from changing standards will be small. If standards were widely implemented and persistent, implementation costs would occur only once (Desphande and Nazemetz, 1999) and be outweighed by the advantages of full harmonization.

Mutual recognition reduces compliance cost (OECD, 1999a) and is easy to put into practice because new standards do not have to be drafted and implemented. However, Pelkmans (2003) shows that it becomes less clear to firms whether their products conform to European and national regulation, creating high information cost. Before the mutual recognition agreement can come into effect, assessments are needed to determine the “equivalence” of one country’s standards with the standards of another’s. These processes are complicated and time-consuming (Pelkmans, 2003). In reality, an alignment of regulatory requirements is difficult to achieve, due to different legal and institutional environments (CEN and CENELEC, 2015; OECD, 2017). Pelkmans (2012) concludes that if countries have very heterogeneous preferences and objectives, and national standards differ significantly, mutual recognition will not be successful.

Moreover, differences in standardization systems between the US and the EU create dissimilar conditions for the implementation of mutual recognition agreements (Egan and Pelkmans, 2015). In the policy paper published in 2015, CEN and CENELEC argue that mutual recognition most likely facilitates market access only for US firms. While standards accepted by European standardization organizations apply for all EU Member States, US states could still impose individual requirements for products and services. In addition, mutual recognition does not facilitate the realization of technical interoperability. Sales increases through mutual recognition, therefore, are expected to be lower than in the case of a wide application of harmonized standards.

Altogether, it can be assumed that the net benefits of a broad adoption of international standards are higher than for bilateral standards. Consequently, preferences are expected to vary depending on whether negotiations are conducted at bilateral or multilateral level. Firms can achieve economies of scale without incurring development and implementation cost when maintaining existing standards. However, anticipated cost savings must be balanced with potentially high increases in information and transaction cost and the limited access to US markets. The net benefits of mutual recognition are expected to be smaller than for harmonized standards. Based on these considerations the following proposition is derived:

Proposition 1: Firms expect integration gains in terms of market access, technical

interoperability, and cost reductions to be highest if standards are established on an international level and lowest for mutual recognition.

3.2.2. Creating Competitiveness Vis-à-Vis Global Rivals

Common standards create a level playing field, enabling initially less competitive firms to stay in the market and/or enter new markets. However, existing firms would see their profit margins shrink because new players enter the market (Swann, 2000) and the exploitation of competitive advantages arising from national or EU standards is no longer possible. In their study on standards and domestic protectionism, Fischer and Serra (2002) can show that profits decrease with common standards. Only if countries develop high-quality formal standards that are well recognized and accepted by consumers, companies will profit from harmonization due to the possibility to ask for higher prices.

The development of such high-quality formal standards seems to be possible in small-scale negotiations only. The international decision-making process requires multiple meetings of interested representatives of all industries, governments, and consumers from different countries and, thus, is time-consuming. Differences among the countries such as language, culture, legislation, and citizens' preferences complicate the achievement of consensus on the international level. As a result, differences between the state of the art and the content of the standard can be larger for international standards by the time they are introduced into the market. While openness to everybody ensures fairness, acceptance, and longevity of standards, it reduces the ability to take into consideration specific and complex interests during formal decision-making processes (Schroder, 2011). The participation and impact of minority groups in the development process are not always ensured and political influence can be undesirably decisive. These shortcomings potentially reduce the quality of international standards compared to national solutions.

Regional standards, in contrast, differentiate products and might serve as a quality signal to consumers. Due to shorter development times, the difference between the state of the art and the content of the standards is smaller and the quality of standards thus higher. Lutz and Pezzino (2012) show theoretically that mutual recognition increases the degree of vertical integration and is beneficial in particular for highly competitive firms. The IMD World Competitiveness Ranking (IMD, 2017) reveals that German firms are among the most competitive worldwide. Mutual recognition of national standards provides German firms with the opportunity to exploit their competitive advantages abroad and consumers with heterogeneous preferences can benefit from a greater variety of products. Positive effects, however, will be partially offset if selling EU products in the US is limited. According to CEN and CENELEC (2015), mutual recognition

would potentially create unequal conditions of competition in so far as market access is not reciprocal due to fundamental differences in standardization systems. German companies then would not achieve competitive advantages from regional standards.

While maintaining the possibility to implement various corporate strategies, regulatory autonomy of national governments introduces unfair competition if only domestic companies have to comply with national rules to fulfill national standards (Swann et al., 1996, Kerber and Bergh, 2007). Moreover, increased competition from US firms could force less competitive German firms to exit the market. Since German firms are among the most competitive worldwide, the benefits from the application of respected European standards could outweigh the disadvantages. It follows:

Proposition 2: Competitive advantages vis-à-vis global rivals arise predominantly from common high-quality standards developed in partnership with the US and from the recognition of European standards by the US.

3.2.3. Influencing International Standardization Processes

Involvement in the development of formal standards is a strategic decision. Firms active in standardization committees can incorporate their own interests and introduce new technologies into markets by influencing the standard-setting process (Blind, 2006a, Blind and Mangelsdorf, 2016). Participants of international standardization processes are interested in developing common standards with a wide scope of application instead of implementing regional standards. They will speak in favor of the adoption of existing international standards to their development they have contributed, as well as the development of new common standards. Firms expect to have greater leverage in the development process involving fewer stakeholders. Accordingly, bilateral negotiations are more attractive to companies participating in international standardization.

The cost associated with the development of formal standards increase with the number of countries participating in negotiations. Costs of developing international standards, for example, are personnel and travel expenses for the participation of qualified staff in various bodies and committees, and costs in terms of time. While international decision-making processes are very time-consuming, bilateral negotiations are smaller in scale and, hence, less costly.

From the perspective of participants in international standardization, net cost savings are highest for the development of bilateral standards. The positive effect for existing international standards is possibly offset by the negative effect for the costly development of standards on the international level. It can be concluded that:

Proposition 3: Firms active in international standardization committees reap benefits from common standards, especially those developed bilaterally.

3.2.4. The Role of Firm Size and Industry

The correlation between firm size and preferences regarding different types of common standards is associated with the relation of benefits from harmonization and negotiation cost. Both are closely related to the number of trading partners. In particular large firms with many trading partners reap the benefits of international standards, as diversification costs are drastically reduced. In the reverse, costs for bilateral negotiations strongly increase with firm size. Smaller companies typically have a lower number of trading partners and gains from reduced diversification costs are smaller. For every mutual recognition agreement with another country, assessment of equivalence is associated with high costs that increase with the number of trading partners.

Proposition 4: Large firms prefer international standards rather than mutual recognition and specific EU-US standards.

The ability to refer to public, widely accepted documents not only serves to demonstrate conformity to regulations, e.g. regarding health, safety, or quality. It creates transparency for customers, which is especially relevant in the context of service trade. The intangible nature of services makes it very difficult for customers to assess the quality of the output. By defining requirements for service design and stages of the business process, which may take place in different locations, uniform standards can serve to demonstrate service quality, to evaluate service performance or to regulate guarantee conditions across state borders. Standards then improve customer satisfaction and business performance (DIN/DKE, 2015, p. 11 ff). Service providers therefore are expected to speak in favor of common standards.

The main purpose of service standards is the provision of information to recipients and the improvement of customer satisfaction. This aim is not necessarily achieved by mutual recognition that implies application of different standards consumer might be unfamiliar with. The latter then might rather be confused with new products floating their markets (Pelkmans, 2003). Acceptance of service standards such as certificates and diplomas could be useful with respect to ensuring free movement of services (Blind, 2006b). However, this requires equivalence of educational standards, because otherwise domestic service providers that have to fulfill higher standards will face unfair competition from foreign companies (Kerber and Bergh, 2007).

Due to the intangible character of services, the costs associated with the maintenance of

existing standards are most likely higher (Pelkmans, 2003). As service standardization beyond national borders is still in its infancy (Wakke et al., 2015), the relevance of mutual recognition of European service standards could be limited. In contrast, many European and international standards exist in manufacturing, in particular in electrical engineering (CENELEC and IEC) and telecommunication (ETSI and ITU). On the one hand, firms operating in these high technology areas and relying on these standards would benefit from maintaining existing European and international standards. On the other hand, the long-term development or implementation of international standards that are possibly not state-of-the-art in industries characterized by rapid development of technologies and short product life cycles seems less favorable (Schroder, 2011; Swann, 2000). Whether high- and medium-technology (HMT)⁸ firms advocate for or against the adoption of international standards is therefore ambiguous. Summing up, the following proposition derives:

Proposition 5: Service providers prefer the adoption of common standards. The existence of numerous European standards supports mutual recognition in high- and medium-technology industries.

3.2.5. Importance of Informal Consortia Standards

Quickly gaining market access through mutually recognizing standards comes to the cost of making the standard system more complex. This is less of a cost for firms to which formal standards are not important and, therefore, will have a higher probability to speak in favor of mutual recognition. Most likely among them are companies operating in markets that develop rapidly such as HMT industries. The protracted establishment of formal standards in the past is less suitable in areas in which being up-to-date is a must, and when specific issues have to be tackled and decisions must be made quickly. For these purposes companies rather organize in so called consortia. According to the OECD, consortia are defined as ‘ad hoc groups with a clear, short-term purpose, often in fast-moving area of technology’ (OECD, 1999b, p.4). The development of standards in consortia is an informal process in which a rather small interest group works on specific problems. The few participants usually have similar interests and the decision-making process is much faster (Delcamp and Leiponen, 2014; Pohlman, 2013; Wegberg, 2006; Schroder, 2011).

⁸ HMT industries include chemistry and pharmaceuticals, electrical engineering, and information and communication technology.

Table 3.1: Proposed pros and cons of the three harmonization solutions

	Common standards		Existing regional standards
	International standards	Bilateral standards	Mutual recognition
P1 Benefits	<ul style="list-style-type: none"> • mutual market access (+) • technical interoperability (+) • economies of scale, learning curve effects, and lower transaction, administrative, and input costs (+) • broad application (+) • either no or one-off implementation cost 	<ul style="list-style-type: none"> • limited scope of application (-) • one-off implementation costs (-) 	<ul style="list-style-type: none"> • possibly unequal market access (-) • no technical interoperability (-) • economies of scale and learning (+) • no implementation cost (+) • high information, transaction and compliance costs (-)
P2 Competition	<ul style="list-style-type: none"> • create a level playing field (+ less competitive firms) • no benefits from competitive EU standards (- more competitive firms) 		<ul style="list-style-type: none"> • exploit competitive advantages (+) • possibly unfair competition (-)
	• lower quality (-)	• higher quality (+)	
P3 Participants formal committees	<ul style="list-style-type: none"> • high development cost (-) • low influence (-) 	<ul style="list-style-type: none"> • lower development cost (+) • great influence (+) 	<ul style="list-style-type: none"> • no development cost (+) • influence only on EU standards (-)
P4 Size	• low diversification costs	• high diversification cost	• low diversification costs
P5 Industry	<ul style="list-style-type: none"> • development of uniform service standards (+) • many existing standards in HMTI (+) • larger differences to the state of the art (-) 		<ul style="list-style-type: none"> • language and cultural barriers (-) • regional diplomas and certificates (+) • existing standards in HMTI (+)
P6 Participants consortia	• lengthy development processes (-)	• faster development of more specific common standards (+)	• fast access to markets (+)

Specific EU-US standards can be based on documents that focus on particular problems and industries. DIN provides its members with the opportunity to develop specifications within the framework of DIN SPEC. The process is organized and supported by DIN, but can be initiated by any economic entities. Standards are developed in small working groups, and not necessarily by consensus, facilitating much faster publishing (DIN, 2015). It follows that negotiations based

on specifications combine the advantages of formal standardization processes with benefits of quick decision-making in informal groups. Rapid harmonization can also be achieved by mutual recognition. It follows:

Proposition 6: Firms that consider informal consortia standards very important prefer the rapid harmonization of standards through mutual recognition or bilateral standards over the development of international standards.

An overview of the pros and cons of the three options to harmonize standards within the TTIP, which are summarized in the six propositions, is provided in Table 3.1.

3.3. Empirical Analysis

3.3.1. Data and Variable Description

Propositions from the previous chapter are examined empirically based on GSP data. This survey was conducted among companies actively participating either in DIN or in DKE. The questionnaire consists of a fixed set of questions and an alternating special section. In 2013, the special section of the GSP dealt with the role of standards and standardization within the framework of TTIP. Data was collected on preferences of German firms regarding different harmonization options, namely international standards, specific EU-US standards, and mutual recognition. Using seven-point Likert scales, respondents were asked to rate whether the respective approach is a very bad (-3) or a very good solution (+3). Same scales were used to collect information regarding the importance of different types of standards (formal and informal) on the national, European, and international level, as well as the significance of formal standards for various business success factors. Among those are the fulfillment of requirements for market access, the realization of technical interoperability, productivity increases (including cost reductions), and competitiveness vis-à-vis rivals. Five-point Likert scales ranging from zero to four were used to assess the strength of impediment from tariff and non-tariff measures to trade between the US and Germany.

Since for some categories of the seven and five-point Likert scales there are only few observations, variables have been converted into binary variables. Dummies equal one if respondents chose extreme positive values for the respective variable (+2 and +3) and zero if values are equal to or lower than one (-3 to +1).⁹ For example, the first dependent variable equals

⁹ Similar approaches were applied to data from the Eurostat Community Innovation Survey (CIS), for example by Laursen and Salter (2006).

one if international standards are considered a very good solution while the control variable market access equals one if the respondent considers formal standards very relevant for the fulfillment of market entry conditions.

Further information was collected on the share of exports to the US and standardization activities at various regional levels. Data on the German Classification of Economic Activities from 2008 and the number of employees was matched from Hoppenstedt database. Unfortunately, the sample does not include a sufficient amount of non-exporters to allow for statistical examination of differences for this group. Only dummies for exporting into the US and participation in international standardization committees are fed into the analysis.

Excluding outliers identified by plotting deviance residuals against the estimated logistic probability (Sarkar et al., 2011), the data set contains 213 companies for which all variables can be observed. The small, non-random sample only includes German firms participating in national standardization and most of them are large exporters.

Table 3.2: Means of explanatory variables by groups and t-test statistics for difference in means

	International standards (IS)			Bilateral standards (BS)			Mutual recognition (MR)		
	0	1	ttest	0	1	ttest	0	1	ttest
Obs	70	143		172	41		87	126	
International standardization	0.40	0.61	0.00	0.51	0.66	0.09	0.61	0.49	0.09
Size (> 250 employees)	0.40	0.56	0.03	0.53	0.41	0.19	0.52	0.50	0.81
HMT industries	0.24	0.32	0.23	0.31	0.22	0.21	0.22	0.35	0.04
Services	0.13	0.24	0.03	0.20	0.22	0.82	0.23	0.19	0.49
Consortia standards	0.14	0.17	0.64	0.12	0.32	0.02	0.07	0.22	0.00
International standards	0.59	0.80	0.00	0.74	0.68	0.48	0.74	0.72	0.83
Barrier US standards	0.47	0.71	0.00	0.60	0.73	0.11	0.56	0.67	0.10
Barrier labeling requirements	0.21	0.31	0.11	0.23	0.49	0.00	0.25	0.30	0.44
Export to US	0.73	0.83	0.12	0.77	0.88	0.09	0.80	0.79	0.74
Market access	0.61	0.90	0.00	0.79	0.85	0.33	0.79	0.81	0.77
Technical interoperability	0.39	0.66	0.00	0.55	0.66	0.19	0.53	0.60	0.34
Productivity increases	0.09	0.21	0.01	0.13	0.34	0.01	0.14	0.19	0.31
Competitiveness	0.61	0.74	0.07	0.67	0.83	0.02	0.62	0.75	0.04

Differences in means by the dependent binary variables for all covariates are reported in Table 3.2. The figures indicate that firms which consider international standards a very good solution within the TTIP (n = 143) are different from companies which state the opposite (n =

70). Among the advocates, a higher percentage of companies is active in international standardization committees, has more than 250 employees, operates in the service industry, considers US standards a strong impediment to exports, rates international standards very high, and states that formal standards are important for all factors relevant for business success. Respondents who prefer specific EU-US standards are in minority (20%). Almost one-third of this sample of 41 firms relies on informal standards, the other part participates in international standardization. A higher share of firms in this group uses formal standards to improve productivity and competitiveness. Regarding mutual recognition, consortia standards are significantly more important to the advocates, who operate in HMT industries. They value formal standards as more beneficial for competitive advantages than firms that reject mutual recognition.

The correlations indicated by the analysis of differences in mean values, however, are possibly spurious, as relationships between variables are ignored. Phi correlation coefficients for binary variables indicate that the dependent variables are not independent of each other. Especially the dummies for the position on specific EU-US standards and mutual recognition are related. The independent variables are also correlated, but not as high as to cause multicollinearity problems. The econometric method applied is described in the next section.

3.3.2. Empirical Model and Results

Exploration of factors that influence whether firms opt in favor or against different options of harmonization in the framework of TTIP, captured by dummy variables, requires an estimation technique that accounts for the fact that predictions must take values ranging from zero to one. While dependent variables are not likely to be related across observations, preferences of each firm potentially are. Apart from observable determinants, certain unobservable factors may determine choices simultaneously, i.e. error terms are correlated across harmonization options. For example, the way in which respondents perceive advantages and disadvantages of an option compared to its alternatives may vary according to the understanding about and experiences with harmonization. Zellner (1962) shows that estimation results of linear models which account for the interdependence of residuals, so called seemingly unrelated regressions (SUR), are more efficient. A model similar to SUR but applicable to more than two binary response variables is the multivariate probit regression.

Following Greene (2012), the harmonization options index is indicated by $m = 1, \dots, M$ (i.e. $M = 3$) and the model is:

$$y_m^* = x_m' \beta_m + \varepsilon_m \quad (\text{B1})$$

where y_m indicates the dummy for option preference, x_m' is the vector of covariates for

each option, β_m are three vectors of coefficients, and ε_m is the respective error term. It applies that $y_m = 1$ if $y_m^* > 0$ and $y_m = 0$ if $y_m^* < 0$. Error terms are assumed to satisfy the following properties:

$$E[\varepsilon_m | x_1, x_2, x_3] = 0, \quad (B2)$$

$$Var[\varepsilon_m | x_1, x_2, x_3] = 1, \quad (B3)$$

$$Cov[\varepsilon_j, \varepsilon_m | x_1, x_2, x_3] = \rho_{jm}, \quad (B4)$$

$$(\varepsilon_1, \varepsilon_2, \varepsilon_3) \sim N_3[0, R]. \quad (B5)$$

while potential correlations between error terms are introduced by $\rho_{jm} \neq 0$ $\rho_{jm} \neq 0$. The trivariate normal probability for a firm is given by:

$$Prob(Y_1 = y_{i1}, Y_2 = y_{i2}, Y_3 = y_{i3} | x_1, x_2, x_3) = L_i = \Phi_3(q_{i1}z_{i1}, q_{i2}z_{i2}, q_{i3}z_{i3}, R^*), \quad (B6)$$

where

$$z_{im} = x'_{im}\beta_m \quad (B7)$$

$$q_{im} = 2y_{im} - 1, \quad (B8)$$

so that $q_{im} = 1$ if $y_{im} = 1$ and $q_{im} = -1$ if $y_{im} = 0$. The variance-covariance matrix of errors has the elements

$$R_{jm}^* = q_{ij}q_{im}\rho_{jm}. \quad (B9)$$

The joint likelihood function for N independent observations is:

$$L = \prod_{i=1}^N \Phi_3(q_{i1}z_{i1}, q_{i2}z_{i2}, q_{i3}z_{i3}, R^*). \quad (B10)$$

Coefficients are determined by maximizing the likelihood of observing the given data set. Maximum likelihood estimation involves evaluation of multivariate normal distribution functions. Thereby, the application of simulation-based methods, such as the Geweke-Hajivassiliou-Keane simulator, yields accurate and efficient results (Börsch-Supan and Hajivassiliou, 1993). A discussion of simulation estimation techniques is provided by Stern (1997) and Gouriéroux and Monfont (1996). Calculation of the trivariate case is discussed in more detail in Cappellari and Jenkins (2003). The authors suggest to choose the number of random draws, R, at least as high as the square root of the number of observations (here N = 211, draws = 15). Probabilities are defined in terms of truncated univariate standard normal variates, which are randomly drawn from the upper-truncated standard normal distribution (Cappellari and

Jenkins, 2003).

The statistical analysis shows that the expectations about the interdependence of choices are partially confirmed: unobserved factors increase the probability of firms to speak in favor of both specific EU-US standards and mutual recognition. This justifies the application of the model. Columns I, II and III of Table 3.3 report the results for the baseline model, columns IV, V, and VI include the motives to apply formal standards. Coefficients do not quantify the effects but only indicate the direction of correlation.

The coefficients for the influencing factors vary depending on the level that negotiations are conducted at and mostly confirm the propositions. International standards are a favorable option for firms that consider formal standards very important for market access. In contrast, market access is not related to the preference for specific EU-US standards or mutual recognition. Likewise, the realization of technical interoperability is a significant factor only in explaining differences in the preferences about the adoption of international standards. This is in accordance with proposition 1 stating that gains in market access and interoperability are highest for the broad-scale implementation of international standards.

Respondents who consider formal standards important for productivity increases and cost reductions expect to achieve these through the implementation of common standards, irrespective of whether negotiations are international or bilateral, but not through mutual recognition. This may be explained by the fact that cost savings related to mutual recognition are offset by high information and transaction costs.

Proposition 2 that advantages vis-à-vis global rivals arise from high-quality standards developed in partnership with the US and from enforcing European standards is also supported. It is in line with the results of the theoretical model in Lutz and Pezzino (2012) and the findings of Swann et al. (1996) that idiosyncratic standards create competitive advantages, in particular for exporting firms.

