

# Growing Exports by Signaling Product Quality: Trade Competition and the Cross-National Diffusion of ISO 9000 Quality Standards

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## Abstract

*Trade policy is an important topic in global public policy. It is recognized that trade is hampered when buyers have incomplete information about the offered products, a problem accentuated in the international markets by the physical and cultural distances between buyers and sellers. Buyers look for proxies to assess product quality, and exporters that can provide assurance about quality gain a competitive advantage. Our paper focuses on voluntary or private regulatory programs that have emerged as important instruments to correct policy failures. We examine how trade competition motivates firms to signal quality by joining ISO 9000, the most widely adopted voluntary quality certification program in the world. Methodologically, our study is novel because we observe trade competition at the bilateral and the sectoral levels. Structural equivalence, the measure of competition we introduce in this paper, captures competitive threats posed by actors that export similar products to the same overseas markets. We study ISO 9000 adoption levels from 1993 to 2002 for 134 countries, and separately for non-OECD countries and non-EU countries. Across a variety of specifications, we find that trade competition drives ISO adoption: The uptake of ISO 9000 is encouraged by ISO 9000 adoption by firms located in countries that are "structurally equivalent" trade competitors. Given that information problems about product quality are likely to be more salient for developing country exporters, we find that trade competition offers a stronger motivation for ISO 9000 adoption in non-OECD countries in relation to developed countries. © 2010 by the Association for Public Policy Analysis and Management.*

## INTRODUCTION

Policy scholars have put in considerable effort examining how information problems lead to governance failures in markets, governments, and nonprofits and how institutional innovations can mitigate the information asymmetries between producers and consumers, and between governments and citizens. The core idea is that consumers and citizens cannot make well-informed choices if they do not have sufficient information to assess the quality of the product they are being offered. Such products could range from a tangible offering such as an automobile (as discussed by Akerlof, 1970, in his classic article, "The Market for 'Lemons'"), or less tangible offerings such as voting records of elected representatives or pollution emissions of a nearby facility. This paper examines an important voluntary, nongovernmental initiative, ISO 9000, which reduces information problems between buyers and sellers in international markets.

ISO 9000 is a quality certification standard that has been sponsored by a non-governmental organization, the International Organization for Standardization. It is the most widely adopted quality standard (and the most widely adopted voluntary program) in the world. Since its launch in 1987, over 700,000 facilities in 164 countries have received ISO 9000 certification. We investigate how trade competition creates incentives for the cross-national diffusion of this important, nontraditional policy solution to information problems. We study ISO 9000 adoption levels from 1993 to 2002 in a panel of 134 countries, and separately for non-OECD countries and non-EU countries. We find that pressures emanating from trade competitors who have adopted ISO 9000 encourage exporters located in other countries to join this quality certification system.<sup>1</sup> Consistent with the argument that information problems about product quality are likely to be more salient for developing country exporters (Chiang & Masson, 1988; Potoski & Prakash, 2009), we find that trade competition offers a stronger motivation for ISO 9000 adoption in non-OECD countries in relation to developed countries.

There is a fair consensus in the global policy literature that international trade supports economic development. The task for governments, trade associations, and economic development bodies is to find ways to improve competitiveness of domestic firms in global markets. In particular, they actively look for policy instruments that can help firms navigate barriers to trade, a key impediment to accessing global markets. Until the 1990s, much of the global policy focus was on reducing tariff barriers, and since the 1994 Uruguay Round of the General Agreement on Tariff and Trade, now the World Trade Organization, there has been an increased effort to eliminate non-tariff barriers to trade.