Proposition 3, which states that participation in international standardization is positively correlated with the preference for the implementation of international standards, is not confirmed by the data. Respondents who are familiar with international decision-making processes seem to be aware of the problems related to the development of international standards. As also stated by proposition 3, in the case of negotiations with the US, participants active in formal standardization do not consider mutual recognition a good harmonization solution. They advocate for common bilateral standards in which they expect to have great leverage and incur relatively low development cost compared to international negotiations.

Table 3.3: Multivariate probit model for preferences about harmonization solutions ($N = 213$)

	MV1			MV2		
	I IS	II BS	III MR	IV IS	V BS	VI MR
International standardization	0.26 (0.2)	0.49** (0.23)	-0.39** (0.19)	0.23 (0.21)	0.46* (0.24)	-0.44** (0.20)
Size (> 250 employees)	0.40* (0.21)	-0.40* (0.23)	0.09 (0.2)	0.39* (0.22)	-0.43* (0.24)	0.11 (0.20)
HMT industries	0.26 (0.23)	-0.51** (0.26)	0.49** (0.22)	0.29 (0.24)	-0.49* (0.27)	0.49** (0.22)
Services	0.83*** (0.28)	-0.21 (0.28)	0.01 (0.25)	0.76** (0.30)	-0.25 (0.29)	0.01 (0.25)
International standards very important	0.56** (0.22)	-0.30 (0.25)	-0.10 (0.22)	0.40* (0.24)	-0.35 (0.27)	-0.09 (0.23)
Consortia standards important	-0.14 (0.27)	0.67** (0.26)	0.94*** (0.29)	-0.25 (0.30)	0.61** (0.27)	0.89*** (0.29)
Export to US	0.23 (0.24)	0.60** (0.3)	-0.18 (0.24)	0.29 (0.26)	0.62** (0.31)	-0.20 (0.24)
Barrier US standards	0.71*** (0.2)	0.24 (0.22)	0.23 (0.19)	0.69*** (0.21)	0.16 (0.23)	0.22 (0.19)
<i>Importance for success</i>						
Market access				0.62** (0.26)	0.38 (0.34)	-0.01 (0.25)
Technical interoperability				0.37* (0.22)	-0.05 (0.25)	0.06 (0.20)
Productivity increases/cost reductions				0.62** (0.31)	0.72*** (0.27)	0.29 (0.26)
Competitiveness				0.29 (0.23)	0.45* (0.27)	0.36* (0.20)
Constant	-1.0*** (0.30)	-1.4*** (0.36)	0.21 (0.28)	-1.9*** (0.38)	-2.0*** (0.47)	-0.08 (0.33)

Note: Standard errors in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

As expected, the firm-size effect, postulated in proposition 4, is positive for the preferences related to international standards and negative for bilateral negotiations. This indicates that both the benefits of international standards and the costs of bilateral negotiations increase with the number of trading partners of a firm. Preferences for mutual recognition are independent of the number of employees.

In accordance with proposition 5, entrepreneurs who operate in HMT industries prefer quick mutual recognition of standards while rejecting the development of new bilateral standards. The effect on the acceptance of international standards is not significantly different from zero.

The negative effect of a time-consuming development is possibly offset by the positive impact of existing international standards, especially in electrical engineering and telecommunication. Service companies clearly prefer international standards over other options.

Estimation results also confirm the expectations stated by proposition 6 that companies that rely on informal consortia standards rate bilateral standards and harmonization through mutual recognition highly. Both solutions facilitate quicker market integration compared to the time-consuming development of international standards.

Finally, firms facing barriers to export to the US are significantly more likely to view common standards as a good solution. While a trade impeding effect of formal standards relates to the preference for international standards, this is not the case for the preferences about specific EU-US standards or mutual recognition. Table 3.6 in the Appendix illustrates that, in contrast, labeling requirements are a predictor for the positive assessment of bilateral standards. Due to the complexity and difficulty of achieving consensus, harmonization of country-specific NTMs possibly cannot be part of international negotiations but might be taken into consideration within the scope of bilateral agreements. If US standards or labeling requirements hinder exports to the US is not found to be relevant in explaining the preference for mutual recognition of existing standards.

3.3.3. Robustness Checks

Post estimation diagnostics for the applied statistical method are still limited. Robustness and quality of the results are first tested by repeating multivariate regressions setting $R=50$. This reveals no inconsistencies with previous results.

The analysis revealed that the preference for international standards is independent of opinions on other options while the error terms of equation II and III are related. Therefore, univariate logit regression for the first equation and a bivariate probit for both the other options are run as further robustness checks. Model statistics for all specifications are reported in Table 3.4. Running the regression for international standards and the other two options separately, as reported in Table 3.5, does not alter estimation results except the correlation between technical interoperability and application of international standards. As coefficients are odds ratios, this model brings about the advantage that effects can be quantified. The probability that large firms opt for international standards is twice as high as for small and medium sized companies. For service providers and respondents who state that US standards are a significant barrier to exports, the effect is more than three times greater. In addition, the availability of post estimation diagnostics makes possible the assessment of model fit and quality at least for the univariate logit model. According to Pearson χ^2 goodness-of-fit tests, the model cannot be rejected. Further scalar

measures also suggest that the model fits well. For example, McFadden's R² is equal to 0.23. Classification analysis reveals that 78% of the observations can be correctly classified.

Table 3.4: Comparison of model statistics

	MV1	MV2	MV3	LOGIT	BV
Wald Chi-Square statistic	74.1	99.3	103.7	66.8	50.9
Prob > chi2	0.000	0.000	0.000	0.000	0.001
Df	30	42	45	14	27
BIC	828.3	858.6	866.7	273.4	572.1
AIC	727.5	717.5	715.5	226.5	481.3
Goodness-of-fit test	NA	NA	NA	0.61	NA
Correctly classified	NA	NA	NA	77.5	NA
Linktest	NA	NA	NA	passed	NA
McFadden's R ²	NA	NA	NA	0.23	NA
Rho (BS-IS)	0.25* (0.14)	0.16 (0.15)	0.15 (0.16)	-	-
Rho (MR-IS)	0.10 (0.40)	0.08 (0.13)	0.07 (0.13)	-	-
Rho (BS-MR)	0.44*** (0.12)	0.41*** (0.13)	0.44*** (0.16)	-	0.42*** (0.15)

*Note: Standard errors in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.*

3.3.4. Limitations and Future Research

Robustness and quality are tested by repeating the applied statistical method with altered settings. This reveals no inconsistencies in the results and in general confirms the good fit and quality of the model. It must be mentioned, however, that univariate regressions for specific EU-US standards and especially for mutual recognition are of poorer quality than the one for international standards. It is not clear, however, if this is due to inaccuracy that results from ignoring correlations between dependent variables, bad fits of the models, or small sample size.

Further research is needed on the magnitudes and validity of the effects. The sample is not random, as it just includes German firms participating in national standardization and most of them being large exporters. No conclusions can be drawn regarding preferences of firms that do not participate in standardization. Although zero cells can be ruled out, the analysis possibly suffers from small sample size, because the applied statistical method requires a large number of cases. Especially firms who opt in favor of specific EU-US standards seem to be a special group of companies. Likewise, heterogeneous effects for certain groups cannot be investigated due to small sample size. Some industries for which the consequences of TTIP are intensively discussed, such as the food industry (Egan and Pelkmans, 2015), are underrepresented.

Table 3.5: Univariate and bivariate probit models for preferences about harmonization solutions (N = 213)

	I Logit (OR) IS	II Bivariate probit BS	III MR
International standardization	1.53 (0.55)	0.45* (0.24)	-0.45** (0.20)
Size (> 250 employees)	2.00** (0.76)	-0.45* (0.24)	0.10 (0.20)
HMT industries	1.68 (0.70)	-0.48* (0.27)	0.49** (0.22)
Services	3.88** (2.06)	-0.22 (0.29)	0.02 (0.25)
International standards very important	2.01* (0.80)	-0.37 (0.27)	-0.09 (0.23)
Consortia standards important	0.66 (0.34)	0.64** (0.27)	0.89*** (0.29)
Export to US	1.54 (0.68)	0.60* (0.31)	-0.21 (0.24)
Barrier US standards	3.22*** (1.17)	0.16 (0.23)	0.22 (0.19)
Market access	2.85** (1.23)	0.39 (0.33)	-0.01 (0.25)
Technical interoperability	1.83 (0.68)	-0.06 (0.25)	0.06 (0.20)
Productivity increases/cost reductions	2.90* (1.62)	0.69** (0.27)	0.29 (0.26)
Competitiveness	1.61 (0.63)	0.46* (0.27)	0.36* (0.20)
Constant	0.04*** (0.03)	-1.97 (0.47)	-0.07 (0.33)

*Note: Standard errors in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.*

Another interesting subject of investigations would be firms that only serve the local market. Following the argumentation of Melitz (2003), non-exporters can either be positively or negatively affected by the TTIP depending on their productivity level. Removing NTMs reduces the cost of exporting and, hence, enables relatively more productive firms to export. The least productive firms, however, are confronted with higher competition and must exit the market. Anticipating this, more productive non-exporters will probably support harmonization while least productive firms speak against all harmonization options. Which of the harmonization solutions they prefer, however, is not straightforward. The considerations also illustrate that ex-post

research on the effects of TTIP on national and international market entry and exit rates will be necessary.

Finally, other variables not considered in this study might appear relevant with respect to the preferences for mutual recognition.

3.4. Summary and Policy Conclusions

This paper aims to explore firm-level characteristics that influence preferences for the implementation of uniform international or bilateral standards versus the mutual recognition of existing standards within the framework of TTIP. The analysis uses data from the German Standardization Panel conducted among German firms active in formal standardization. Multivariate probit estimation using simulated maximum likelihood is applied to control for possible correlations between firm's preferences. The results suggest that the average assessments of the practicality of potential harmonization solutions within the TTIP across companies are driven by strong opinions of specific groups. The more detailed analysis reveals that German firms' preferences differ depending on firm characteristics and business environment.

On average, the adoption of international standards by US and European firms is the option German companies prefer most. This is in line with the propositions from the theoretical model introduced by Lutz and Pezzino (2012) that shows that advantages of full harmonization are high when the cost differential between the two countries is low. Large firms, service industries and companies stating that US standards are a major barrier to exports are significantly more likely to vote in favor of international standards. This option is also preferred by companies that reap benefits from the broad implementation of standards in the form of easier market access, technical interoperability, productivity increases and cost reductions.

Such benefits, in contrast, cannot be generated by mutually recognizing existing standards. One of the main drivers for the on average positive assessment of mutual recognition is the existence of well-established European standards in HMT industries. The application of European standards is associated with the realization of competitive advantages, providing further support for the theoretical model of Lutz and Pezzino (2012). In addition, companies involved in informal consortia might advocate for this option because they believe that the acceptance of existing standards integrates markets more quickly. The fact that the GSP respondents expect these benefits to be high reflects their belief that mutual recognition is the second-best solution, although public representatives in Germany and Europe generally consider mutual recognition unfeasible or difficult to apply (e.g. VdTÜV, 2015; CEN and CENELEC, 2015; DGUV and SVLFG, 2014). Apparently, German firms engaged in standardization do not anticipate that that

European standards might actually not be recognized by the US, as US states might still have the ability to impose additional import requirements.

The outcome that the survey respondents on average reject the development of specific EU-US standards results from the negative assessment of firms in HMT industries where existing regional and international standards are important. However, bilateral negotiations based on semi-formal specifications could be an alternative route for rapid harmonization that combines the advantages of formal and informal processes. The argument is based on the finding that firms relying on fast decision-making in informal consortia are more likely to vote in favor of this option. Bilateral negotiations also enhance the quality of standards, providing applicants with competitive advantages vis-à-vis global rivals. At the same time, specific EU-US standards serve to generate benefits from ‘commonality across countries’ in terms of cost reductions and productivity increases. Firms that export to the US struggle with US labeling requirements, which are identified to be another significant influencing factor for preferring specific EU-US standards. The fact that the harmonization of country-specific NTMs cannot be part of international negotiations could explain why this is not relevant for the preference of international standards. Other NTMs might be taken into consideration within the scope of bilateral agreements, which therefore seem to be a favorable option if standards are not the only barrier to trade. The negotiation of bilateral standards appears to be a hybrid between international standards and mutual recognition that combines the advantages of the two solutions but has received little attention in public debates or economic theory.

Altogether, the results indicate that there is no one-size-fits-all solution for the removal of trade barriers arising from standards. Each option serves certain objectives and comes with cost or efficiency advantages for certain types of companies but contrary effects for others. Overall, three dimensions are identified that determine firms’ preferences regarding the various harmonization solutions: 1) company-specific factors, like size, industry, and motives to apply standards, 2) the position vis-à-vis other market participants, and 3) the dynamics of the market the company operates in.

The harmonization solution in the framework of TTIP, therefore, should allow for a careful selection of the appropriate approach and the combination of different options in specific areas. The parties should seek to identify, develop, and promote initiatives that, in addition to sector-specific issues, address differences in the competitive and technological environment of the firms most affected by TTIP.

3.5. References

- Baller S. (2007). Trade Effects of Regional Standards Liberalization. *Policy Research Working Papers*, No. 4124, World Bank, Washington, D.C., USA.
- Berden K., Francois J., Thelle M., Wymenga P., Tamminen S. (2009). Non-tariff Measures in EU-US Trade and Investment – An Economic Analysis. Study for the European Commission, Directorate-General for Trade, Ecorys, Rotterdam, Netherlands. Available at: <http://goo.gl/HPSDZf>.
- Blind K. (2004). The Economics of Standards. Theory, Evidence, Policy. Cheltenham, UK, Northampton, MA, USA: Edward Elgar.
- Blind K. (2006a). Explanatory Factors for Participation in Formal Standardisation Processes: Empirical Evidence at Firm Level. *Economics of Innovation and New Technology*, 15(2), pp. 157-170.
- Blind K. (2006b). A Taxonomy of Standards in the Service Sector: Theoretical Discussion and Empirical Test. *The Service Industries Journal*, 26(4). pp. 397-420.
- Blind K., Mangelsdorf A. (2016). Motives to Standardize: Empirical Evidence from Germany. *Technovation*, 48-49, pp. 13-24.
- Börsch-Supan A., Hajivassiliou V.A. (1993). Smooth Unbiased Multivariate Probability Simulators for Maximum Likelihood Estimation of Limited Dependent Variable Models. *Journal of Econometrics*, 58, pp. 347-368.
- Capaldo J. (2014). The Trans-Atlantic Trade and Investment Partnership: European Disintegration, Unemployment and Instability. *Global Development And Environment Institute Working Papers*, No. 14-03, Tufts University, Medford, MA, USA.
- Cappellari L., Jenkins S.P. (2003). Multivariate Probit Regression Using Simulated Maximum Likelihood. *The Stata Journal*, 3, pp. 278-294.
- CEN, CENELEC (2015). The Risk of Mutual Recognition of Voluntary Industry Standards within the Context of a Future EU-US Trade Agreement (TTIP) and Alternative Approaches. *CEN and CENELEC Policy Paper*. Available at: <http://goo.gl/TjuSXa>.
- CEPR/BIS (2013). Estimating the Economic Impact on the UK of a Transatlantic Trade and Investment Partnership (TTIP) Agreement between the European Union and the United States. Final Report. Centre for Economic Policy Research (CEPR). Available at: <https://goo.gl/PH4KJc>.
- Chen M.X., Mattoo A. (2004). Regionalism in Standards: Good or Bad for Trade. *Policy Research Working Papers*, No. 3809, World Bank, Washington, D.C., USA.

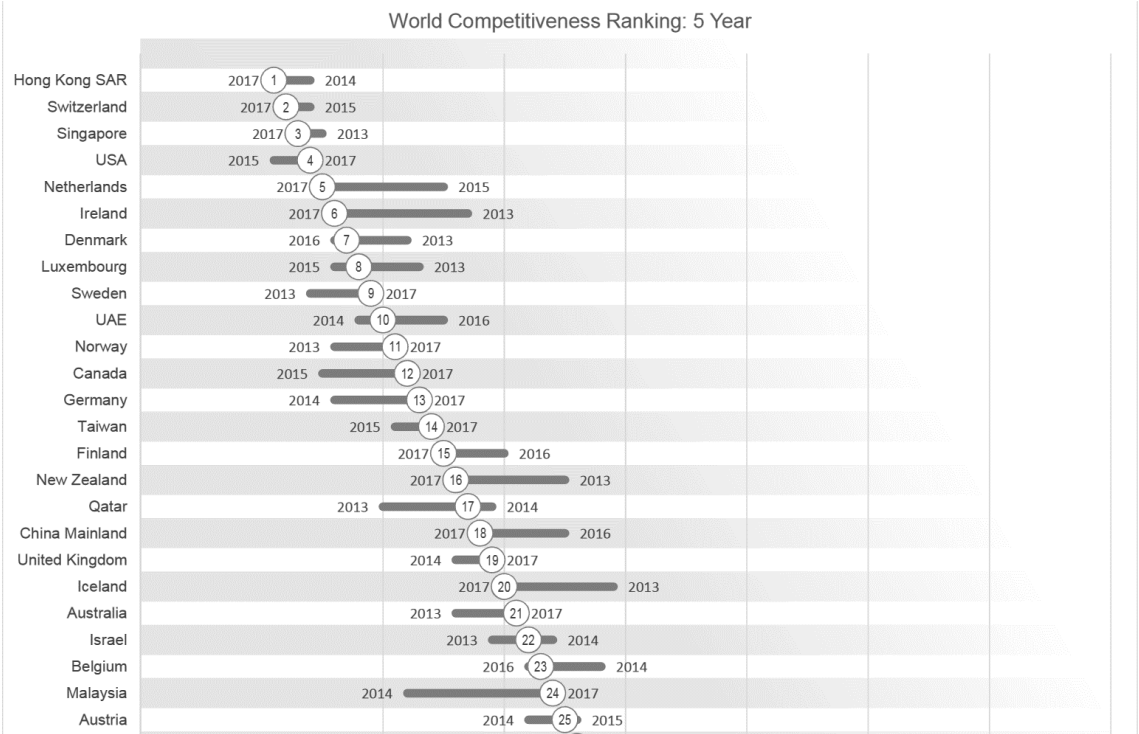
- Delcamp H., Leiponen A. (2014). Innovating Standards through Informal Consortia: The Case of Wireless Telecommunications. *International Journal of Industrial Organization*, 36(C), pp. 36-47.
- Deshpande S., Nazemetz J.W. (1999). Global Harmonization of Standards. Paper developed under the Computer Assisted Technology Transfer (CATT) Research Program, Oklahoma State University. Available at: <http://goo.gl/mmRbkR>.
- DGUV, SVLFG (2014). Comments by the Statutory Accident Insurance Institutions in Germany on a Transatlantic Trade and Investment Partnership (TTIP) between the European Union and the USA. Available at: <http://goo.gl/Xd62Zv>.
- DIN (2015). DIN SPEC – Your Competitive Edge on the Market. Available at: <http://goo.gl/aQUc6t>.
- DIN/DKE (2015). Deutsche Normungsroadmap Dienstleistungen [German standardisation roadmap services]. Berlin, Germany: DIN e.V..
- Egan M., Pelkmans J. (2015). TTIP's Hard Core: Technical Barriers to Trade and Standards. Paper No. 13 in the CEPS-CTR project 'TTIP in the Balance' and CEPS Special Report No. 117.
- Egger P., Francois J., Manchin M., Nelson D. (2015). Non-tariff Barriers, Integration and the Transatlantic Economy. *Economic Policy*, 30(83), pp. 539-584.
- European Union (2008). Regulation (EC) No 764/2008 of the European Parliament and of the Council. *Official Journal of the European Union*, L 218/21.
- Feenstra R.C., Taylor A.M. (2008). International Economics. Basingstoke, UK: Palgrave-Macmillan.
- Felbermayr G.J., Heid B., Larch M., Yalcin (2015). Macroeconomic Potentials of Transatlantic Free Trade: A High Resolution Perspective for Europe and the World. *Economic Policy*, 30(83), pp. 491-537.
- ISO (2004). Global Relevance of ISO Technical Work and Publications. ISO/TMB Policy and Principle Statement, 30 June. Available at: <http://goo.gl/ogD1Cx>.
- Fischer R., Serra P. (2000). Standards and Protection. *Journal of International Economics*, 52(2), pp. 377-400.
- Gourieroux C., Monfont A. (1996). Simulation-Based Econometric Methods. Oxford, UK: Oxford University Press.
- Greene W.H. (2012). Econometric Analysis (7th ed.). Boston, MA, USA: Prentice Hall.
- IMD World Competitive Center (2017) IMD Yearbook 2017. Lausanne, Switzerland, Singapore: IMD.

- Joseph F., Manchin M., Norberg H., Pindyuk O., Tomberger P. (2013). Reducing Trans-atlantic Barriers to Trade and Investment: An Economic Assessment. Final Project Report. Centre for Economic Policy Research (CEPR), London, UK. Available at: goo.gl/ttRFxd.
- Kerber W., Bergh, R. van den. (2007). Unmasking Mutual Recognition: Current Inconsistencies and Future Chances. *Marburg Papers on Economics*, 11-2007.
- Krugman P.R., Obstfeld M. (2008). International Economics: Theory and Policy (7th ed.). Upper Saddle River; NJ, USA: Prentice Hall.
- Laursen K., Salter A. (2006). Open for Innovation: The Role of Openness in Explaining Innovation Performance among U.K. Manufacturing Firms. *Strategic Management Journal*, 27(2), pp. 131-150.
- Lutz S., Pezzino M. (2012). International Strategic Choice of Minimum Quality Standards and Welfare. *Journal of Common Market Studies*, 50(4), pp. 594-613.
- Melitz M.J. (2003). The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity. *Econometrica*, 71(6), pp. 1695-1725.
- Michalek J.J., Hagemejer J., Roshal V., Rothert J., Tovas A., Pugacewicz M., Vancauteren M. (2005). Comparative Analysis of Importance of Technical Barriers to Trade (TBT) for Central and Eastern European Countries and Mediterranean Partner Countries' Exports to the EU. *FEMISE Research Paper*, FEM 22-03, Warsaw University, Warsaw.
- OECD (1999a). An Assessment of the Costs for International Trade in Meeting Regulatory Requirements. OECD Working Party of the Trade Committee, TD/TC/WP(99)8/FINAL. Available at: <https://www.oecd.org/tad/ntm/1955269.pdf>.
- OECD (1999b). Regulatory Reform and International Standardization. OECD Working Party of the Trade Committee, TD/TC/WP(98)36/FINAL. Available at: <https://goo.gl/XsxoK>.
- OECD (2017). International Regulatory Co-operation and Trade: Understanding Trade Costs of Regulatory Divergence and the Remedies. OECD publishing, Paris, France. DOI: <http://dx.doi.org/10.1787/9789264275942-en>.
- Pelkmans J. (2003). Mutual Recognition in Goods and Services: An Economic Perspective. *European Network of Economic Policy Research Institutes (ENEPRI) Working Paper*, No. 16, Brussels, Belgium.
- Pelkmans J. (2012). Mutual Recognition: Economic and Regulatory Logic in Goods and Services. *Bruges European Economic Research (BEER) Papers*, No. 24.
- Plaisier N., Mulder A., Vermeulen J., Berden, K. (2012). Study on "EU-US High Level Working Group". Final Report. Ecorys, Rotterdam, Netherlands. Available at: <https://goo.gl/IfNMDs>.

- Pohlmann T.C. (2013). Attributes and Dynamic Development Phases of Informal ICT Standards Consortia. Available at SSRN: <http://dx.doi.org/10.2139/ssrn.1633403> .
- Zúñiga Schroder H. (2011). Harmonization, Equivalence and Mutual Recognition of Standards: An Analysis from a Trade Law Perspective. *Global Trade Law Series*, 36.
- Stern S. (1997). Simulation-based Estimation. *Journal of Economic Literature*, 35, pp. 2006-2039.
- Swann G.P. (2010). International Standards and Trade: A Review of the Empirical Literature. *OECD Trade Policy Papers*, No. 97, OECD Publishing, Paris, France.
- Swann G. P. (2000). The Economics of Standardisation. Final Report for Standards and Technical Regulations Directorate Department of Trade and Industry, 11 December. Available at <https://goo.gl/cwBXW6>.
- Swann G. P., Temple P. and Shurmer M. (1996). Standards and Trade Performance: the UK Experience. *The Economic Journal*, 106(438): pp. 1297-1313.
- VdTÜV (2015). Making TTIP a success. Position Paper, Verband der TUV e.V. Available at: <https://goo.gl/4or8IB>.
- Wakke P., Blind K., De Vries H. (2015). Driving Factors for Service Providers to Participate in Standardization: Insights from the Netherlands. *Industry & Innovation*, 22 (4), pp. 299-320.
- Wegberg M.V. (2006). Standardisation and Competing Consortia. In Jakobs K. (Ed.), *Advanced Topics in Information Technology Standards and Standardisation Research*, pp. 111-127. Hershey, PA, USA: IGI Global.
- Zellner A. (1962). An Efficient Method of Estimating Seemingly Unrelated Regressions and Tests for Aggregation Bias. *Journal of the American Statistical Association*, 57(298), pp. 348-368.

3.6. Appendix

Figure 3.2: World Competitiveness Ranking – 5-year comparison



Source: IMD World Competitiveness Yearbook 2017
(<https://www.imd.org/globalassets/wcc/docs/release-2017/wcy-5yrs---final.pdf>).

Table 3.6: Multivariate probit model (MV3) for preferences about harmonization solutions including labeling requirements (N = 213)

	I IS	II BS	III MR
International standardization	0.23 (0.21)	0.51** (0.25)	-0.44** (0.20)
Size (> 250 employees)	0.39* (0.22)	-0.51** (0.25)	0.11 (0.20)
HMT industries	0.29 (0.24)	-0.52* (0.28)	0.49** (0.22)
Services	0.76** (0.30)	-0.17 (0.30)	0.02 (0.25)
International standards very important	0.39* (0.24)	-0.36 (0.27)	-0.09 (0.23)
Consortia standards important	-0.25 (0.30)	0.59** (0.28)	0.88*** (0.29)
Export to US	0.29 (0.26)	0.50 (0.32)	-0.21 (0.24)
Barrier US standards	0.69*** (0.21)	0.01 (0.24)	0.21 (0.19)
Barrier labeling requirements	-0.03 (0.25)	0.70*** (0.25)	0.07 (0.22)
Market access	0.63** (0.26)	0.27 (0.35)	-0.03 (0.25)
Technical interoperability	0.38* (0.22)	-0.10 (0.26)	0.06 (0.20)
Productivity increases/cost reductions	0.62** (0.31)	0.66** (0.28)	0.28 (0.26)
Competitiveness	0.28 (0.23)	0.57** (0.28)	0.37* (0.2)
Constant	-1.93*** (0.38)	-2.00*** (0.49)	-0.07 (0.33)

*Note: Standard errors in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.*

4. Why Corporate Groups Care about Company Standards: An Empirical Analysis of the Motives to Standardize

Abstract: *The role of company standards as a strategic tool for the optimization of internal processes and the governance of inter-firm relationships has only recently received researchers' attention. This paper adds to the existing literature by providing empirical evidence of the motives to apply company standards and their importance in corporate groups. Using data from the GSP, the empirical analysis confirms that companies that are part of a corporate group utilize a higher number of company standards than single firms. By codifying and transferring company-specific information, internal standardization enhances legal security, productivity, and quality. In particular for corporate groups, they additionally play a crucial role in the realization of technical interoperability, which facilitates the development and management of internal platforms.*

4.1. Introduction

In the course of increasing globalization, firms aim to simultaneously increase the level of product adaption as well as productivity in order to meet the strong opposing pressures for customization and cost efficiency. An increase in production volumes through exporting increases revenue and fosters productivity improvements through economies of scale and scope. An alternative way to adapt to the rapid globalization is the development complex international strategies including outsourcing and FDI. Possible motivations for a “slicing up of the value-chain” (Krugman, 1995) are access to markets (market seeking), access to resources (resource seeking), and cost reductions (efficiency seeking) (Dunning, 1993).

The costs of market transactions as compared to internal transactions determines whether it is more beneficial to perform different stages of the value-chain in-house or by subcontractors (Coase, 1937). Interactions with external business partners at home or abroad are beneficial if products and processes are characterized by a high degree of market compatibility and low amount of company-specific knowledge. The development of standards in informal consortia or formal standard-setting organizations plays a crucial role in the realization of interoperability between different products in the market. Formal standards are generally not specific to one particular company but industries or regions and can be accessed by all market players (Blind, 2004). Participation in formal standardization processes reduces the level of differentiation between products and bears the risk of inadvertently leaking proprietary information. If technologies and business practices that are transferred between value-chain activities convey knowledge that is valuable to the firm, companies will seek to keep such assets within the boundaries of the firm (Gereffi et al., 2005). The development of company standards, which are generally not open to the public, provides a tool to transfer sensitive, company-specific information between firms of the same corporate group (Sturgeon et al., 2008).

A corporate group is a set of legally separate firms which are subject to common control by the parent firm. Corporate groups have to be differentiated from sets of firms that enter into strategic alliances, and from single firms. The establishment of subsidiaries creates internal interfaces which become the more complex the more dispersed the international operations are. The conglomeration of firms from different businesses not only expands the product portfolio but creates a need to integrate different corporate cultures and management systems. Integrating value-chain activities worldwide and coordinating internal interfaces creates high managing, monitoring, and transaction costs. For MNEs that establish subsidiaries abroad challenges especially arise from different operating conditions in different countries.

One way for corporate groups to meet their special need for internal consistency is the application of standards (e.g. Dunning, 2001; Dowell et al., 2000; Guler et al., 2002; Christmann, 2004; Gereffi et al., 2005; Gibbon and Ponte, 2005; Prakash and Potoski, 2007; Clogherly and Grajek, 2008, 2014; Kaplinsky, 2010; Fortanier et al., 2011; Perez-Aleman, 2011; Gereffi and Lee, 2012). Only a handful of studies discuss motives for the application of company standards and their role in supply chain governance (e.g. Jaffee and Masakure, 2005; De Vries, 2007; De Vries et al., 2006; Großmann and von Gruben, 2014; Großmann et al., 2016). They focus on certain industries and insights are based on case studies because no data on the application of company standards is generally available. Even though none of the studies explicitly addresses the application of company standards in intra-firm transactions, their results imply a crucial role of internal standardization for the governance of corporate groups.

This paper summarizes the existing literature on the motives for internal standardization and draws conclusions on the special role of company standards in corporate groups. The theoretical considerations are presented in the first section. The empirical analysis, which is based on data from the GSP, is introduced in the second section. The data from the unique survey conducted among German firms active in formal standard-setting organizations provides information on five different types of standards. For the first time, differences in the utilization of company standards and its motives depending on the form of business organization can be investigated empirically. A summary of the results and the conclusion are provided in the last section.

4.2. Motives for the Application of Company Standards

Focused coordination and control of intra- and inter-firm relationships are crucial for the success of international strategies. By providing “(...) for common and repeated use, rules, guidelines, or characteristics for activities or their results (...)” (DIN EN 45020), standards reduce transaction costs and facilitate the specialization of companies on different stages of the value-chain (Swann, 2010). The focus of this paper lies on the motives for internal standardization and the differences in the application of company standards between single companies and firms that belong to a corporate group.

Standards can be classified depending on their purpose and theme (DIN EN 45020). Based on data from three global German companies, Großmann et al. (2016) conclude that the following types of company standards exist: basic, testing, process, product, material, delivery, quality, and construction standards. The authors also provide an overview of the effects of such standards, which are summarized in the following.

Why corporate groups care about company standards

Company standards have two major fields of application: the coordination of inter-firm relationships and the improvement of internal processes (Blind and Großmann, 2014).

4.2.1. External Perspective on the Application of Company Standards

Standards can be imposed on business partners in order to ensure compatibility of products, quality, and legal security. External standards that do not comprise firm-specific information can play a significant role in inter-firm relationships. In particular international management system standards, such as ISO 9001 for quality management, can be a tool in the governance of global value-chains (e.g. Maruchek et al., 2011; Kaplinsky, 2010). The role of company standards in inter-firm relations has been discussed by Großmann and von Gruben (2014). Company standards can be especially relevant to strengthening the *bargaining position* towards suppliers and customers and to meet liability and reputation concerns in integrated value-chains.

Quality assurance is essential for the development of a global brand. It increases customer satisfaction and loyalty, thereby improving the global image of the firm and strengthening its reputation (e.g. Christmann, 2004; Dowell et al., 2000). While Hudson and Jones (2003) conclude that the application of the international quality management system standard (ISO 9000) is associated with an improvement of internal processes, Baake and Schlippenbach (2011) argue that MNEs apply corporate standards which are of higher quality than market standards to meet liability and reputation concerns. For the example of environmental standards, Dowell et al. (2000) show that the application of corporate standards that exceed the minimum market standard increases the market value of the firm. Through differentiation from competitor products, company standards may be a strategic tool to create *competitive advantages* (Henson and Reardon, 2005). In corporate groups, they can be used to transfer high-value assets between subsidiaries and facilitate the exploitation of competitive advantages abroad.

Another incentive for firms to develop company standards is to gain first mover advantages when converting company standards into external standards. Especially if such standards include know-how that is patented, the risk of losing knowledge decreases and companies can reap large benefits from so-called “standard-essential patents” (e.g. Lerner and Tirole, 2014).

4.2.2. Internal Perspective on the Application of Company Standards

By facilitating *technical interoperability*, standardization fosters modularization strategies (e.g. Perera, 2007; Muffatto, 1999) that are associated with deintegration of value-chain

activities, because of decreased asset specificity (e.g. Argyres and Bigelow, 2010). However, standardization in conjunction with deintegration implies that firm-specific, idiosyncratic knowledge can no longer be used as a source of competitive advantages (Schilling, 2000). Modularization through the application of company standards can simultaneously enhance differentiation (Großmann et al., 2016) and efficiency by facilitating the internal fragmentation of value-chain activities and the development of a high-performance company network. The conclusion that vertical integration is most dominant in modular industries is also supported by Christensen et al. (2002).

Globally operating firms seek to increase efficiency by coordinating business activities on a worldwide scale. Products produced for the global market are centrally managed and sold under a global brand. Large scale production of standardized products generates economies of scale and scope. The key aspect of such an efficiency-seeking strategy in corporate groups is that all members of the group jointly work towards a defined set of objectives within the global strategy. Internal standardization can be a tool to diffuse company-specific knowledge and technologies between value-chain activities (Sturgeon et al., 2008). Company standards facilitate the implementation of harmonized product specifications and ‘common language’ (Clougherty and Grajek, 2008) across subsidiaries. It supports the development of a high-performance enterprise network with a strong corporate culture (Festing and Eidems, 2011; Forntanier et al. 2011; Dowell et al., 2000; Larsson and Finkelstein, 1999). Developing routines within the firm-specific strategic context helps to ensure responsible corporate behavior, thereby *reducing internal transaction costs*. Studies show that the effectiveness of international management system standards such as ISO 9001 and ISO 14001 in improving internal processes is limited (e.g. Boiral, 2003, 2007). Other scholars indicate that internal standardization can be a better tool to reach this goal. Ton and Huckman (2008), for example, show that the application of internal process standards can reduce the negative effects of turnover because it avoids that knowledge is locked in employees and facilitates knowledge diffusion. Formalization through company standards can serve as a control mechanism that enables the monitoring of subsidiary performance (Bartlett and Ghoshal, 2002; Harzing and Sorge, 2003; Mellahi et al. 2015). This is especially relevant in MNEs whose subsidiaries operate in different business environments and cultures.

In order to meet specific needs of buyers in different countries, corporate groups might need to adopt a flexible approach that, as far as possible, maximizes cost efficiency through concentrated production, optimal sourcing, and centralized organizational activities while manufacturing remains locally responsive if necessary. Pressures for responsiveness arise from cultural, language, economic or regulatory differences between the home and the host country (Prahalad and Doz, 1987). Modular strategies and the development of platforms enable the

adaption of products to local demands while economies of scale and scope are still achieved (Langlois and Robertson, 1992; Simpson, 2004). Platforms are “subsystems and interfaces that form a common structure from which a company can efficiently develop and produce a family of products (...)” (Gawer and Cusumano, 2014: 419). Developing and managing internal platforms in line with a company-specific strategy is complex. Company standards are indispensable for the development of platform thinking and the creation of system stability because they can be used as a tool to implement common practices, routines, and non-person-oriented information transfer processes (Sturgeon et al. 2008; Festing and Eidems, 2011; Gawer and Cusumano, 2013; De Casanove and Lambert, 2016).

Moreover, company standards help to “describe the technological state of the art of the company” (Großmann et al., 2016, p. 87). Even if knowledge is too ‘sticky’ to be transferred via formal channels itself, standards can create common practice and understanding and, thus, the absorptive capacity required to diffuse knowledge (Tallman and Chacar, 2011; Hansen and Lovas, 2004). Diffusion of know-how throughout the corporate group has a positive effect on *R&D and innovation* (Blind, 2013) and *international competitiveness* (Jaffee and Masakure, 2005). As the codification of company-specific competencies and inherent organizational know-how requires a clear understanding of the processes, company standards foster learning and innovation (Bartlett and Ghoshal, 2002; Kogut and Zander, 1993; Großmann, 2015).

Internal standardization as a tool for the optimization of internal processes can be complementary to regulation and formal standardization by specifying requirements that products and processes must conform with, thereby increasing *legal security* and facilitating *market access*.

Figure 4.1: Effects of company standards on intra and inter-firm relations

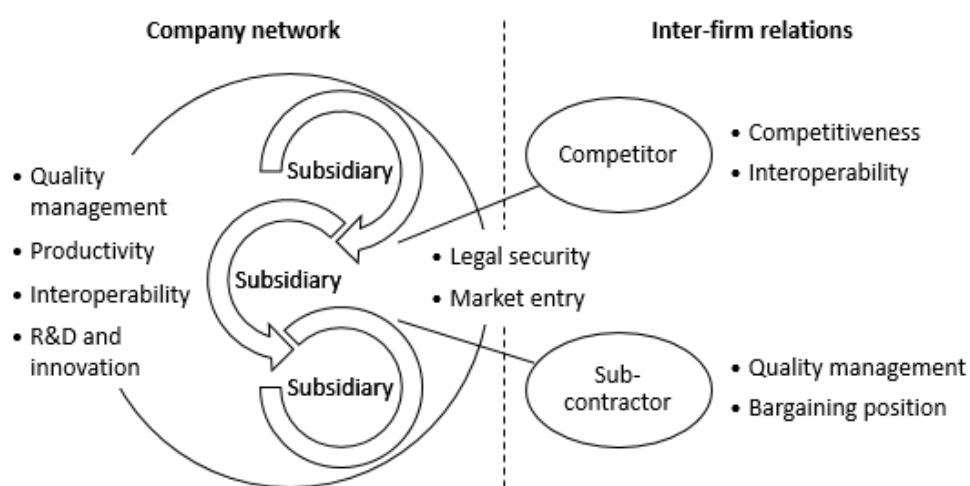


Figure 4.1 summarizes the effects of company standards for the governance of company networks and inter-firm relationships. The special role of company standards for corporate groups

follows from the integration of value-chain activities and interdependencies between domestic and foreign subsidiaries. Integration will be profitable only if internal interfaces are optimally coordinated, advantages fully utilized, and assets kept within the boundaries of the firm. The application of company standards can act as a tool to achieve these goals, as they diffuse company-specific information within but not out of the corporation (Sturgeon et al., 2008). Corporate groups are expected to apply a larger number of company standards than single firms because internal standardization can be of particular importance for the governance of internal interfaces, the reduction of intra-firm transaction costs, the improvement of quality, and the optimization of R&D and innovation activities in foreign affiliates.

4.3. Empirical Analysis

4.3.1. Data and Variable Description

The empirical analysis is based on data from the GSP collected in 2013, 2014, 2015 and 2016. The final sample consists of 725 firms.

The dependent variable is the number of internal company standards utilized by the firm. It is divided into four categories: no company standards ($n = 121$), between 1 and 10 ($n = 252$), between 11 and 100 ($n = 237$), or more than 100 ($n = 115$) company standards. The independent variable of interest is whether the company is part of a corporate group or not. 11% of the firms are part of a corporate group whose headquarters and subsidiaries are located in Germany, 55% are MNEs with headquarters either in or outside of Germany, and 34% are single firms unattached to a corporate group. Simple descriptive statistics reported in Table 4.1 show that the majority of firms in the sample utilizes between 1 and 100 company standards. The share of non-users is highest among single firms and lowest among international groups. While only 6% of the single firms utilize more than 100 company standards, this applies to more than 20% of all corporate groups.

The impact of company standards on eight factors of business success is rated on a scale from -3 (very negative) to +3 (very positive). Figure 4.2 reports the average ratings for single firms and corporate groups. The impact on “quality improvements”, but also on “productivity increases (including cost reductions)” and “legal security” is rated especially highly by the respondents. Firms that belong to a corporate group perceive the application of company standards as more beneficial to most of the success factors than single firms. According to simple t-test statistics, only the ratings for “optimization of R&D and innovation activities” are equally high independent of the form of business organization. Significant differences in the mean values

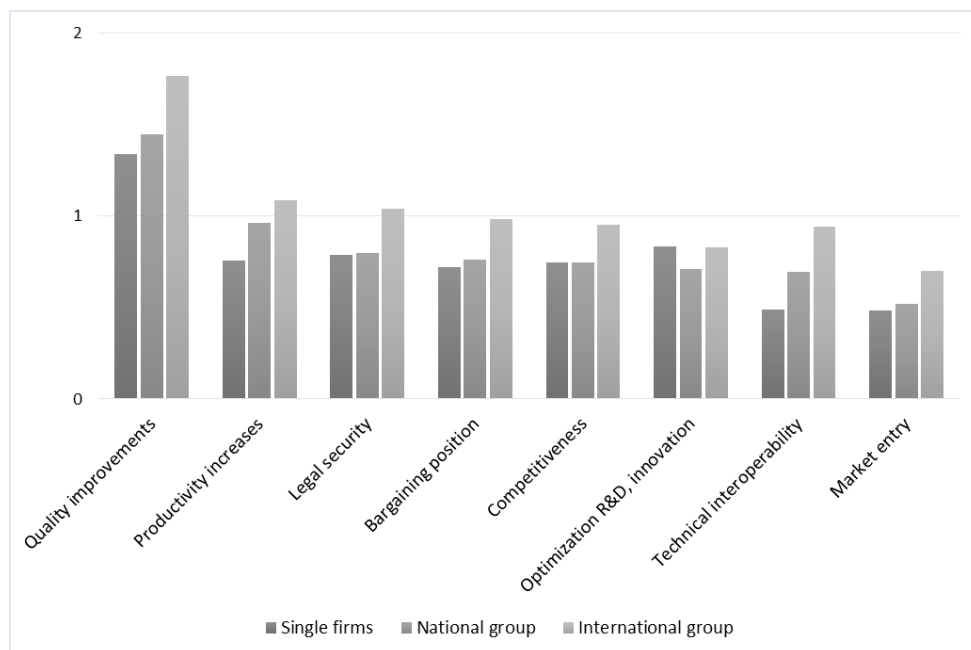
Why corporate groups care about company standards

between national and international corporate groups exist with respect to “quality improvements”. Due to small sample size, the following analyses use binary variables to measure the motives for the application of company standards. The variables equal 1 if the impact of company standards on the respective factor is positive (value 2) or very positive (value 3) and zero otherwise (values -3 to 1).