Information asymmetries about product quality are particularly worrisome in global markets given the physical and cultural distances between buyers and sellers. Buyers look for proxies to assess product quality. Exporters that can provide assurance about quality gain a competitive advantage; the higher the level of competition is, the greater the incentives are to adopt quality signaling mechanisms. Furthermore, such incentives are likely to be higher for developing country exporters given their poor reputations, the higher variability in quality of their exported products, and the inability of global markets to differentiate high-quality products from others (Chiang & Masson, 1988; Potoski & Prakash, 2009). Instead of relying on government-sponsored initiative alone, we investigate how trade competition encourages actors to pursue a decentralized, nontraditional solution (ISO 9000) to mitigate informational barriers to trade (Clougherty & Grajek, 2008). Indeed, the emerging literature on voluntary certification systems underscores the possibilities of decentralized policy solutions to a variety of information problems pertaining to issues such as environmental stewardship, labor practices, organic content in food items, the use of child labor, and the protection of dolphins.<sup>2</sup> Our paper, therefore, contributes to the broader literature that investigates how private,

<sup>1</sup> Observing their competitors joining ISO 9000, exporters might believe this constitutes a norm of appropriate corporate behavior. ISO adoption might therefore be motivated by the logic of appropriateness (DiMaggio & Powell, 1983; March & Olsen, 1989). Although we recognize that both motivations might be at work, it is difficult to apportion variance between instrumental and normative motivations behind the decision to join ISO 9000.

<sup>2</sup> There is a parallel literature on information-based policies sponsored by governments (the Toxics Release Inventory Program), nonprofits (charity watchdogs), and for-profit actors (rankings published by various magazines) (Gormley & Weimer, 1999; Weil et al., 2006). Unlike voluntary programs where actors choose to join a program, actors may or may not elect to be rated or assessed via an information disclosure policy. Further, while voluntary programs typically require participants to adhere to obligations that are beyond the legal requirements, this is typically not so in the case of information-based policies. Thus, while voluntary programs and information-based regulatory initiatives speak to a similar governance problem rooted in information deficits, there are important analytical differences between the two approaches.

voluntary, or decentralized solutions, along with government-sponsored initiatives, can mitigate a core governance problem, namely information asymmetries between consumers and producers, and between governments and citizens.

Our paper also engages with another major literature in global and comparative public policy: trade-driven policy diffusion (DiMaggio & Powell, 1983; Burt, 1987; Guler, Guillen, & MacPherson, 2002; Simmons & Elkins, 2004; Lee & Strang, 2006; Elkins, Guzman, & Simmons, 2006; Simmons, Dobbin, & Garrett, 2006; Cao & Prakash, 2010). Scholars debate whether trade competition will lead to a race to the bottom or a race to the top, and what types of policies or organizational practices are more amenable to diffusion processes (Drezner, 2001; Greenhill, Mosley, & Prakash, 2009). Instead of examining the “whether” or “what” questions, our focus on information problems and ISO 9000 moves the policy debate to the study of the “how” question, namely, how trade competition leads to the diffusion of governance innovation such as ISO 9000.

The core idea in the policy diffusion literature is that, given policy interdependence, countries carefully watch policies of their competitors to ensure that they are not disadvantaged due to “bad” policies. Trade-induced competitive pressure is often the key variable in the regulatory races literature: The higher the pressure, the greater the chance is that a government will adopt specific policies. In making this argument, diffusion scholars observe trade-induced competitive pressures in two ways: (1) through bilateral trade patterns at the aggregate level, with no distinction among the types of goods being traded (Lee & Strang, 2006); and (2) through role equivalence, that is, countries’ sectoral-level export profiles, with no distinction regarding the destination of these exports (Guler, Guillen, & MacPherson, 2002). We submit that both of these measures of trade competition can mislead. In the former, two countries exporting to the same overseas market might export different products. In the latter, two countries exporting similar products might target different overseas markets. Given that the existing literature tends to employ incomplete and therefore potentially incorrect measures of trade competition, we introduce a new measure of trade competition, structural equivalence, which reflects trade competition at the bilateral and the sectoral levels (Cao & Prakash, 2010). In addition to our theoretical contributions, our paper has a major methodological advantage over previous policy diffusion studies because we do a substantially better job of measuring trade competition, the key concept in the policy diffusion literature. Moreover, because our analysis reduces ecological inference problems (our competition measure is based on sectoral data, whereas previous studies often look at national level data), our test of the trade competition hypothesis is much more direct and gives us more confidence in the causal inference.