Table 4.1: Application of company standards by form of business organization

<i>Dependent variable</i>	Full sample (N = 725)	Single firm (N = 247)	National group (N = 79)	International group (N = 399)
Number of company standards				
No company standards	0.17	0.29	0.18	0.09
1 – 10 company standards	0.35	0.39	0.37	0.32
11 – 100 company standards	0.33	0.26	0.23	0.39
> 100 company standards	0.16	0.06	0.23	0.21

Figure 4.2: Average impact of company standards on business success factors by form of business organization; measured on a scale from -3 (very unimportant) to +3 (very important)



The number of applied standards, the form of business organization, and the impact of company standards on success factors are potentially correlated with the size, innovation activities, and extent of internal and external standardization work of the firm. For example, large firms have more resources to develop standards (Blind, 2004) and their value-chains are more likely to be fragmented.

Table 4.2: Mean values of independent variables by form of business organization

	Full sample (N = 725)	Single firms (N = 247)	National groups (N = 79)	International groups (N = 399)
<i>Positive impact on success factors:</i>				
Quality improvements	0.57	0.48	0.48	0.64
Productivity increases	0.37	0.31	0.33	0.41
Legal security	0.34	0.28	0.32	0.38
Bargaining position	0.30	0.23	0.29	0.34
Competitiveness	0.31	0.29	0.25	0.33
Optimization R&D, innovation	0.29	0.30	0.24	0.29
Technical interoperability	0.28	0.19	0.30	0.34
Market entry	0.23	0.16	0.19	0.28
<i>Control variables</i>				
Number of employees	5,956	723	3,702	9,642
Standardization department	0.29	0.19	0.28	0.35
International standardization	0.53	0.40	0.51	0.62
Product innovation	0.77	0.71	0.82	0.79
Process innovation	0.60	0.53	0.51	0.67
Consumer goods	0.07	0.08	0.08	0.06
CPRP	0.10	0.08	0.09	0.12
Manufacture of metals and metal	0.08	0.09	0.04	0.08
Electrical engineering	0.22	0.19	0.18	0.24
Mechanical engineering	0.19	0.14	0.15	0.22
Automotive engineering	0.06	0.03	0.09	0.06
Local industries and providers ¹⁰	0.09	0.07	0.14	0.09
Service industry	0.21	0.32	0.24	0.14
Year 2013	0.12	0.09	0.11	0.15
Year 2014	0.20	0.24	0.22	0.17
Year 2015	0.08	0.04	0.10	0.10
Year 2016	0.60	0.63	0.57	0.58

Internal standardization work is captured by a binary variable that takes the value one if the company has its own standardization department and zero otherwise. The extent of the firm's external standardization activities is captured by its engagement in international standardization organizations like ISO and IEC because almost 90% of the firms in the sample are active at

¹⁰ Includes mining and quarrying, EWS, and construction.

national level. Binary variables indicate whether a firm undertook product or process innovation in the previous year. Industry and year dummies control for sector- and year-specific effects.

Mean values of the independent variables for single firms and corporate groups are reported in Table 4.2. Simple t-test statistics indicate that corporate groups are larger, more often engaged in internal and external standardization work, more innovative and more often operate in mechanical and automotive engineering. The share of service providers is higher among single firms. Differences in mean values also exist between national and international corporate groups. MNEs employ a higher number of employees and more often have own standardization departments. They are more likely to operate in the metal industry, but less likely to be service providers.

Table 4.7 in the Appendix reports pairwise correlations between potential confounding factors and the variables of interest. The results provide no indication of multicollinearity problems.

4.3.2. Empirical Model and Results

The empirical analysis aims to assess the relationship between the number of company standards and form of business organization. Generalized ordered logit models take into account the ordinal scale of the dependent variable and allow to test the proportional odds assumption, i.e. whether the effect is the same for each category of the dependent variable (Williams, 2006). If all explanatory variables meet the assumption, the proportional odds model is applied. The partial proportional odds model, in contrast, allows effects to differ between categories of the dependent variable. The response variable is indicated by Y and has four ordered categories j ($j = 1, \dots, C$ with $C = 4$). The probability of each category on a vector x of p covariates is given by¹¹:

$$Pr[Y = j | x] = \phi_j(x) \quad (1)$$

The ordinal logistic model considers one set of dichotomies for each cut-off of the response variable and compares the probability of an equal or smaller response ($Y \leq j$) to the probability of a larger response ($Y > j$). In case of the number of company standards, the first set compares no versus at least 1 company standard, the second set few versus some and the third set compares the application of a medium versus high amount of standards. As the probability that the response variable equals C or smaller values is always one, $C-1$ cumulative probabilities are considered. The equation for the proportional odds model is:

¹¹ Explanations for the formal model are based on Hosmer et al. (2013) and Fullerton (2009).

Why corporate groups care about company standards

$$\ln\left(\frac{Pr[Y \leq k | x]}{Pr[Y > k | x]}\right) = \ln\left(\frac{Pr[Y \leq k | x]}{1 - Pr[Y \leq k | x]}\right) = \ln\left(\frac{\phi_1(x) + \dots + \phi_k(x)}{\phi_{k+1}(x) + \dots + \phi_C(x)}\right) \quad (2)$$

$$= \alpha_k - (\beta_{1k}x_1^* + \dots + \beta_{pk}x_p^*) - (\beta_1x_1 + \dots + \beta_px_p) \quad (3)$$

where $k = 1, \dots, C-1$, α_k is the cut point ($\alpha_1 < \dots < \alpha_{C-1}$), and β the vector of coefficients.

It follows:

$$Pr[Y \leq k | x] = F(\alpha_k - x\beta) = \frac{\exp[(\alpha_k - x^*\beta_k - x\beta)]}{1 + \exp[(\alpha_k - x^*\beta_k - x\beta)]} \quad (4)$$

The probability for any given category j is then given by:

$$\begin{aligned} Pr[Y = j | x] \\ = \begin{cases} F(\alpha_k - x^*\beta_k - x\beta) & k = 1 \\ F(\alpha_k - x^*\beta_k - x\beta) - F(\alpha_{k-1} - x^*\beta_k - x\beta) & 1 < k \leq C - 1 \\ 1 - F(\alpha_{k-1} - x^*\beta_k - x\beta) & k = C - 1 \end{cases} \end{aligned} \quad (5)$$

Parameters are estimated using maximum likelihood estimation.

The model results are depicted in Table 4.4. In the first specification (SI), reported in column I, the main independent variable of interest is the binary variable that indicates whether a firm is part of a corporate group or not. In column II, an interaction term indicating if firm introduced both product and process innovation is included. Both specifications fulfill the parallel lines assumption. Specification SIII and SIV report coefficients for the variables measuring the motives for standardization. Since all variables, except the measure of the impact on quality improvements, meet the parallel lines assumption, it is refrained from reporting the results for all cut-points. Model statistics in Table 4.3 indicate an overall good fit of the models. The estimation results for increasingly restrictive assumptions for outliers, determined by plotting deviance residuals against the estimated logistic probability (Sarkar et al., 2011), show that the findings are robust towards the exclusion of outliers.

The estimation results confirm that the membership with a corporate group is positively related to the application of company standards. Including the interaction of product and process innovations as a measure for more innovative firms does not affect the results (see column II) and indicates that process innovations alone increase the likelihood to apply company standards. A more detailed analysis is reported in Table 4.5 and reveals that the effect is the same for each category only for MNEs. National corporate groups that have no subsidiaries abroad are more likely than single firms to apply more than 100 company standards, but with respect to lower amounts no differences between the two groups can be observed. This implies that some national

Why corporate groups care about company standards

groups are more similar to single firms with respect to the application of company standards than others.

Table 4.3: Model statistics

	SI	SII	SIII	SIV	SV
Parallel lines assumption	fulfilled	fulfilled	not fulfilled	not fulfilled	not fulfilled
Pseudo R2	0.14	0.14	0.23	0.23	0.15
Wald Chi-Prob > chi2	227.2	227.2	314.8	316.3	229.8
Linktest	passed	passed	passed	not passed	passed
AIC	1692	1692	1547	1546	1691
BIC	1802	1802	1690	1693	1810

Column III of Table 4.4 illustrates that firms that expect company standards to have a positive impact on quality, productivity, legal security, and technical interoperability apply more company standards than firms for which they are less beneficial. However, quality improvements are not significantly related to the application of more than 100 company standards. The variables measuring importance of formal standards for market entry, optimization of R&D and innovation activities, competitiveness, and bargaining position towards suppliers and customers are not correlated with more extensive internal standardization.

The literature review revealed that the special role of company standards in corporate groups stems from their positive impact on intra-firm transaction costs, quality management, and the governance of internal interfaces through the realization of product portfolio compatibility and transfer of company-specific know-how. A first indication that only minor differences in the motives depending on the form of business organization exist results from the fact that the inclusion of the corporate group dummy does not render the result.

In order to analyze the differences in motives between corporate groups and single firms more deeply, binary variables measuring a positive assessment of the impact of company standards on factors of business success are regressed on the form of business organization, firm size, standardization and innovation activities, industry, and year dummies. Multivariate probit models are applied to control for unobserved factors that determine the impact assessments regarding the success factors simultaneously (Greene, 2012). The results for corporate groups are reported in Table 4.6.

Table 4.4: Proportional and partial proportional odds models

	SI	SII	SIII	SIV
	Number CS	Number CS	Number CS	Number CS
Corporate group	0.319* (0.172)	0.319* (0.172)		0.326* (0.177)
Quality improvements			1.167*** (0.284)	1.163*** (0.285)
Productivity increases			0.363** (0.186)	0.362* (0.186)
Legal security			1.12*** (0.200)	1.13*** (0.200)
Bargaining position			0.123 (0.191)	0.116 (0.191)
Competitiveness			-0.089 (0.194)	-0.074 (0.194)
R&D, innovation			0.252 (0.198)	0.285 (0.199)
Technical interoperability			0.681*** (0.212)	0.657*** (0.212)
Market entry			-0.291 (0.221)	-0.311 (0.22)
Log number of employees	0.292*** (0.038)	0.292*** (0.038)	0.308*** (0.037)	0.280*** (0.039)
Standardization department	0.653*** (0.173)	0.665*** (0.173)	0.442** (0.179)	0.455** (0.180)
International standardization	0.122 (0.155)	0.127 (0.155)	0.225 (0.160)	0.211 (0.160)
Product innovation	-0.159 (0.184)	0.006 (0.239)	-0.121 (0.189)	-0.119 (0.189)
Process innovation	0.336** (0.158)	0.625** (0.310)	0.213 (0.162)	0.224 (0.163)
Product and process innovation		-0.385 (0.354)		
Industry dummies	yes	yes	yes	yes
Year dummies	yes	yes	yes	yes
Observations	725	725	725	725

Note: Standard errors in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 4.5: Partial proportional odds model (SV) differentiating between national and international corporate groups

	Cut 1	Cut 2	Cut 3
Number of company standards	no CS vs any CS	up to 10 CS vs more than 10	up to 100 CS vs more than 100
National corporate group	0.177 (0.342)	0.257 (0.286)	1.02*** (0.338)
Multinational corporate group	0.317* (0.182)	0.317* (0.182)	0.317* (0.182)
Log number of employees	0.294*** (0.039)	0.294*** (0.039)	0.294*** (0.039)
Standardization department	0.653*** (0.173)	0.653*** (0.173)	0.653*** (0.173)
International standardization	0.127 (0.155)	0.127 (0.155)	0.127 (0.155)
Product innovation	-0.16 (0.185)	-0.16 (0.185)	-0.16 (0.185)
Process innovation	0.352** (0.159)	0.352** (0.159)	0.352** (0.159)
Industry dummies	yes	yes	yes
Year dummies	yes	yes	yes
Observations	725	725	725

*Note: Standard errors in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.*

Firms that are part of a corporate group more often state that company standards have a positive impact on market access and interoperability than single firms. The findings undermine that the importance of internal standardization for the conformance of products and processes with local entry requirements is greater for multinational corporations that operate in different business environments all over the world. With respect to the realization of technical interoperability, the coefficient is significantly positive for both national and multinational groups. The results point towards a special role of company standards in the development and management of internal platforms.

What additionally draws one's attention is that the existence of a standardization department is a highly significant predictor for a positive assessment of the impact of company standards while participation in international standardization processes is not related to any of the different motives to apply company standards. Company standards can possibly be more successfully applied when the responsibilities for their development lie with a specialized

department. It is not clear, however, whether the results imply that the perception of the effects of company standards is higher because of the existence of such a department or vice versa.

The empirical analysis further confirms that large firms are more likely than smaller firms to apply company standards for improvements in quality, legal security, competitiveness, and interoperability. In contrast, internal standardization facilitates productivity increases and cost reductions and improvements in bargaining position towards suppliers and customers in both small and large firms.

Interesting differences also exist with respect to the type of innovation. Firms that introduced product innovations in the previous year are more likely to successfully apply company standards for the optimization of R&D and innovation activities. The result supports the arguments of other scholars about the effect of standardization on innovation processes. Christensen et al. (1998), for example, highlight that modularity fosters product component innovation that facilitates adaption to consumer needs and increases differentiation (Lawless and Anderson, 1996; Langlois and Robertson, 1992). Process innovation is related to a more positive assessment of the impact of company standards on all factors relevant for business success except bargaining position and competitive advantages.

Assuming that the direction of the effect is from innovation to impact on success factors, the findings imply that innovative processes facilitate the application of company standards to ensure quality, law conformity, interoperability, and fulfillment of market entry conditions through specification of relevant requirements. In addition, only firms with optimized processes can gain from internal standardization in terms of optimized R&D activities, efficiency gains, and cost reductions through economies of scale and scope. It may also be the case that the results reflect a positive impact of the application of company standards on process innovation. Unfortunately, the present analysis does not allow to draw conclusions on the direction of causality.

The major limitation of the empirical analysis is the selection bias towards German firms participating in national standardization organizations. Even though it may increase comparability of the firms in the sample, general validity of the results cannot be concluded. The internal validity of the results could be affected by the influence of unobserved factors and errors of measurement. For example, the variable capturing innovativeness may not be a perfect proxy for the R&D activities of the firms. In addition, no statements can be made about the direction of causality based on cross-sectional analysis. Unfortunately, the data from the GSP does not yet allow for robust panel data analysis, due to small sample size.

Table 4.6: Multivariate probit regressions for the motives to apply company standards

	QI	PI	LS	BA	CO	RD	IO	ME
Corporate group	0.07 (0.11)	0.09 (0.12)	0.05 (0.12)	0.14 (0.12)	-0.09 (0.12)	-0.18 (0.12)	0.28** (0.12)	0.24* (0.13)
Log employees	0.1*** (0.02)	0.03 (0.02)	0.04* (0.03)	0.02 (0.03)	0.05** (0.03)	0.03 (0.03)	0.05** (0.03)	0.02 (0.03)
Standardization department	0.23** (0.11)	0.27** (0.11)	0.5*** (0.12)	0.26** (0.12)	0.22* (0.12)	0.3*** (0.12)	0.10 (0.12)	0.22** (0.12)
International standardization	-0.03 (0.10)	-0.07 (0.11)	-0.09 (0.11)	0.03 (0.11)	-0.06 (0.11)	-0.10 (0.11)	-0.01 (0.11)	-0.03 (0.12)
Product innovation	0.07 (0.12)	-0.05 (0.13)	0.02 (0.13)	-0.00 (0.13)	0.05 (0.13)	0.31** (0.14)	0.03 (0.14)	0.18 (0.15)
Process innovation	0.26** (0.10)	0.20* (0.11)	0.24** (0.11)	0.15 (0.11)	0.12 (0.11)	0.20* (0.11)	0.23** (0.11)	0.3*** (0.12)
Industries	yes	yes	yes	yes	yes	yes	yes	yes
Year dummies	yes	yes	yes	yes	yes	yes	yes	yes
Observations	725	725	725	725	725	725	725	725

Note: Standard errors in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

The results indicate but provide no direct evidence that there is a positive relationship between FDI and the application of company standards. The preferred group to compare with MNEs would be corporate groups without subsidiaries abroad instead of single companies, because they are more similar to MNEs with respect to their organizational structure. However, estimation results of differences between MNEs and national corporate groups would be questionable due to small sample size.

4.4. Conclusion

In the course of global integration, international firms face strong pressures to adapt products to consumer needs and to achieving cost efficiency in order to compete with global competitors. The reduction of communication and transaction facilitates the fragmentation of the value-chains and opens up opportunities to develop complex international strategies. By codifying information, specifying requirements, and increasing interoperability, standards play a crucial role for the success of such operations. Corporate groups particularly benefit from the application of company standards. If value-chain activities become more complex and include company-specific know-how and resources, company standards can act as a tool for coordinating internal interfaces and integrating subsidiaries worldwide. They transfer information and knowledge,

thereby keeping high-value assets within the boundaries of the firm and facilitating the exploitation of competitive advantages abroad. Internal standardization supports the development of a strong corporate culture and makes possible the monitoring of subsidiary performance. Better quality assurance increases customer satisfaction and loyalty, and thereby improves the global image of the firm. Standardization of product specifications facilitates modularization and the development of product platforms, which increases flexibility while efficiency gains can still be achieved.

Using data from the GSP, this paper empirically tests the relationship between the application of company standards and the form of business organization. Controlling for size, standardization and innovation activities, and industry, the results confirm that corporate groups utilize a higher number of company standards than single companies in Germany. Additional explaining factors are firm size, the existence of a standardization department, and process innovation.

The main motives for internal standardization are quality improvements, productivity increases, legal security, and technical interoperability. Differences between corporate groups and single firms only exist regarding the impact of company standards on the realization of technical interoperability and the fulfillment of market entry conditions. While only multinational corporate groups have a higher likelihood to give a positive assessment regarding market access, both national and international groups state more often that company standards enhance interoperability. The results underline the special role of internal standardization for the development and management of internal platforms and the conformity of products and processes with local entry requirements when operating in different business environments. In addition, large firms are more likely than smaller firms to apply company standards for quality improvements, legal security, technical interoperability, and competitiveness. No differences exist with respect to improvements in productivity and bargaining position depending on firm size. Accordingly, small and especially medium-sized firms should consider internal standardization as a strategic tool for the optimization of internal processes. The level of innovativeness is a relevant factor for the impact of company standards on all success factors except bargaining position and competitiveness.

The implications of this study are of considerable importance to value-chain managers, who should consider the effects of company standards on the governance of inter- and intra-firm relationships. In addition, the application of high-quality company standards creates positive externalities, providing a rationale for government support for internal standardization. The results of the study suggest that support should be targeted in particular to small and medium-sized enterprises that value company standards as beneficial for productivity increases and cost

reductions as large firms. However, the latter still are more likely to successfully apply company standards for improvements in quality, competitiveness, and interoperability.

More research is needed on the role of company standards for the diffusion of information, cultural norms, and values in corporate groups. Both innovation and standardization researcher should focus their attention on the positive relationship between process innovation and application of company standards, and delve deeper into the mechanisms of technology transfer in order to assess the potentials of standardization for innovation activities.

4.5. References

- Argyres N., Bigelow L. (2010). Innovation, Modularity, and Vertical Deintegration: Evidence from the Early U.S. Auto Industry. *Organization Science*, 21 (4), pp. 842-853.
- Baake P., Schlippenbach V. (2011). Quality Distortions in Vertical Relations. *Journal of Economics*, 103(2), pp. 149–169.
- Bartlett C.A., Ghoshal S. (2002). *Managing Across Borders: The Transnational Solution*. Boston, MA, USA: Harvard Business School Press.
- Blind K. (2004). *The Economics of Standards. Theory, Evidence, Policy*. Cheltenham, UK, Northampton, MA, USA: Edward Elgar.
- Blind K. (2013). The Impact of Standardization and Standards on Innovation. *NESTA Working Papers*, No. 13/15, London, UK. Available at: <https://goo.gl/BsSCnv>.
- Blind K., Großmann A.-M.C. (2014). An Exploratory Analysis of Company Standards –Evidence from the German Standardization Panel. In I. Mijantovic and K. Jakobs (Eds.), *EURAS Proceedings 2014, Cooperation between Standardisation Organisations and the Scientific and Academic Community*. Aachen, Germany: Mainz, G.
- Boiral O. (2003). ISO 9000: Outside the Iron Cage. *Organization Science*, 14(6), pp. 720-737.
- Boiral O. (2007). Greening through ISO 14001: A Rational Myth? *Organization Science*, 18(1), pp. 127-146.
- Christensen C., Suarez A., Utterback J. (1998). Strategies for Survival in Fast-Changing Industries. *Management Science*, 44, pp. 207-220.
- Christensen C., Verlinden M., Westerman G. (2002). Disruption, Disintegration and the Dissipation of Differentiability. *Industrial and Corporate Change*, 11, pp. 955-993
- Christmann P. (2004). Multinational Companies and the Natural Environment: Determinants of Global Environmental Policy Standardization. *Academy of Management Journal*, 47(5), pp. 747–760.

- Clougherty J.A., Grajek M. (2008). The Impact of ISO 9000 Diffusion on Trade and FDI: A New Institutional Analysis. *Journal of International Business Studies*, 39(4), pp. 613-633.
- Clougherty J.A., Grajek M. (2014). International Standards and International Trade: Empirical Evidence from ISO 9000 Diffusion. *International Journal of Industrial Organization*, 36, pp. 70-82.
- Coase R.H. (1937). The Nature of the Firm. *Economica*, 4(16), pp. 386-405.
- De Casanove A., Lambert I. (2016). How Corporate Standardisation Shapes Tomorrow's Business. In K. Jakobs (Ed.), *Effective Standardization Management in Corporate Settings*, pp. 1-17. Hershey, PA, USA: IGI Global.
- De Vries H. (2007). Fundamentals of Standards and Standardization. In W. Hesser, A. Feilzer, H. de Vries et al. (Eds.), *Standardization in Companies and Markets* (2nd ed.), pp. 1-44. Hamburg, Germany: Helmut Schmidt University.
- De Vries H., Slob F., van Gansewinkel, Z. (2006). Best Practice in Company Standardization. *International Journal of IT Standards and Standardization Research*, 4, pp. 62-85.
- DIN EN 45020 (2007). Berlin, Germany: Beuth Verlag GmbH.
- Dowell G., Hart S., Yeung B. (2000). Do Corporate Global Environmental Standards Create or Destroy Market Value? *Management Science*, 46(8), pp. 1059–1074.
- Dunning J.H. (1993). *Multinational Enterprises and the Global Economy*. Harlow, UK: Addison-Wesley.
- Festing M., Eidems J. (2011). A Process Perspective on Transnational HRM Systems - A Dynamic Capability-based Analysis. *Human Resource Management Review*, 21(3), pp. 162–173.
- Fortanier F., Kolk A., Pinkse J. (2011). Harmonization in CSR Reporting. *Management International Review*, 51, pp. 665–696.
- Fullerton A.S. (2009). A Conceptual Framework for Ordered Logistic Regression Models. *Sociological Methods & Research*, 38(2), pp. 306–347.
- Gawer A., Cusumano M.A. (2013). Industry Platforms and Ecosystem Innovation. *Journal of Product Innovation Management*, 31(3), pp.417-433.
- Gereffi G., Lee J. (2012). Why the World Suddenly Cares About Global Supply Chains. *Journal of Supply Chain Management*, 48(3), pp. 24–32.
- Gereffi G., Humphrey J., Sturgeon T. (2005). The Governance of Global Value-chains. *Review of International Political Economy*, 12(1), pp. 78–104.
- Gibbon P., Ponte S. (2005). *Trading Down: Africa, Value-chains and the Global Economy*. Philadelphia, PA, USA: Temple University Press.
- Greene W.H. (2012). *Econometric Analysis* (7th ed.). Boston, MA, USA: Prentice Hall.

- Großmann, A.-M.C. (2015). The Microeconomics of Standards. Five Essays on the Relation of Standards to Innovation and Inter-firm Relationships. Dissertation. Berlin, Germany: Technische Universität Berlin.
- Großmann A.-M.C, Gruben P.-V. von (2014). The Role of Company Standards in Supply Chains – The Case of The German Automotive Industry. In T. Blecker (Ed.), *Innovative Methods in Logistics and Supply Chain Management: Current Issues and Emerging Practices*, pp. 99-121. Berlin, Germany: epubli GmbH.
- Großmann A.-M.C., Gruben P.-V. von, Lazina L.K. (2016). Strategic Development and Implementation of Company Standards. In Jakobs K. (Ed.), *Effective Standardization Management in Corporate Settings*, pp. 77–104. Hershey, PA, USA: IGI Global.
- Guler I., Guillén M.F., Macpherson J.M. (2002). Global Competition, Institutions, and the Diffusion of Organizational Practices: The International Spread of ISO 9000 Quality Certificates. *Administrative Science Quarterly*, 47(2), pp. 207-232.
- Hansen MT, Lovas B. 2004. How Do Multinational Companies Leverage Technological Competencies? Moving from Single to Interdependent Explanations. *Journal of Management Studies*, 25, pp. 801–822.
- Harzing A.-W., Sorge A. (2003). The Relative Impact of Country of Origin and Universal Contingencies on Internationalization Strategies and Corporate Control in Multinational Enterprises: Worldwide and European Perspectives. *Organization Studies*, 24(2), pp. 187–214.
- Henson S., Reardon T. (2005). Private Agri-food Standards: Implications for Food Policy and the Agri-food System. *Food Policy*, 30, pp. 241–253.
- Hosmer D.W., Lemeshow S., Sturdivant R.X. (2013). *Applied Logistic Regression* (3rd ed.). Hoboken, NJ, USA: John Wiley & Sons.
- Hudson J., Jones P. (2003). International Trade in ‘Quality Goods’: Signalling Problems for Developing Countries. *Journal of International Development*, 15(8), pp. 999-1013.
- Jaffee S., Masakure O. (2005). Strategic Use of Private Standards to Enhance International Competitiveness: Vegetable Exports from Kenya and Elsewhere. *Food Policy*, 30(3), pp. 316–333.
- Kaplinsky R. (2010). The Role of Standards in Global Value-chains. *Policy Research Working Papers*, No. 5396, World Bank, Washington, D.C., USA.
- Kogut B, Zander U. (1993). Knowledge of the Firm and the Evolutionary Theory of the Multinational Corporation. *Journal of International Business Studies*, 24(4), pp. 625-646.

- Larsson R, Finkelstein S. (1999). Integrating Strategic, Organizational, and Human Resource Perspectives on Mergers and Acquisitions: A Case Study of Synergy Realization. *Organization Science*, 10(1), pp. 1-26.
- Krugman, P. (1995). Growing World Trade: Causes and Consequences. *Brookings Papers on Economic Activity*, 25(1), pp. 327-362.
- Langlois R, Robertson P. (1992). Networks and Innovation in a Modular System: Lessons from the Microcomputer and Stereo Component Industries. *Research Policy*, 21, pp. 297-313.
- Lerner J., Tirole J. (2014). A Better Route to Tech Standards. *Science*, 343(6174), pp. 972-973.
- Maruchek A., Greis N., Mena C., Cai L. (2011). Product Safety and Security in the Global Supply Chain: Issues, Challenges and Research Opportunities. *Journal of Operations Management*, 29 7-8, pp. 707-720.
- Mellahi K., Frynas, J. G., Collings D. G. (2015). Performance Management Practices within Emerging Market Multinational Enterprises: The Case of Brazilian Multinationals. *The International Journal of Human Resource Management*, pp. 1-30.
- Muffatto M. (1999). Introducing a Platform Strategy in Product Development. *International Journal of Production Economics*, 60, pp. 145-153.
- Perera C. (2007). Standardization in Product Development and Design. In W. Hesser (Ed.), *Standardisation in Companies and Markets*, pp. 171-212. Hamburg, Germany: Helmut-Schmidt-University.
- Perez-Aleman P. (2011). Collective Learning in Global Diffusion: Spreading Quality Standards in a Developing Country Cluster. *Organization Science*, 22(1), pp. 173-189.
- Prahalad C.K., Doz Y. (1987). *The Multinational Mission: Balancing Local Demands and Global Vision*. New York, USA: Free Press.
- Prakash A., Potoski M. (2007). Investing Up: FDI and the Cross-country Diffusion of ISO 14001 Management Systems. *International Studies Quarterly*, 51, pp. 723-744.
- Sarkar S.K., Midi H., Rana S. (2011). Detection of Outliers and Influential Observations in Binary Logistic Regression: An Empirical Study. *Journal of Applied Sciences*, 11, 26-35.
- Schilling M. (2000). Toward a General Modular Systems Theory and its Application to Interfirm Product Modularity. *The Academy of Management Review*, 25, pp. 312-334.
- Simpson T.W. (2004). Product Platform Design and Customization: Status and Promise. *Artificial Intelligence for Engineering Design, Analysis and Manufacturing*, 18(1), pp. 3-20.
- Sturgeon T., van Biesebroeck J., Gereffi G. (2008). Value-chains, networks and clusters: reframing the global automotive industry. *Journal of Economic Geography*, 8, pp. 297-321.

- Swann G.M.P. (2010). International Standards and Trade: A Review of the Empirical Literature. *OECD Trade Policy Papers*, No. 97, OECD Publishing, Paris, France.
- Tallman S., Chacar A.S. (2011). Knowledge Accumulation and Dissemination in MNEs: A Practice-Based Framework. *Journal of Management Studies*, 48, pp. 278–304.
- Ton Z., Huckman R.S. (2008). Managing the Impact of Employee Turnover on Performance: The Role of Process Conformance. *Organization Science*, 19(1), pp. 56-68.
- Williams R. (2006). Generalized Ordered Logit/Partial Proportional Odds Models for Ordinal Dependent Variables. *The Stata Journal*, 6(1), pp. 58-82.

4.6. Appendix

Table 4.7: Pairwise correlations of variables measured by Spearman's rho (*significant at 1%).

	N° CS	NG	MNE	SF	lnE	DEP	PAR	PDI	PZI
National groups (NG)	0.01	1.00							
International groups (MNE)	0.27*	-0.39*	1.00						
Single firms (SF)	-0.29*	-0.25*	-0.80*	1.00					
Log number of employees (lnE)	0.47*	0.03	0.49*	-0.50*	1.00				
Standardization department (DEP)	0.31*	0.01	0.15*	-0.16*	0.32*	1.00			
International standardization (PAR)	0.18*	0.02	0.19*	-0.19*	0.29*	0.20*	1.00		
Product innovation (PDI)	0.14*	0.05	0.07	-0.10*	0.20*	0.18*	0.13*	1.00	
Process innovation (PZI)	0.21*	-0.07	0.15*	-0.11*	0.29*	0.18*	0.22*	-0.28*	1.00
Consumer goods	0.01	0.01	-0.03	0.03	0.04	-0.05	-0.03	0.06	-0.04
Chemicals, pharmaceuticals, rubber, plastic	0.06	-0.01	0.06	-0.05	0.07	-0.05	0.02	0.04	0.03
Metals and metal products	0.05	-0.05	0.01	0.02	-0.02	-0.02	-0.02	0.03	0.01
Electrical engineering	0.01	-0.03	0.06	-0.04	0.06	0.04	0.14*	0.14*	0.03
Mechanical engineering	0.09	-0.03	0.10*	-0.08	0.08	0.14*	-0.01	0.12*	0.02
Automotive engineering	0.18*	0.05	0.04	-0.07	0.11*	0.15*	-0.03	0.00	0.02
Service industry	-0.29*	0.03	-0.20*	0.19*	-0.30*	-0.15*	-0.06	-0.25*	-0.06
Local industries and providers	0.00	0.07	0.00	-0.05	0.05	-0.05	-0.06	-0.14*	-0.01

	LS	ME	IO	PI	QI	RD	CO	BA
Legal security (LS)	1.00							
Market entry (ME)	0.51*	1.00						
Technical interoperability (IO)	0.48*	0.48*	1.00					
Productivity increases (PI)	0.34*	0.28*	0.39*	1.00				
Quality improvements (QI)	0.41*	0.32*	0.36*	0.51*	1.00			
Optimization R&D, innovation (RD)	0.36*	0.35*	0.42*	0.37*	0.38*	1.00		
Competitiveness (CO)	0.40*	0.38*	0.36*	0.34*	0.35*	0.44*	1.00	
Bargaining position (BA)	0.36*	0.36*	0.40*	0.35*	0.35*	0.30*	0.44*	1.00
Number company standards	0.43*	0.27*	0.39*	0.34*	0.43*	0.29*	0.26*	0.28*
National groups	-0.02	-0.03	0.02	-0.03	-0.06	-0.04	-0.04	-0.00
International groups	0.10*	0.13*	0.14*	0.10*	0.16*	0.01	0.06	0.11*
Single firms	-0.09	-0.12*	-0.15*	-0.09	-0.13*	0.02	-0.03	-0.11*
Log number of employees	0.17*	0.14*	0.20*	0.15*	0.24*	0.10*	0.13*	0.15*
Standardization department	0.21*	0.14*	0.13*	0.14*	0.16*	0.14*	0.12*	0.15*
International standardization	0.03	0.05	0.05	0.04	0.08	0.03	0.01	0.07
Product innovation	0.07	0.09	0.06	0.05	0.12*	0.13*	0.05	0.06
Process innovation	0.13*	0.14*	0.11*	0.10*	0.15*	0.10*	0.07	0.08
Consumer goods	0.00	0.01	-0.01	0.00	0.02	0.09	0.03	0.02
Chemicals, pharmaceuticals, rubber, plastic	0.06	0.06	0.05	0.04	0.07	0.09	0.06	0.05
Metals and metal products	0.06	-0.01	0.00	0.06	0.07	0.02	0.05	-0.07
Electrical engineering	-0.08	-0.01	-0.06	-0.07	-0.03	0.01	-0.08	0.00
Mechanical engineering	0.07	0.06	0.09	0.09	0.10*	-0.02	0.06	0.05
Automotive engineering	0.07	0.06	0.14*	0.05	0.06	0.06	0.07	0.09
Service industry	-0.15*	-0.12*	-0.16*	-0.15*	-0.21*	-0.12*	-0.10*	-0.14*
Local industries and providers	0.06	0.00	0.03	0.05	-0.02	-0.05	-0.01	0.06

5. Subsidiary Strategy and Importance of Standards: Reinterpreting the Integration-Responsiveness Framework

***Abstract:** According to the IRF, subsidiaries of multinational enterprises (MNEs) are assigned different strategic roles depending on the business environment they operate in. MNEs are classified into multinational, international, transnational, and global firms depending on the pressures they face for local responsiveness and global integration. This study adds a new dimension to this characterization: the importance of standards. Cluster analysis confirms that MNE subsidiaries can be grouped according to variables indicating the importance of formal and company standards. While conformity with national formal standards is necessary to meet pressures for local responsiveness, the application of international standards provides firms with access to global markets. Company standards and management system standards are of particular importance to firms that simultaneously face pressures for global integration and local responsiveness. They facilitate efficiency gains and improve bargaining position, and thereby promote the development of platforms.*

5.1. Introduction

Worldwide economic, financial, and cultural integration requires companies to take a global perspective. The reduction of communication and transaction cost makes possible the fragmentation of the value-chain (Deardorff, 2001), opening up opportunities to adapt to the rapid globalization by developing complex international strategies. The development of international production networks, known as global value-chains, facilitates the specialization in core competencies, to profit from efficiency gains and lower input prices, and to access new markets. Vertical integration of international value-chain activities by acquiring 10% or more of the voting power in a business enterprise in another country is referred to as FDI (OECD, 2016). Data from OECD Statistics reveals that, in 2014, global FDI inflows amounted to \$1.23 trillion, 55% of which were channeled to developing countries. Germany is the world's fifth biggest investor as well as an important host of FDI. According to the Federal Statistical Office of Germany 2016, more than three million people were employed by foreign owned enterprises in Germany, illustrating the economic significance of direct investment.

Due to the major contribution MNEs make to the economy, the development of a typology of MNEs has been subject of research for decades already. Classification facilitates investigation of the motives for FDI, understanding of the modes and effects of establishing multinational organizations, and predictability of such complex activities (Harzing, 2000).

MNEs create value through “international arbitrage” - the exploitation of benefits from multiple embeddedness through effective deployment of resources around the world. Studies show that one way for MNEs to coordinate and integrate value-chain activities worldwide is the application of standards (e.g. Dunning, 2001; Dowell et al., 2000; Guler et al., 2002; Christmann, 2004; Jaffee and Masakure, 2005; Gereffi et al., 2005; Gibbon and Ponte, 2005; Prakash and Potoski, 2007; Clogherty and Grajek, 2008, 2014; Kaplinsky, 2010; Fortanier et al., 2011; Gereffi and Lee, 2012; Großmann and von Gruben, 2014; Großmann et al., 2016). However, many of the existing studies on global value-chains and standards focus on certain industries, lack precise definitions of and differentiation between various types of standards, and neglect differences in the effects of standards between types of MNEs.

MNE subsidiaries take different roles within the group. “Strategic control (...) involves the assignment of different strategic missions to subsidiaries, depending on the nature of competitive interaction (...)” (Prahalad and Doz, 1987: 160). Along the two imperatives pressures for local responsiveness and pressures for global integration, Bartlett and Ghoshal (2002) classify MNEs into multinational, international, transnational, and global firms. Subsidiaries may be intended to access new markets and to meet local needs, or to take an important role within a

highly integrated network of firms. The various strategies imply differences between subsidiaries regarding the adaption to market-specific requirements, the allocation of resources, the control over the design of products and processes, and the dependencies with headquarters and other group members. The type of knowledge shared between group members depends on the strategic purpose of the respective subsidiaries and determines how the knowledge is transferred (Tallman and Chacar, 2011). Accordingly, the importance of different types of standards possibly varies depending on the subsidiary's strategy, but yet no studies exist on the relationship between the strategic focus of a firm and the importance of standards.

The contribution of this study is to apply the widely accepted IRF, which has greatly influenced the international management literature (Rugman et al., 2011; Harzing, 2000), to standards in order to derive conclusions on the relationship between subsidiary strategy and the application of different types of standards. By identifying additional variables characterizing different types of MNEs, this study takes a further step towards overcoming the "lack of conceptual clarity" of the IRF (Roth and Morrison, 1990: 545). The next section derives hypotheses about the implications of MNE subsidiary strategy for the relative importance of different types of standards. The empirical analysis based on data from the GSP is introduced in the third section. This survey data provides detailed information on the importance of standards to subsidiaries in different industries and allows clear differentiation of various types of standards. The last section discusses potential limitations of the study and concludes.

5.2. Conceptual Framework

In order to analyze the relationship between subsidiary strategies and the application of standards, it is important to define the various roles subsidiaries can take in the company and to understand how they differ and what their implications are for local management and parent company involvement. A significant contribution to the international management literature is the IRF that provides an extensive typology of multinational firms.

5.2.1. The Integration-Responsiveness Framework

The IRF was first introduced by Prahalad and Doz (1987) and has been continuously developed over the following 20 years. Harzing (2000) provides a broad overview of the developments. The framework distinguishes strategies of MNEs depending on the business environment they operate in. In its origins, three types of firms were identified: multinational, global, and transnational firms. This study is mainly based on the second edition of Bartlett and

Ghoshal's work published in 2002, in which they additionally consider a fourth category: the international firm. Most empirical studies provide empirical support for the framework (e.g. Roth and Morrison, 1990; Johnson, 1995; Taggart, 1997; Harzing, 2000; Meyer and Estrin, 2014), strengthening its acceptance in the research field of international management.

The IRF classifies MNEs along the two imperatives “pressures for local responsiveness” and “pressures for global integration”. The former pressure may result from cultural, language, economic, or regulatory differences between the home and the host country. It causes market-based adaptations of products to meet specific needs of buyers. As only the most productive firms are able to sell abroad (Melitz, 2003), companies aim to increase efficiency and reduce costs by establishing specialized factories, exploiting cost advantages through optimal sourcing, and coordinating business activities on a worldwide scale. Products produced for the global market in few locations are centrally managed and sold under a global brand, generating economies of scale and fostering learning. If pressures are high for local responsiveness but low for global integration, subsidiaries will pursue a *multinational strategy* and act autonomously (Taggart, 1998). Affiliates in different countries act independently from each other and are granted autonomy to adapt products and management practices to local conditions such as national formal standards.

If no pressure exists for local responsiveness and products meet the requirements of a broader range of customers, the MNE can duplicate successful activities from its home country in the foreign country without having to adjust products or management practices to local conditions. This is referred to as *international strategy* or “quiescent strategy” as introduced by Taggart (1998). Subsidiaries exploit parent company knowledge but are viewed as independent from home activities. As pressures for integration are low, the interconnection between members of the MNE is low.

MNEs that face high pressures towards global integration seek to achieve global efficiency by centrally producing, managing, and advertising worldwide business activities. Global firms specialize in products that meet a universal need instead of local requirements. The *global strategy* is characterized by economies of scale and cross-national learning (Birkinshaw et al., 1995). Sourcing from well-integrated suppliers is also part of the efficiency strategy. Typically, activities that are less know-how intensive are offshored in order to exploit cost advantages in terms of lower input prices. Integration of the fragmented value-chain creates interdependencies between subsidiaries. Control and strategic coordination of resource allocation, logistics, pricing, and interactions between headquarters and subsidiaries are essential for the success of a global firm (Prahalad and Doz, 1987).

The fourth type of a MNE describes a highly integrated firm which at the same time needs to adjust products or management practices to local conditions. The transnational strategy implies a flexible approach in which, as far as possible, cost efficiency is maximized through optimal sourcing and centralized organizational activities while product development and manufacturing remain locally responsive if necessary. Subsidiaries may differ regarding the extent of local responsiveness, depending on the markets they operate in. While some are granted autonomy to adapt products to local needs, others take an important role within the integrated network, and hence are more centrally controlled (Bartlett and Ghoshal, 2002). Product platforms and modularization allow production of a wide product range (Muffatto, 1999), and thereby facilitates cross-subsidizing, greater bargaining power, and faster amortization of technologies (Prahalad and Doz, 1987).

Bartlett and Ghoshal (2002) provide a summary of the different MNEs' organizational characteristics which is depicted in Table 5.1. The IRF has interesting implications regarding the relative importance of different types of standards for MNEs' subsidiaries, depending on their strategic role. The various types of standards are introduced in the following.

Table 5.1: Organizational Characteristics of Multinational, Global, International and Transnational Companies

Organizational characteristics	Multinational	Global	International	Transnational
Configuration of assets and capabilities	Decentralized and nationally self-sufficient	Centralized and globally scaled	Sources of core competencies centralized, others decentralized	Dispersed, interdependent, and specialized
Role of overseas operations	Sensing and exploiting local opportunities	Implementing parent company strategies	Adapting and leveraging parent company competencies	Differentiated contribution by national units to integrated worldwide operations
Development and diffusion of knowledge	Knowledge developed and retained within each unit	Knowledge developed and retained at the center	Knowledge developed at the center and transferred to overseas units	Knowledge developed jointly and shared worldwide

Source: Bartlett and Ghoshal, 2002: 65.

5.2.2. Types of Standards and Their Role in MNEs

A standard is a “document, that provides, for common and repeated use, rules, guidelines, or characteristics for activities or their results, aimed at achievement of the optimum degree of order in a given context (...)” (DIN EN 45020). According to DIN 820-3 standards can be classified, depending on their purpose, into service, fitness for purpose, supply, measurement, planning, testing, quality, safety, material, process, and comprehensibility standards. The application of standards can reduce transaction costs and facilitates the specialization of companies on different stages of the value-chain (Swann, 2010b). They can be used to diffuse internal knowledge and external information (Großmann et al., 2016). Gupta and Govindarajan (2000) discuss seven types of knowledge that flow within MNEs: marketing know-how, distribution know-how, packaging design, product design, process design, purchasing know-how, management systems, and management practices. Standards can act as a tool to diffuse information and technologies between subsidiaries (Sturgeon et al., 2008; Swann, 2010b). However, the type of standard to be used differs according to the intended scope of information distribution. This study considers two types of standards to be of particular relevance for the internal governance of international firms: formal standards and company standards.

Formal standards are established in consensus-based decision-making processes and are available to all market players (Blind, 2004). The application of formal standards is typically considered less expensive than in-house development and provides certainty to customers and business partners (De Casanove and Lambert, 2016).

National formal standards developed at national institutes involving experts that represent local interests are specific to the domestic market. The application of national standards can create competitive advantages abroad, and thereby improve firms’ export performance (Swann, 2010a). In addition, they can be used to protect domestic producers by raising costs of exporting for foreign firms (Chen et al., 2006).

International harmonization of standards reduces barriers to trade by facilitating compatibility between products and reducing information asymmetries (Swann, 2010a). International formal standards comprise standards important for selling products on global markets, such as date and time formats, or language codes. Independent of the market focus, they additionally play a major role in management systems. The most prominent standards concern quality management, environmental management, energy management and social responsibility. International management system standards can represent the code of conduct for operations in corporate groups (Bénézech et al., 2001), and play an important role in international company networks. Clougherty et al. (2016) provide some evidence that the acquisition of an internationally

recognized quality certification is positively related to interactions between parent and affiliated companies. In addition, guidelines exist for labor regulation and transparency (Prahalad and Doz, 1987). In some cases, international standards interact with or even replace regulatory governance (e.g. Löhe and Blind, 2015; Blind et al., 2017).

The importance of national relative to international formal standards relates to the degree of responsiveness, i.e. whether the target of the firm is the domestic or the global market. Implementation of harmonized management systems through the application of international standards can foster integration of subsidiaries.

Formal standardization reduces the level of differentiation between products and bears the risk of inadvertently leaking proprietary information. If technologies and business practices that are transferred between value-chain activities convey knowledge that is valuable to the firm, companies will seek to keep such assets within the boundaries of the firm (Gereffi et al., 2005).

A *company standard* is developed by a firm to meet its own needs and requirements (Düsterbeck et al., 1995). In contrast to formal standards, they have a private character and are generally not open to public access (Blind, 2004). Company standards are more specific than formal standards, they incorporate the latest available technological advances which have yet not been documented in formal standards, and their development requires less time (de Vries, et al., 2006; Großmann et al., 2016).

By facilitating modularization, standardization is associated with deintegration of value-chain activities, because of a decrease in asset specificity (e.g. Argyres and Bigelow, 2010). Standardization for deintegration implies, however, that firm-specific, idiosyncratic knowledge can no longer be used as a source of competitive advantages (Schilling, 2000). Variety reduction then results in profit losses. Modularization through the application of company standards can simultaneously enhance differentiation and efficiency (Großmann et al., 2016) by facilitating the internal fragmentation of value-chain activities and the development of a high-performance company network.

Standardized product specifications facilitate the development of product platforms (Muffatto, 1999). Platforms are “subsystems and interfaces that form a common structure from which a company can efficiently develop and produce a family of products (...)” (Gawer and Cusumano, 2014: 419). This enables adaption of products to local demands while economies of scale and scope are still achieved (Langlois and Robertson, 1992; Simpson, 2004).

Managing product platforms in line with a company-specific strategy is complex and requires the development of a strong corporate culture, routines, and knowledge transfer processes. Internal standardization can be a tool to diffuse company-specific knowledge and technologies between value-chain activities (Sturgeon et al., 2008). This enables the transfer of

high-value assets within the boundaries of the firm and the exploitation of competitive advantages abroad (Christmann, 2004; Guler et al., 2002; Jaffee and Masakure, 2005). Even if knowledge is “sticky” and can only be transferred through personal contacts, standards can create common practice and understanding and, thus, the absorptive capacity required to diffuse knowledge (Tallman and Chacar, 2011; Hansen and Lovas, 2004). As the codification of company-specific competencies and tacit organizational know-how requires a clear understanding of the processes, standards foster learning and innovation (Blind, 2013; Swann, 2010b; Lazina, 2016; Kogut and Zander, 1993). Developing routines and knowledge transfer processes within the firm-specific strategic context helps to ensure responsible corporate behavior, and to establish a global brand. Internal standardization thereby supports the development of a high-performance enterprise network with a strong corporate culture (e.g. Festing and Eidems, 2011; Dowell et al., 2000). Company standards act as a tool to implement common organizational practices and values across all subsidiaries and facilitate company-specific performance measurement procedures (De Casanove and Lambert, 2016; Festing and Eidems, 2011). This can serve as a control mechanism to monitor subsidiary performance tailored to the needs of the corporate group (e.g. Bartlett and Ghoshal, 2002; Ferner, 2000; Harzing and Sorge, 2003). Quality assurance is essential for the development of a global brand. It increases customer satisfaction and loyalty, thereby improving the global image of the firm and strengthening its reputation (Dowell et al., 2000). Low-quality formal standards can be seen as a reason to develop company standards (Hoops and Hesser, 2003).

While some studies show that the effectiveness of international management system standards such as ISO 9001 and ISO 14001 in improving internal processes is limited (e.g. Boiral, 2007; Boiral, 2003), others argue that the implementation and certification of internationally recognized management systems can enhance integration and efficiency (e.g. Larsson and Finkelstein, 1999; Hudson and Jones, 2003; Clougherty and Grajek, 2008). Likewise, the development and implementation of company standards can help to optimize internal processes. Internal standardization might constitute an even better tool to reach this goal because they are adapted to the company’s specific needs. Ton and Huckman (2008), for example, show that the application of internal process standards can reduce the negative effects of turnover because it avoids that knowledge is locked in employees and facilitates knowledge diffusion. Internal standardization can serve as a control mechanism that enables the monitoring of subsidiary performance (Bartlett and Ghoshal, 2002; Harzing und Sorge, 2003). This is especially relevant in MNEs whose subsidiaries operate in different business environments and cultures.

Applying the IRF to standardization reveals interesting implications for the relative importance of different types of standards depending on the subsidiary’s strategy.

5.2.3. The Relationship between Subsidiary Strategy and the Application of Standards

O'Donnell (2000) provides empirical evidence that the extent of supervision by the headquarters is decreasing in the level of subsidiary autonomy. Accordingly, the need for independence of subsidiaries pursuing a multinational strategy in terms of organizational practices and product specifications in order to optimally suit distinct conditions hints at an overall lower importance of internal company standards. It also may indicate that international formal standards are less relevant than national formal standards. The implementation of harmonized management systems through the application of international formal standards, in contrast, can be important irrespective of whether the firm is highly integrated into the group or not. Local consumers are increasingly demanding high-quality products, social responsibility and environmental consciousness of firms, which can be signaled through certification according to international management system standards. They improve bargaining position as well as legal security and facilitate efficiency gains in terms of economies of scale and scope.

MNEs that pursue the *international strategy* and adopt parent company competences may achieve competitive advantages from the application of internationally respected national standards if foreign companies do not have access to the standard and complementary resources, or do not have the necessary know-how to implement it (Blind, 2004). At the same time, their global products may meet the requirements of a broader range of customers, because they fulfill international standards (Blind et al., 2010). Centralization can involve the implementation of management systems, e.g. through international formal standards, implying that national and international formal standards are equal in their importance to the international firm. By developing internal company standards, the duplication of successful products and practices in foreign subsidiaries can be facilitated. However, pressures for integration and interconnection between members of the MNE is low, hinting at an overall moderate importance of company standards as a tool for internal coordination between value-chain activities.

Compatibility and similarity is a crucial factor for successful integration of global MNEs (Prahalad and Doz, 1987; Fey and Beamish, 2001) and can be realized through the application of standards (Roth and Morrison, 1990). The *global strategy* builds upon a shared vision between headquarters and subsidiaries aiming at creating a differentiated, globally competitive product. All members of the group jointly work towards a set of objectives defined within the global strategy. This can be achieved by applying company standards which transfer common organizational practices and values across all affiliates. Due to liability and reputation concerns, MNEs are likely to apply corporate standards which are of higher quality than market standards (Baake and Schlippenbach, 2011). Global MNEs specialize in products that are sold worldwide without taking into account local requirements. Governments, industry associations, and

shareholders exert high pressure on global firms to comply with international safety, environmental, health, accounting, or human resource management system standards (see e.g. Prahalad and Doz, 1987; Dowell et al., 2000; Hebb and Wójcik, 2005; Maruchek et al., 2011; Cugin and Williamson, 2014). Clougherty et al. (2016) provide evidence that certification of quality management systems is more likely among export-oriented firms. Accordingly, corporate as well as international standards are expected to be of great relevance to firms that operate in a global environment while national standards play a minor role.

Belderbos (2003) argues that the subsidiary's strategy can transform from duplication of the parent company's product to adoption of products to local markets, as market-specific knowledge is accumulated over time. The *transnational* firm applies formal and informal systems to coordinate and manage the highly integrated network of specialized and interdependent subsidiaries (Bartlett and Ghoshal, 2002). Christensen et al. (2002) conclude that vertical integration is most dominant in modular industries. Standards enable the implementation of such modularization strategies in which products can be adapted to local demands while economies of scale and scope can still be achieved (Bartlett and Ghoshal, 2002; Simpson, 2004). Company standards are particularly essential for the management of a platform of products in line with a company-specific strategy. They facilitate delegation (Bartlett and Ghoshal, 2002), efficiency gains, and the diffusion of information between group members (Sturgeon et al., 2008). Bartlett and Ghoshal (2002) point out that harmonized processes, clear structures, and systems have a supportive role in the diffusion of tacit knowledge and values between subsidiaries, and hence are complementary to face-to-face interactions. Therefore, company standards are indispensable for the development of platform thinking and the creation of system stability in transnational firms (Festing and Eidems, 2011; Gawer and Cusumano, 2013). Company standards can be comparatively easily modified and provide a tool to meet the transnational firm's need to develop individual solutions and implement flexible management systems (Großmann et al., 2016). This facilitates the internal fragmentation of value-chain activities and the development of modular strategies within a high-performance company network.

The transnational strategy involves the establishment of relationships with local business in order to meet local needs. As company standards also play a particular role in intra and inter-firm relationships (Großmann and von Gruben, 2014; Großmann et al., 2016), they can be of high importance to the transnational firm. Altogether, transnational firms are expected to reap major benefits from the application of company standards. The relative importance of national and international formal standards depends on the level of local responsiveness.

Table 5.2: Application of the IRF to standards

		Global Strategy	Transnational Strategy
Pressures for Global Integration	Strong	<ul style="list-style-type: none">• international standards for the establishment of a global brand• standardized global product for increased efficiency• management system standards for supply chain governance	<ul style="list-style-type: none">• company standards for increased efficiency through modularization• national standards to meet local responsiveness• management system standards for supply chain governance• international standards for reputation
	Weak	<ul style="list-style-type: none">• national standards for domestic market entry and international competitiveness• international standards for the establishment of an international brand• management system standards for increased efficiency and reputation	<ul style="list-style-type: none">• national standards to meet local responsiveness• international management system standards for increased efficiency and reputation
		Weak	Strong
Pressures for Local Responsiveness			

In summary, the theoretical framework, as illustrated in Table 5.2, implies that subsidiaries of MNEs can be grouped according to the importance of different types of standards. The importance of national formal standards relates to the pressure for local responsiveness, while international standards provide access to global markets, and therefore are especially relevant for the global strategy. For subsidiaries facing high pressures for integration, company standards and international management system standards can be a strategic tool to optimize internal processes as well as inter-firm relationships. By specifying company-specific requirements, internal standardization is particularly important for the successful implementation of internal platform strategies.

5.3. Empirical Analysis

The starting point of the empirical analysis is the assumption that MNE subsidiaries can be grouped according to the importance of company standards, national formal standards, and international formal standards. Cluster analysis is applied to data on standardization activities of German firms that are part of a MNE.

5.3.1. Data and Variable Description

The empirical analysis is based on data from the GSP. The survey was conducted among companies actively participating either in DIN or DKE in 2013, 2014, 2015 and 2016. A fixed set of questions was used to gather information about the application of standards, internal and external standardization work, and company characteristics.

Seven-point Likert scales ranging from 1 (very unimportant) to 7 (very important) were used to assess the importance of different types of standards on the national and international level. The final sample consists of 997 firms that are part of an international corporate group with headquarters based either inside of Germany (47%) or outside (53%). The majority of firms operates in electrical engineering, mechanical engineering, and manufacturing of CPRP. To the firms in this sample, international formal standards are on average more important than national formal standards, and company standards. This emphasizes the significant role of management systems as well as compliance with safety and environmental standards for MNEs. However, the figures provide some indication the importance of standards varies among the respondents of the survey.

5.3.2. Grouping of Subsidiaries by Importance of Standards

Cluster analysis is applied in order to test the assumption that MNE subsidiaries can be grouped according to the relative importance of different types of standards. K-means clustering is the simplest unsupervised learning algorithm that forms a set number of clusters for which the reduction in mean squared error through reassignment of observations is minimal. The starting point is the selection of centroids for the set number of clusters. Each observation is assigned to the cluster with the closest mean and the centroid is updated. The latter two steps are repeated until reassignment no longer improves the results (MacQueen, 1967).

Grouping is based on the three variables indicating the importance of national formal standards, international formal standards, and internal company standards. First, Single-linkage clustering is applied to identify outliers. Based on the Jaccard similarity measure, clusters that contain the closest pair of elements are combined (Everitt et al., 2001). The results indicate that six observations should be excluded from the analysis. Subsequently, the number of groups is determined applying Ward's Method, a hierarchical clustering procedure that assigns observations to groups so that the increase in error sum of squares (within-cluster variance) is minimized.

The optimal number of clusters is indicated by the Duda and Hart index (Duda et al., 2000), which takes higher values for more distinct clusters, as well as the pseudo-T-squared

statistic which is lower for more distinct clusters. The results of the stopping rule are reported in Table 5.6 in the Appendix and imply that the optimal number of clusters is four. Because differences in the pseudo-T-squared statistic between the four and five cluster solution are minor, both solutions will be presented.

Table 5.3: Number of observations assigned to clusters in four and five cluster solution

		Four cluster solution				
		Cluster 1	Cluster 2	Cluster 3	Cluster 4	Total
Five cluster solution	Cluster 1	148				148
	Cluster 2		313	22		335
	Cluster 3	5		144		149
	Cluster 4	1			155	156
	Cluster 5		117	19	73	209
	Total	154	430	185	228	997

K-means clustering is applied to assign the 997 MNE subsidiaries that participated in the GSP to four and five clusters.

Table 5.3 illustrates that the assignment of observations to Cluster 1 and Cluster 2 is mostly consistent across the two solutions. Descriptive statistics of the importance of standards for the resulting groups are reported in Table 5.4. An indirect check for whether the grouping relates to differences in the strategic focus is to compare the industry distributions resulting in this study with the results of Ghoshal and Nohria (1993), who classify subsidiaries of 66 MNEs in different industries according to the IRF. Table 5.7 in the Appendix reports industry share factors that are calculated by dividing the share of industry i in group j by the share of the industry i across all groups. Values larger than one indicate that the industry has a particularly strong presence in the respective group, while industries with values lower than one are under-represented. Figure 5.1 compares the results from this analysis to the findings of the comparative study. Unfortunately, the industrial classifications do not perfectly match because data from the GSP is only available in an aggregate form and also includes industries not represented in the sample of MNEs investigated by Ghoshal and Nohria (1993).

Cluster 1 consists of subsidiaries that show characteristics similar to those expected for global firms. Corporate as well as international management system standards, which can be used as a tool to integrate subsidiaries and achieve efficiency gains worldwide, are very important to firms that pursue a global strategy. In particular, the application of international standards can

improve a firm's reputation, thereby facilitating the establishment of a global brand. National standards are of minor importance for firms with a global focus.

Table 5.4: Descriptive statistics for clusters identified by means of K-means algorithm

			Obs.	Importance of		
				National standards	International standards	Company standards
Four cluster solution	Cluster 1	Global strategy	154	3.69	6.53	5.59
	Cluster 2	Transnational strategy	430	6.58	6.68	6.73
	Cluster 3	Local integration strategy	165	5.58	4.26	6.37
	Cluster 4	Autonomy strategy	228	6.41	6.26	3.55
Five cluster solution	Cluster 1	Global strategy	148	3.74	6.63	5.64
	Cluster 2	Transnational strategy	335	6.58	6.57	7.00
	Cluster 3	Local integration strategy	149	5.12	4.04	6.30
	Cluster 4	Multinational strategy	156	6.28	6.13	2.86
	Cluster 5	International strategy	209	6.67	6.47	5.63

Information and communication services (ICS) and electrical engineering industries have a particularly strong presence in Cluster 1. The mechanical engineering industry represents the third-highest factor value result. The findings are mostly in line with the findings of Ghoshal and Nohria (1993) who conclude that scientific measuring instrument and machinery are among the industries that operate in global environments. The result that the ICS industry belongs to the global group is consistent with the findings of Blind et al. (2010). The authors argue that international standards play a significant role in communication technology industries for the global distribution of products and processes.

The largest group in both grouping specifications is Cluster 2. All types of standards are of high importance to the firms in this group, but company standards play an especially significant role. The characteristics indicate a transnational strategy, in which both company standards and international management system standards can be used to support the governance of internal and external platforms. Conformance with national standards facilitates market access and competitive advantages at home and abroad.

The firms in Cluster 3 consider company standards and national formal standards more important than international standards. This indicates that the firm is highly integrated into the group and has a strong focus on the local market at the same time. This is also in line with the transnational strategy, in which modularization facilitates adaption to local standards while

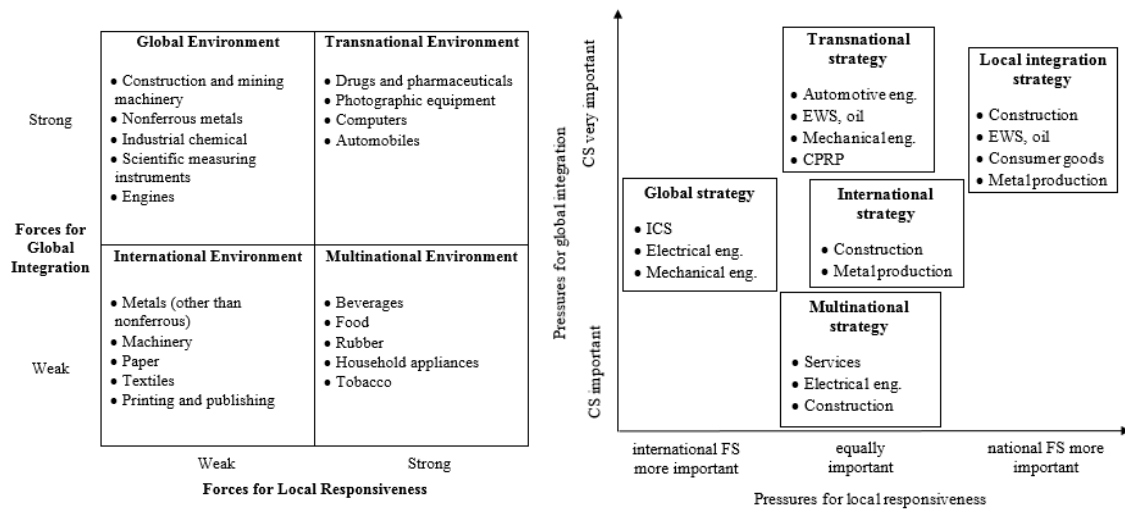
efficiency increases can still be achieved. Bartlett and Ghoshal (2002) argue that subsidiaries of transnational firms can differ regarding the extent to which they respond to local need. Some subsidiaries take an important role in the efficiency strategy of the group while others adapt products to local needs. Accordingly, in the analysis on hand, the transnational cluster is understood to consist of firms with a more global focus while subsidiaries that serve the local markets are referred to as firms that employ a *local integration strategy*.

In line with the literature on the application of standards in the automotive industry (e.g. Lazina, 2016; Großmann and von Gruben, 2014), automotive engineering is most dominant in the cluster of highly integrated, transnational firms that value company standards as very important. In addition, firms in mechanical engineering are assigned disproportionately frequently to the group of transnational firms with a stronger global focus. This partially confirms the finding of Ghoshal and Nohria (1993) that the industries construction machinery, mining machinery, and engines are more likely to operate in a global environment. Moreover, the comparative study revealed that industrial chemical producers are classified as global while manufacturers of drugs and pharmaceuticals operate in a transnational environment. This is supported by the present analysis which indicates that manufacturing of CPRP has a strong presence in cluster 2.

The transnational firms with a strong local focus predominantly operate in the following sectors: construction, manufacturing of consumer goods, EWS, as well as manufacturing of metals and metal products. Consistent with the proposition of the theoretical framework, all of these are industries that benefit from platform strategies because the type of products allows to simultaneously achieve efficiency improvements and gains from adaption to local markets. The high importance of national standards can also be explained by the fact these industries have many formal standards established on the national level.

Contrary to the results from the GSP, Ghoshal and Nohria (1993) conclude that most consumer goods manufacturers pursue a multinational strategy. However, Bartlett and Ghoshal (2002) argue that in the contemporary world characterized by high pressures for both integration and local responsiveness, there must be an increasing trend in implementing some or all of the transnational strategy. According to this, it is plausible that, within the next 25, many multinational-domestic firms will have established transnational structures in order to cope with the forces of rapid globalization. This also supports the finding that the group of firms pursuing a more global transnational strategy is the largest.

Figure 5.1: Comparison of industry shares by clusters between Ghoshal and Nohria (1993) (left) and own results (right)



Source: Ghoshal and Nohria, 1993: 27 (left), and author's own calculations based on GSP data (right).

The present conclusion on the relationship between the application of standards and the level of integration is in line with the findings of Kobrin (1991). The author uses levels of intra-firm trade to compare industries and concludes that automotive engineering, certain fields of electronic and mechanical engineering, as well as manufacturing of chemical and rubber products show high levels of integration.

The firms assigned to Cluster 2 and 4 in the four cluster solution are separated into firms that value company standards as “more important” or “less important”. The additional group in the five cluster solution consists of subsidiaries that consider company standards medium important.

Cluster 4 consists of companies that consider company standards less relevant while national as well as international standards are of equally high importance. Low levels of integration and a strong focus on local markets indicate a *multinational approach*. However, national formal standards should play a much more prominent role to multinational subsidiaries than international standards. The results may be explained by the fact that independent subsidiaries apply international management system standards to optimize production and to signal high quality and environmental consciousness to local consumers. In addition, the figures on the industry distribution undermine that the group consists of industries that consider formal product standards less important, such as services and construction. In line with Ghoshal and Nohria (1993), some fields in electrical engineering operate in the multinational environment while others take a global perspective.

For the last group, consisting of 209 firms, national formal standards are somewhat more important than the international ones while company standards are of moderate importance. For

the international strategy, national products are “international enough” to be sold on broader regional markets without having to be adapted to local needs. At the same time, national standards can create competitive advantages abroad, which fosters the establishment of export platforms if trade costs are too high (Ekholm et al., 2007). Once home competencies are transferred, the subsidiary can operate mostly independently. The relevance of company standards is therefore modest. The outcome that manufacturers of metals and metal products are overrepresented in the international cluster supports the findings of Ghoshal and Nohria (1993). The second industry with a strong presence in this group is the construction industry. The results are partially in line with Johnson Jr. (1995), who shows that the sample of 177 businesses in the construction industry in the U.S. can be divided into three groups according to the IRF as originally introduced by Prahalad and Doz (1987). Over 60% are classified as global, and 20% each as locally responsive and transnational. However, the author does not consider the international group of MNEs introduced by Bartlett and Ghoshal (2002). The analysis based on data from the GSP reveals an above average share of construction companies is high among local integrators, international firms, and multinational firms. Considering that the differences between global and international firms with respect to the importance of standards are minor, the results of the two studies mostly coincide. Inconsistencies may result from differences in the conceptual basis and the fact that the sample on hand is much smaller and possibly not representative.

5.3.3. Export Intensity and Subsidiary Strategy

Additional support for the theoretical concept is provided when comparing the export intensity of the clusters. According to Meyer and Estrin (2014) and Pearce and Papanastassiou (1997), export intensity can serve as an indicator for subsidiary strategy. Meyer and Estrin (2014) add export orientation as a third dimension in the IRF to differentiate between strategic roles on the subsidiary level. They find responsiveness to be negatively related to export orientation and integration while no significant correlation exists between export orientation and integration. The findings are in line with the conclusions of Pearce and Papanastassiou (1997) who analyze the relationship between export intensity (final versus intermediate product and intra versus inter-group trade) and four distinct subsidiary strategies similar to those from the IRF. The first strategy they consider is to produce established products of the MNE and sell them on the local market. This role, which is compatible with the international strategy, is found to be negatively related to exports and intra-group trade. The group of highly integrated firms that contribute to the “supply network by producing and exporting component parts for assembly elsewhere” (Pearce and Papanastassiou, 1997: 249) shows the same characteristics as the cluster of local integrators identified in the present analysis. This group has a rather local focus as well. Pearce and

Papanastassiou (1997) define another subsidiary type that serves local or wider markets with stand-alone products. Those firms show similarity with firms that pursue the multinational strategy and those that pursue the transnational strategy. While exports are expected to be low for the multinational strategy firms, the transnational strategy firms are expected to serve both the local and global markets. The fourth group of subsidiaries specializes in producing parts of the established products that are sold in the foreign market and characterized by high intensity of intra and inter group exports. Such high levels of integration and focus on the global market is consistent with the global strategy.

Table 5.7 in the Appendix reports mean values of the importance of standards and export shares by clusters for those firms for which data on export shares is available. Subsidiaries that are assumed to pursue the local integration strategy have the lowest average export share in sales, the multinational cluster ranks second. This is consistent with the assumption that both of them have a strong focus on local markets. The results also indicate that the multinational firm, that is more independent from the group, is less focused on the German market than the integrated subsidiary that is part of a modular platform strategy. According to the theoretical framework, international companies serving as export platforms are expected to show medium levels of export. In line with the expectations as well as the findings of Taggart (1998), this group is on average the third largest exporter. Subsidiaries employing a global strategy are the most export-intensive.

5.3.4. Motives to Apply Standards

The GSP also collects information about the relevance of formal and company standards for various business success factors. Firms were asked to assess the importance of various types of standards for internal as well as external factors. Factors that concern the business environment of a firm are legal security, fulfillment of requirements for market access, competitiveness vis-à-vis rivals, and bargaining position regarding suppliers and customers. The improvement of quality and productivity (including cost reductions), as well as the optimization of research, development and innovation activities relate to the improvement of internal processes.

For those firms for which data is available, Table 5.5 reports differences in mean values of the importance of formal standards and company standards for the success factors by clusters, and probabilities that the null hypothesis - that respondents on average value the two standard types as equally important for the success factors - is true. If the t-test reveals that the probability is lower than 10%, the difference can be considered to be statistically significant.

Company standards have the greatest impact on quality improvements for all companies. The comparison of means reveals that only transnational firms and local integrators value

company standards as more important for quality than formal standards. For local integrators, the difference will be between -0.81 and -0.24 with a probability of 95%.

Internal standardization is more relevant for productivity increases than the application of formal standards for all firms except multinational ones that consider company standards generally less important. Transnational firms assess the impact of company standards on technical interoperability more positive than other groups. For local integrators, the probability that the importance is no different from the importance of formal standards is 16%, indicating that the null hypothesis cannot be rejected.

Table 5.5: Difference in the importance of formal standards and company standards for business success factors by clusters, and t-test statistics.

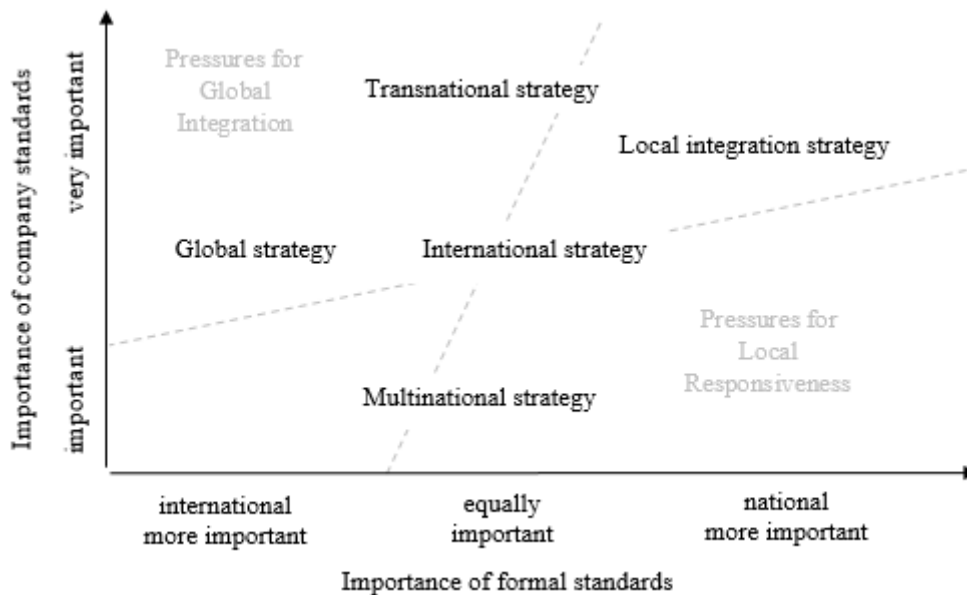
	Cluster 1 Global firms (n = 91)		Cluster 2 Trans- national strategy (n = 192)		Cluster 3 Local integration strategy (n = 86)		Cluster 4 Multi- national firms (n = 89)		Cluster 5 Inter- national firms (n = 119)	
	Dif	Prob	Dif	Prob	Dif	Prob	Dif	Prob	Dif	Prob
Legal security	1.38	0.00	0.81	0.00	0.66	0.00	2.52	0.00	1.53	0.00
Market entry	1.67	0.00	1.17	0.99	0.97	0.00	2.18	0.00	1.61	0.00
Interoperability	0.99	0.00	0.59	0.00	0.21	0.16	1.70	0.00	0.98	0.00
Productivity increases	-0.57	0.00	-0.78	0.00	-0.65	0.00	0.44	0.02	-0.31	0.02
Quality improvements	-0.07	0.70	-0.42	0.00	-0.52	0.00	1.06	0.00	0.22	0.08
R&D and innovation	0.27	0.08	-0.06	0.52	-0.12	0.42	1.08	0.00	0.23	0.08
Competitiveness	0.25	0.13	0.10	0.37	0.05	0.78	1.29	0.00	0.55	0.00
Bargaining position	0.97	0.00	0.71	0.00	0.33	0.03	1.55	0.00	0.88	0.00

The results undermine the importance of company standards for the governance of internal platforms, in particular to highly integrated firms. The application of formal standards primarily affects external success factors. Formal standards are used more successfully than company standards to improve legal security, market entry, and bargaining position. Both internal standardization and the application of formal standards play an important role in creating competitive advantages.

Overall, the empirical analysis supports the theoretical concept about the relationship between different strategies of MNEs and the importance of standards derived from the IRF. The results are illustrated in Figure 5.2. The level of global integration is related to the application of corporate and international management standards, which facilitates the optimization of internal processes and the governance of inter-firm relationships. Local responsiveness requires an increased application of national standards and can either be accompanied by internal

standardization, if it is part of a modular platform strategy, or result in greater independence of the subsidiaries from the group. In addition, regional standards can promote international competitive advantages and, in combination with management system standards, facilitate platform strategies.

Figure 5.2: Framework of the relationship between subsidiary strategies and application of standards.



5.4. Discussion and Conclusion

The link between FDI and the application of international standards as well as the importance of firm-specific guidelines and routines in globally dispersed firms have both been discussed in the economic literature. However, whether the importance of standards varies with the strategic role of the subsidiary is still an open research topic. This study is the first to apply the extensive and influential typology of MNEs provided by the IRF to standards in order to derive a theoretical concept about the implications of MNE subsidiary strategy for the relative importance of different types of standards.

The four internationalization strategies - multinational, international, transnational, and global strategy - differ depending on the extent of pressures for local responsiveness and/or global integration. Company standards and international management system standards are expected to be more relevant for highly integrated firms that employ a global or transnational strategy. They foster the establishment of a global network, knowledge transfer within the group, and monitoring of subsidiary performance and quality. The more the products are adapted to local markets, the

more they need to conform to national formal standards. Accordingly, multinational as well as transnational subsidiaries are more likely to apply this type of standard.

Cluster analysis is applied to data from the GSP in order to test the assumption that subsidiaries can be grouped according to the expected patterns. The results support the initial concept and reveal subtleties with respect to the structure of the groups.

The importance of national formal standards relates to the pressure for local responsiveness, while international standards provide access to global markets, and therefore are especially relevant if products are sold abroad. The implementation of harmonized management systems through the application of international standards can be important irrespective of whether the firm is highly integrated into the group or not. They improve bargaining position and legal security and facilitate efficiency gains in terms of economies of scale and scope. By specifying company-specific requirements, internal standardization promotes the development of internal and external platforms. Company standards and international management system standards are of particular importance to firms that simultaneously face pressures for global integration and local responsiveness.

However, no direct empirical test of the relationship between the application of standards and subsidiary strategy can be provided in the framework of this study because no information about the strategic focus of the subsidiaries is available. In addition, data from the GSP is not a random sample, as it only includes German firms participating in national standardization. No conclusions can be drawn on the relationship between standards and subsidiary strategy for MNEs that do not participate in standardization.

This study nevertheless takes a further step towards overcoming the “lack of conceptual clarity” of the IRF (Roth and Morrison, 1990: 545) by identifying additional variables related to different types of MNEs. The study addresses problems of many prior studies that focus on certain industries and lack precise definitions of and differentiation between various types of standards. Future research could provide empirical evidence for the developed theoretical concept about the relationship between standards and subsidiary strategies or subsidiary functions (Rugman et al., 2011). Additional research is needed on the role of company standards for the diffusion of knowledge in order to better understand the mechanisms in multinational corporations. The results of this study indicate that researchers in different fields should focus their attention on the heterogeneous effects of different types of standards.

5.5. References

- Argyres N., Bigelow L. (2010). Innovation, Modularity, and Vertical Deintegration: Evidence from the Early U.S. Auto Industry. *Organization Science*, 21 (4), pp. 842-853.
- Baake P., Schlippenbach V. (2011). Quality Distortions in Vertical Relations. *Journal of Economics*, 103(2), pp. 149–169.
- Bartlett C.A., Ghoshal S. (2002). *Managing Across Borders: The Transnational Solution*. Boston, MA, USA: Harvard Business School Press.
- Belderbos R. (2003). Entry Mode, Organizational Learning, and R&D in Foreign Affiliates: Evidence from Japanese Firms. *Strategic Management Journal*, 24, pp. 235-259.
- Bénézech D., Lambert G., Lanoux B., Lerch C., Loos-Baroin J. (2001). Completion of Knowledge Codification: An Illustration through the ISO 9000 Standards Implementation Process. *Research Policy*, 30, pp. 1395–1407.
- Birkinshaw J., Morrison A., Hulland J. (1995). Structural and Competitive Determinants of a Global Integration Strategy. *Strategic Management Journal*, 16, pp. 637-655.
- Blind K. (2004). *The Economics of Standards. Theory, Evidence, Policy*. Cheltenham, UK, Northampton, MA, USA: Edward Elgar.
- Blind K. (2013). The Impact of Standardization and Standards on Innovation. *NESTA Working Papers*, No. 13/15, London, UK. Available at: <https://goo.gl/BsSCnv>.
- Blind K, Gauch S, Hawkins R. 2010. How Stakeholders View the Impacts of International ICT Standards. *Telecommunications Policy*, 34, pp. 162–174.
- Blind K., Petersen S.S., Riillo C.A.F (2017). The Impact of Standards and Regulation on Innovation in Uncertain Markets. *Research Policy*, 46, pp. 249-264.
- Boiral O. (2003). ISO 9000: Outside the Iron Cage. *Organization Science*, 14(6), pp. 720-737.
- Boiral O. (2007). Greening through ISO 14001: A Rational Myth? *Organization Science*, 18(1), pp. 127-146.
- Chen M.X., Otsuki T., Wilson J.S. (2006). Do Standards Matter for Export Success? *World Bank Policy Research Working Papers*, No. 3809, World Bank, Washington, D.C., USA.
- Christensen C., Verlinden M., Westerman G. (2002). Disruption, Disintegration and the Dissipation of Differentiability. *Industrial and Corporate Change*, 11, pp. 955-993
- Christmann P. (2004). Multinational Companies and the Natural Environment: Determinants of Global Environmental Policy Standardization. *Academy of Management Journal*, 47(5), pp. 747–760.
- Clougherty J.A., Grajek M. (2008). The Impact of ISO 9000 Diffusion on Trade and FDI: A New Institutional Analysis. *Journal of International Business Studies*, 39(4), pp. 613-633.

- Clougherty J.A., Grajek M., Shy O. (2016). Taking ‘Some’ of the Mimicry Out of the Adoption Process: Quality Management and Strategic Substitution. *European School of Management and Technology (ESMT) Working Papers*, No. 16-05, Berlin, Germany. Available at: <https://ssrn.com/abstract=2875395>.
- Cogin J.A., Williamson I.O. (2014). Standardize or Customize: The Interactive Effects of HRM and Environment Uncertainty on MNC Subsidiary Performance. *Human Resource Management*, 53, pp. 701–21.
- Deardorff A.V. (2001). Fragmentation in Simple Trade Models. *The North American Journal of Economics and Finance*, 12(2), pp. 121–137.
- De Casanove A., Lambert I. (2016). How Corporate Standardisation Shapes Tomorrow’s Business. In K. Jakobs (Ed.), *Effective Standardization Management in Corporate Settings*. Hershey: IGI Global, 1–17.
- De Vries H., Slob F., van Gansewinkel Z. (2006). Best practice in company standardization. *International Journal of IT Standards and Standardization Research*, 4, pp. 62–85.
- DIN 820–3:2014. Berlin, Germany: Beuth Verlag GmbH.
- DIN EN 45020:2007. Berlin, Germany: Beuth Verlag GmbH.
- Dowell G., Hart S., Yeung B. (2000). Do Corporate Global Environmental Standards Create or Destroy Market Value? *Management Science*, 46(8), pp. 1059–1074.
- Duda R.O., Stork D.G., Hart P.E. (2000). *Pattern Classification and Scene Analysis* (2nd ed.). Chichester, UK: Wiley.
- Dunning J.H. (1993). *Multinational Enterprises and the Global Economy*. Harlow, UK: Addison-Wesley.
- Düsterbeck B., Hesser W., Inklaar A., Vischner J. (1995). An Introduction to Standards and Standardization. In Deutsches Institut für Normung e.V. (Ed.), *DIN Normungskunde*, 36, pp. 99–138. Berlin, Germany: Beuth Verlag GmbH.
- Ekholm K., Forslid R., Markusen J.R. (2007). Export-platform Foreign Direct Investment. *Journal of the European Economic Association*, 5(4), pp. 776–795.
- Everitt B.S., Landau S., Leese M. (2001). *Cluster Analysis* (4th ed.). London, UK: Arnold.
- Ferner A. (2000). The Underpinnings of Bureaucratic Control Systems: HRM in European Multinationals. *Journal of Management Studies*, 37, pp. 521–540.
- Festing M., Eidems J. (2011). A Process Perspective on Transnational HRM Systems - A Dynamic Capability-based Analysis. *Human Resource Management Review*, 21(3), pp. 162–173.
- Fey C.F., Beamish P.W. (2001). Organizational Climate Similarity and Performance: International Joint Ventures in Russia. *Organization Studies*, 22(5), pp. 853–882.

- Fortanier F., Kolk A., Pinkse J. (2011). Harmonization in CSR Reporting. *Management International Review*, 51, pp. 665–696.
- Gawer A., Cusumano M.A. (2013). Industry Platforms and Ecosystem Innovation. *Journal of Product Innovation Management*, 31(3), pp.417-433.
- Gereffi G., Lee J. (2012). Why the World Suddenly Cares About Global Supply Chains. *Journal of Supply Chain Management*, 48(3), pp. 24–32.
- Gereffi G., Humphrey J., Sturgeon T. (2005). The Governance of Global Value-chains. *Review of International Political Economy*, 12(1), pp. 78–104.
- Ghoshal S., Nohria N. (1993). Horses for Courses: Organizational Forms for Multinational Corporations. *Sloan Management Review*, 34, pp. 23–35.
- Gibbon P., Ponte S. (2005). Trading Down: Africa, Value-chains and the Global Economy. Philadelphia, PA, USA: Temple University Press.
- Großmann A.-M.C, Gruben P.-V. von (2014). The Role of Company Standards in Supply Chains – The Case of The German Automotive Industry. In T. Blecker (Ed.), *Innovative Methods in Logistics and Supply Chain Management: Current Issues and Emerging Practices*, pp. 99-121. Berlin, Germany: epubli GmbH.
- Großmann A.-M.C., Gruben P.-V. von, Lazina L.K. (2016). Strategic Development and Implementation of Company Standards. In Jakobs K. (Ed.), *Effective Standardization Management in Corporate Settings*, pp. 77–104. Hershey, PA, USA: IGI Global.
- Guler I., Guillén M.F., Macpherson J.M. (2002). Global Competition, Institutions, and the Diffusion of Organizational Practices: The International Spread of ISO 9000 Quality Certificates. *Administrative Science Quarterly*, 47(2), pp. 207-232.
- Gupta A., Govindarajan V. (2000). Knowledge Flows within MNCs. *Strategic Management Journal*, 21, pp. 473–496.
- Hansen MT, Lovas B. 2004. How Do Multinational Companies Leverage Technological Competencies? Moving from Single to Interdependent Explanations. *Journal of Management Studies*, 25, pp. 801–822.
- Harzing A.-W. (2000). An Empirical Analysis and Extension of the Bartlett and Ghoshal Typology of Multinational Companies. *Journal of International Business Studies*, 31, pp. 101–120.
- Harzing A.-W., Sorge A. (2003). The Relative Impact of Country of Origin and Universal Contingencies on Internationalization Strategies and Corporate Control in Multinational Enterprises: Worldwide and European Perspectives. *Organization Studies*, 24(2), pp. 187–214.

- Hebb T., Wójcik D. (2005). Global Standards and Emerging Markets: The Institutional-investment Value Chain and the CalPERS Investment Strategy. *Environment and Planning*, A37, pp. 1955–1974.
- Hoops L.-P., Hesser W. (2003). Final Report for the European Union: The Advantage of Standardisation as a Management Instrument in Companies. Hamburg, Germany: University of the Armed Forces Hamburg.
- Hudson J., Jones P. (2003). International Trade in ‘Quality Goods’: Signalling Problems for Developing Countries. *Journal of International Development*, 15(8), pp. 999-1013.
- Jaffee S., Masakure O. (2005). Strategic Use of Private Standards to Enhance International Competitiveness: Vegetable Exports from Kenya and Elsewhere. *Food Policy*, 30(3), pp. 316–333.
- Johnson Jr. J.H. (1995). An Empirical Analysis of the Integration-Responsiveness Framework: U.S. Construction Equipment Industry Firms in Global Competition. *Journal of International Business Studies*, 26, pp. 621–635.
- Kaplinsky R. (2010). The Role of Standards in Global Value-chains. *Policy Research Working Papers*, No. 5396, World Bank, Washington, D.C., USA.
- Kobrin S.J. (1991). An Empirical Analysis of the Determinants of Global Integration. *Strategic Management Journal*, 12, pp. 17-31.
- Kogut B., Zander U. (1993). Knowledge of the Firm and the Evolutionary Theory of the Multinational Corporation. *Journal of International Business Studies*, 24(4), pp. 625-646.
- Langlois R., Robertson P. (1992). Networks and Innovation in a Modular System: Lessons from the Microcomputer and Stereo Component Industries. *Research Policy*, 21, pp. 297-313.
- Lazina L.K. (2016). Company Standardization: Five Essays with a Focus on the Automotive Industry. Dissertation. Berlin, Germany: Technische Universität Berlin.
- Löhe M., Blind K. (2015). Regulation and Standardization of Data Protection in Cloud Computing. *Proceedings of the 2015 ITU Kaleidoscope Academic Conference*, pp. 77-82.
- Larsson R., Finkelstein S. (1999). Integrating Strategic, Organizational, and Human Resource Perspectives on Mergers and Acquisitions: A Case Study of Synergy Realization. *Organization Science*, 10(1), pp. 1-26.
- MacQueen J.B. (1967). Some Methods for Classification and Analysis of Multivariate Observations. *Proceedings of 5-th Berkeley Symposium on Mathematical Statistics and Probability*, 1, pp. 281–297.

- Marucheck A., Greis N., Mena C., Cai L. (2011). Product Safety and Security in the Global Supply Chain: Issues, Challenges and Research Opportunities. *Journal of Operations Management*, 29 7-8, pp. 707–720.
- Melitz M.J. (2003). The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity. *Econometrica*, 71(6), pp. 1695-1725.
- Meyer K.E., Estrin S. (2014). Local Context and Global Strategy: Extending the Integration Responsiveness Framework to Subsidiary Strategy. *Global Strategy Journal*, 4, pp. 1–19.
- Muffatto M. (1999). Introducing a Platform Strategy in Product Development. *International Journal of Production Economics*, 60, pp. 145–153.
- O'Donnell S.W. (2000). Managing Foreign Subsidiaries: Agents of Headquarters, or an Interdependent Network? *Strategic Management Journal*, 21, pp. 525-548.
- OECD (2016). OECD Factbook 2015-2016: Economic, Environmental and Social Statistics. Paris, France: OECD Publishing.
- Pearce R., Papanastassiou M. (1997). European Markets and the Strategic Roles of Multinational Enterprise Subsidiaries in the UK. *Journal of Common Market Studies*, 35, pp. 243–266.
- Prahalad C.K., Doz Y. (1987). The Multinational Mission: Balancing Local Demands and Global Vision. New York, USA: Free Press.
- Prakash A., Potoski M. (2007). Investing Up: FDI and the Cross-country Diffusion of ISO 14001 Management Systems. *International Studies Quarterly*, 51, pp. 723–744.
- Roth K, Morrison A.J. 1990. An empirical analysis of the Integration-Responsiveness framework in global industries. *Journal of International Business Studies*, 21, 541–564.
- Rugman A., Verbeke A., Yuan W. (2011). Re-conceptualizing Bartlett and Ghoshal's Classification of National Subsidiary Roles in the Multinational Enterprise. *Journal of Management Studies*, 48, pp. 253–277.
- Schilling M. (2000). Toward a General Modular Systems Theory and its Application to Interfirm Product Modularity. *The Academy of Management Review*, 25, pp. 312-334.
- Simpson T.W. (2004). Product Platform Design and Customization: Status and Promise. *Artificial Intelligence for Engineering Design, Analysis and Manufacturing*, 18(1), pp. 3-20.
- Sturgeon T., van Biesebeek J., Gereffi G. (2008). Value-chains, networks and clusters: reframing the global automotive industry. *Journal of Economic Geography*, 8, pp. 297–321.
- Swann G.M.P. (2010a). International Standards and Trade: A Review of the Empirical Literature. *OECD Trade Policy Papers*, No. 97, OECD Publishing, Paris, France.

- Swann G.M.P. (2010b). The Economics of Standardization: An Update. Report for the UK Department of Business, Innovation and Skills (BIS), Version 2.2, 27 May 2010. Available at: goo.gl/MKQYAL.
- Taggart J.H. (1997). An Evaluation of the Integration-Responsiveness Framework: MNC Manufacturing Subsidiaries in the UK. *Management International Review*, 37, pp. 295–318.
- Taggart J.H. (1998). Strategy Shifts in MNC Subsidiaries. *Strategic Management Journal*, 19, pp. 663–681.
- Tallman S., Chacar A.S. (2011). Knowledge Accumulation and Dissemination in MNEs: A Practice-Based Framework. *Journal of Management Studies*, 48, pp. 278–304.
- Ton Z., Huckman R.S. (2008). Managing the Impact of Employee Turnover on Performance: The Role of Process Conformance. *Organization Science*, 19(1), pp. 56-68.

5.6. Appendix

Table 5.6: Optimal number of clusters - Ward's Method and Duda-Hart index

Number of clusters	Duda/Hart	
	Je(2)/Je(1)	pseudo T-squared
1	0.9520	50.20
2	0.9387	59.46
3	0.9311	61.74
4	0.9051	7.87
5	0.8556	10.97

Table 5.7: Industry distribution and descriptive statistics for subsidiaries with export data

	Cluster 1 Global strategy	Cluster 2 Trans- national strategy	Cluster 3 Local integration strategy	Cluster 4 Multi- national strategy	Cluster 5 Inter- national strategy
<i>Industry distribution full sample</i>					
Consumer goods	0.87	1.10	1.24	0.83	0.88
Manufacturing CPRP	0.75	1.15	1.10	0.76	1.03
Production of metals & metal products	0.75	0.93	1.34	0.85	1.17
Electrical engineering	1.48	0.87	0.65	1.17	0.99
Mechanical engineering	0.99	1.16	0.83	0.85	0.98
Automotive engineering	0.95	1.57	0.70	0.78	0.50
EWS	0.00	1.27	1.67	0.68	1.02
Construction	0.23	0.59	2.23	1.07	1.27
Services	0.84	0.71	1.16	1.43	1.14
ICS	2.14	0.54	1.21	1.16	0.65
<i>Sample with export data</i>					
Importance of national standards	3.74	6.58	5.07	6.28	6.69
Importance of international standards	6.64	6.57	3.98	6.09	6.45
Importance of company standards	5.75	7.00	6.18	2.82	5.65
Export share	66.3	52.3	42.4	46.7	50.4
Number of observations	84	174	82	102	119

Note: The industry factor is calculated by dividing the share of industry within the group by the share of industry across all industries.

6. Conclusion

The study presents an empirical examination of the role of standardization in international business. Particular attention is directed towards the drivers for the development and application of internationally harmonized standards as compared to regional standards, on the one hand, and the importance of company standards for the governance of corporate groups, on the other hand.

The starting point of the discussion of the first part on the development and application of standards on different regional levels is that formal standards can act as barriers to or catalyst for trade and investment. One way to remove trade barriers arising from national standards is the development of international standards. While uniform standards push mutual market access, technical interoperability of products, and cost reductions, they also reduce variety and limit differentiation from competitors (Swann, 2000). The application of internationally accepted national standards is beneficial in particular for highly competitive firms (Lutz and Pezzino, 2012) that reap competitive advantages if foreign companies do not have access to the standard and complementary resources, or do not have the necessary know-how to implement the same standards (Blind, 2004).

While strategic motives for the development of national standards have been studied (e.g. Blind and Mangelsdorf, 2016; Lazina, 2016), no cross-sectional, quantitative studies exist on the drivers for firms' participation in international standardization. The first of the four individual papers that are part of this dissertation aims to examine the relevance of industry and firm specific factors for the likelihood to participate in supranational in addition to national standard-setting organizations.

The discussion on the application of harmonized standards versus regional standards is also prevailing with respect to the reduction of trade barriers through trade agreements and investment treaties. The TTIP belongs to the most economically significant regional free trade agreements in history. The bulk of studies concludes that the removal of NTMs in the framework of this agreement will result in increases in real income and trade on both sides of the Atlantic. While different solutions to harmonize standards have been discussed theoretically (e.g. Lutz and Pezzino, 2012), no empirical studies analyze how to remove barriers arising from standards in specific case of TTIP. The second study takes a step towards closing this research gap by exploring factors that influence firms' preferences about the various options to dismantle export barriers arising from standards.

Conclusion

The second part of the dissertation rests upon the significant role of standards in value-chain governance, which is undisputed in economic literature (e.g. Gereffi and Lee, 2012; Kaplinsky, 2010; Gereffi et al., 2005; Gibbon and Ponte, 2005; Nadvi and Wältring, 2004). Studies exist on the link between foreign direct investment and international management standards (e.g. Guler et. al, 2012; Smith, 2009), and the importance of internal guidelines and routines in globally dispersed firms is not new by any means either (see e.g. Dowell et al., 2000; Christmann, 2004; Jaffee and Masakure, 2005).

However, most of these contributions focus on international management system standards and lack precise differentiation between various types of standards. Only a handful of studies discuss motives for the application of company standards and their role in supply chain governance (e.g. de Vries, 2007; de Vries et al., 2006; Großmann and von Gruben, 2014; Großmann et al., 2016). They often focus on certain industries and insights are based on case studies because of a lack of data on the application of company standards. In addition, the existing studies primarily focus on the importance of standards in inter-firm relationships.

The contribution of the third paper, presented in chapter four, is the discussion of the special role of internal standardization in corporate groups. It, in addition, provides empirical evidence of the motives to apply company standards.

From the extensive literature on the typology of multinational corporations, it must be concluded that the importance of standardization for foreign direct investment differs depending on the strategic focus. The last paper applies the widely accepted IRF, which has greatly influenced the international management literature (Rugman et al., 2011; Harzing, 2000), to standards in order to develop a theoretical concept about the relationship between subsidiary strategies and application of different types of standards.

6.1. Main Results

The empirical results illustrate that companies have different ways to integrate standardization into their international strategies, depending on the dimensions of the strategy as well as external circumstances.

The development of international standards facilitates export strategies in which products are produced for the global market. Involvement in standardization processes is an important knowledge sourcing activity because it facilitates knowledge acquisition and benchmarking with competitors. However, the empirical results point towards a deterring effect of high levels of market regulation on the engagement in international standardization, implying that German firms expect to have little influence on international regulation through standardization. While firm size

Conclusion

is a relevant factor in raising the required resources for participation in standard-setting processes, there is no indication that large firms with high market power form standardization cartels by excluding less powerful competitors.

Differences depending on firm size also exist with respect to the application of international standards as one way to reduce non-tariff barriers to EU-US trade and investment. In particular large firms with many trading partners reap benefits of applying international standards because diversification costs are drastically reduced. The more detailed analysis additionally revealed that positive assessments of international standards rely on their positive impact on market access, technical interoperability, and productivity. Mutual recognition of regional standards is associated with a quicker integration of markets and the creation of competitive advantages abroad. Bilaterally negotiating standards appears to be a hybrid between international standards and mutual recognition, combining the advantages of the two solutions. However, German firms on average reject the development of new EU-US standards as an alternative to harmonize standards within TTIP, in particular if well-established European or international standards already exist.

Changing the focus from formal standardization to the role of internal standardization in global business, the second part of the study highlighted the relevance of international management system standards and company standards for the governance of global value-chains. They act as a tool to implement common organizational practices and company-specific requirements, thereby boosting the integration of subsidiaries worldwide. The main motives for internal standardization are quality improvements, productivity increases, legal security, and technical interoperability. They can be of particular importance for the development of internal platforms that facilitate the adaption of products to local needs and the achievement of efficiency gains at the same time. The results of the study suggest that small and medium-sized enterprises value the impact of company standards on productivity increases and cost reductions as high as large firms. However, they are less likely than large firms to successfully apply company standards for improvements in quality, competitiveness, and interoperability. Chapter 5 showed that subsidiary strategy relates to the interplay between formal standards and company standards.

6.2. Implications

6.2.1. Implications for Economic Policy

Detering effect of market regulation on the engagement in international standardization

Policy makers are needed to find effective ways to implement a complementary relationship between regulation and standardization as within the regime of the New Approach in the European Union on the international level. This could increase the incentives for participation in international standardization.

No one-size-fits-all solution for the removal of non-tariff trade barriers within TTIP

According to the explorative analysis, the harmonization solution in the framework of TTIP should allow a careful selection of the appropriate approach and the combination of different options in specific areas. To this end, the parties should seek to implement trade facilitating initiatives that, in addition to firm and sector-specific issues, address differences in the competitive and technological environment of companies most affected by TTIP.

Company standards are a tool to increase productivity and quality

Internal standardization can result in increases in consumers' surplus through lower product prices and the application of high corporate quality standards creates positive externalities. The results provide a rationale for government support for internal standardization.

Lacking resources and understanding discourage small firms from standardization

The results of the study suggest that support should be targeted to small and medium-sized enterprises in order to improve their perception of the effects of company standards, as well as their resources to engage in both external and internal standardization activities.

6.2.2. Implications for Research Policy

Corporate groups apply a higher number of company standards

The role of standards in modularization strategies is undisputed in platform literature. The results of this study suggest that internal standardization is of particular importance to corporate groups. Platform researchers should increase their effort to differentiate between different types of standards in order to reveal new insights on the evolution and management of platforms.

Firms that undertake process innovations apply more company standards

Both innovation and standardization researcher should focus their attention on the positive relationship between process innovation and application of company standards in order to assess the potentials of standardization for innovation activities.

Subsidiaries of MNEs can be grouped by relevance of different standards

The importance of standards is a new dimension that adds to the typology of multinational corporations, enhancing the understanding of the modes and effects of establishing multinational organizations. Researchers in international management should raise particular attention to the relationship between the motives for FDI and the application of standards.

6.2.3. Implications for Management

External standardization can be part of the firm's knowledge strategy

For innovation management, attention should be attributed to the potential of participation in standardization processes to provide access to the pool of industry knowledge. It can be a strategic tool for the acquisition of knowledge and facilitates benchmarking with competitors.

Internal standardization facilitates productivity increases and cost reductions in both small and large firms

Small and especially medium-sized firms should consider internal standardization as a strategic tool for the optimization of internal processes. By specifying product requirements and routines, the application of company standards increases legal security and facilitates productivity gains and cost reduction.

Company standards are important for quality management and interoperability

Internal standardization facilitates the implementation of modularization strategies and acts as a tool for quality management in large firms. Value-chain managers should consider the potentials of company standards for the development and governance of inter- and intra-firm relationships.

6.3. Limitations and Future Research

This dissertation takes a further step towards understanding the role of standardization in international business activities. The major limitation of the empirical part is the focus on German firms actively participating in national standardization bodies. Even though it may increase comparability of the firms in the sample, general validity of the results cannot be concluded because no conclusions can be drawn on firms that do not undertake standardization activities. In addition, some economic groups, such as the agriculture and food sector, small firms, and non-exporters are underrepresented. The external validity of the results is therefore limited.

The internal validity of the results could be affected by measurement errors, the influence of unobserved factors, and in some cases small sample size. One has to keep in mind that the study uses data that is based on subjective assessments of the respondents, and therefore might be biased or wrong. Problems also arise with respect to the point of view from which the company representative answered the questions. While some refer to the corporate group, others answer on the company or plant level. However, merging information from other data sources is limited due to data security and access concerns.

In addition, based on cross-sectional analysis, no statements can be made about the direction of causality. Unfortunately, the data from the GSP does not yet allow for robust panel data analysis to control for unobserved factors and reversed causality.

The dissertation points out possible directions for future research, as further questions arise in the light of the analysis. More insights on the role of standards in corporate groups can be gained using direct measures of the degree of vertical integration, e.g. exports in intermediates. Further research is needed on the importance of standards for the diffusion of knowledge and cultural norms in corporate groups, and the relationship between motives for FDI and the application of different types of standards.

The dissertation is concluded emphasizing that special attention should be placed on the role of company standards for the governance of internal platforms, in particular in multinational enterprises. In the age of global business and interconnectedness, the optimization of the interplay between formal standards and company standards as part of the strategic objectives may take on a new significance.

6.4. References

Blind K., Mangelsdorf A. (2016). Motives to Standardize: Empirical Evidence from Germany. *Technovation*, 48-49, pp. 13-24.

Conclusion

- Christmann P. (2004). Multinational Companies and the Natural Environment: Determinants of Global Environmental Policy Standardization. *Academy of Management Journal*, 47(5), pp. 747–760.
- De Vries H. (2007). Fundamentals of Standards and Standardization. In W. Hesser, A. Feilzer, H. de Vries et al. (Eds.), *Standardization in Companies and Markets* (2nd ed.), pp. 1-44. Hamburg, Germany: Helmut Schmidt University.
- De Vries H., Slob F., van Gansewinkel, Z. (2006). Best Practice in Company Standardization. *International Journal of IT Standards and Standardization Research*, 4, pp. 62-85.
- Dowell G., Hart S., Yeung B. (2000). Do Corporate Global Environmental Standards Create or Destroy Market Value? *Management Science*, 46(8), pp. 1059–1074.
- Gereffi G., Lee J. (2012). Why the World Suddenly Cares About Global Supply Chains. *Journal of Supply Chain Management*, 48(3), pp. 24–32.
- Gereffi G., Humphrey J., Sturgeon T. (2005). The Governance of Global Value-chains. *Review of International Political Economy*, 12(1), pp. 78–104.
- Gibbon P., Ponte S. (2005). *Trading Down: Africa, Value-chains and the Global Economy*. Philadelphia, PA, USA: Temple University Press.
- Großmann A.-M.C, Gruben P.-V. von (2014). The Role of Company Standards in Supply Chains – The Case of The German Automotive Industry. In T. Blecker (Ed.), *Innovative Methods in Logistics and Supply Chain Management: Current Issues and Emerging Practices*, pp. 99-121. Berlin, Germany: epubli GmbH.
- Großmann A.-M.C., Gruben P.-V. von, Lazina L.K. (2016). Strategic Development and Implementation of Company Standards. In Jakobs K. (Ed.), *Effective Standardization Management in Corporate Settings*, pp. 77–104. Hershey, PA, USA: IGI Global.
- Guler I., Guillén M.F., Macpherson J.M. (2002). Global Competition, Institutions, and the Diffusion of Organizational Practices: The International Spread of ISO 9000 Quality Certificates. *Administrative Science Quarterly*, 47(2), pp. 207-232.
- Harzing A.-W. (2000). An Empirical Analysis and Extension of the Bartlett and Ghoshal Typology of Multinational Companies. *Journal of International Business Studies*, 31, pp. 101–120.
- Jaffee S., Masakure O. (2005). Strategic Use of Private Standards to Enhance International Competitiveness: Vegetable Exports from Kenya and Elsewhere. *Food Policy*, 30(3), pp. 316–333.
- Kaplinsky R. (2010). The Role of Standards in Global Value-chains. *Policy Research Working Papers*, No. 5396, World Bank, Washington, D.C., USA.

Conclusion

- Lazina L.K. (2016). Company Standardization: Five Essays with a Focus on the Automotive Industry. Dissertation. Berlin, Germany: Technische Universität Berlin.
- Lutz S., Pezzino M. (2012). International Strategic Choice of Minimum Quality Standards and Welfare. *Journal of Common Market Studies*, 50(4), pp. 594-613.
- Nadvi K., Wältring F. (2004). Making Sense of Global Standards. In H. Schmitz (ed.), *Local Enterprises in the Global Economy*. Cheltenham, UK: Edward Elgar.
- Rugman A., Verbeke A., Yuan W. (2011). Re-conceptualizing Bartlett and Ghoshal's Classification of National Subsidiary Roles in the Multinational Enterprise. *Journal of Management Studies*, 48, pp. 253–277.
- Smith G. (2009). Interaction of public and private standards in the food chain. *OECD Food, Agriculture and Fisheries Papers*, No. 15, OECD Publishing, Paris, France.