In sum, our analysis focuses on a core issue in contemporary policy literature: information asymmetries leading to governance failure. Unlike much of the existing public policy literature, which focuses on governmental policies to mitigate problems, our analytical domain is different. We focus on voluntary or private regulation, which has emerged as an important regulatory instrument for the for-profit (Vogel, 2005) as well as the nonprofit sector (Prakash & Gugerty, 2010). Furthermore, our novel measure of trade competition offers a new perspective to the policy debates on globalization, regulatory races, and cross-border policy diffusion.

## INFORMATION ASYMMETRIES AND ISO 9000

The International Organization for Standardization (ISO) established the ISO 9000 quality management standards. Standards are benchmarking rule systems to reduce information asymmetries between buyers and sellers, enabling them to compare different products, activities, or outputs. Consequently, standards serve an important public policy objective by ameliorating market failures. The “World Trade Report” notes:

Whether as end consumers or as producing firms acquiring inputs, buyers may be at a significant disadvantage compared to sellers because the latter possess information about the good or service not available to the buyer. This asymmetry can significantly hamper the efficient functioning of markets, and standards can help solve the problem and increase efficiency. . . .

Among the factors accounting for heightened standardization activity are demands by consumers for safer and higher quality products, technological innovations, the expansion of global commerce and increased concern over social issues and the environment. (World Trade Organization, 2005, pp. xxvi, 26)

ISO 9000 is an explicit, externally verifiable certification standard that requires organizations to adopt specific management systems. The objectives of this certification program are twofold. Internally, it seeks to improve the organization's quality management practices; externally, it seeks to provide the organization with a mechanism to signal to its external stakeholders (who cannot fully observe what the organization is doing internally) its commitment to quality assurance. While the extent to which ISO 9000 improves quality at the facility level is contested (Terziovski, Power, & Sohal, 2003), primarily because scholars tend to draw on different populations of ISO 9000 adopters in their empirical analyses, there is consensus that ISO 9000 adoption is valuable because it constitutes a credible signal about firms' internal quality assurance practices. Exporting firms are therefore likely to believe that ISO 9000 adoption will improve their competitive position in relation to the non-ISO 9000 certified firms, or deny advantage to their competitors who have adopted these standards.

Arguably, firms might want to adopt ISO 9000 simply to improve the quality of their products. However, instead of thinking about ISO 9000 as a quality signal, they might believe that ISO 9000-induced improvements in quality will make their products more competitive and therefore translate into higher exports. Although this motivation can certainly influence firms' decisions regarding ISO 9000, it raises an important question: Why would a firm desire ISO 9000's branding? After all, ISO 9000's requirements are fairly straightforward and can be downloaded on the Internet free of charge. If improvement in quality were the sole motivation, firms would adopt ISO 9000-like practices without bothering with third-party certification, which is required to get the firm registered as ISO 9000 certified. Obviously, firms are willing to bear the expenses of third-party certification because they perceive some value in getting a formal ISO 9000 certification. This suggests that the ISO 9000 brand allows them to signal quality and improve their competitiveness.

The International Organization for Standardization is an important institution of global public policy whose standard-making domain encompasses a variety of issue areas. This organization has developed over 18,000 standards across issue areas except for electrical and electronic engineering, which is the domain of the International Electrotechnical Commission, and telecommunications, which is the domain of the International Telecommunication Union. Established in 1946, this Geneva-based organization is a network of national standards-setting bodies representing 162 countries (ISO, 2010a). While some of its members, the national standards organizations, are a part of their countries' governmental structures (such as Mexico's General de Normas), other national standard setting organizations are not (such as the American National Standards Institute).

The sharp and continuous increases in ISO 9000 uptake over the last two decades can be attributed to the international context in which quality assurance as a desired management practice is constructed. Because the salience of quality assurance as reflected in ISO 9000 adoption varies across countries, even within the developed world, we investigate its drivers. We are most interested in the role of trade competition as a driver of cross-country ISO 9000 diffusion because the quality norm (of which ISO 9000 serves as a proxy) has been articulated in the context of the so-called competitiveness debate (Commission of the European Communities, 1993; Thurow,



1992). Indeed, in several countries, to further competitiveness of domestic firms in global markets, governments (Chinese Business World, 2007) and trade associations (Srinivasan, 2002) have actively encouraged the adoption of ISO 9000. It is therefore instructive to examine whether trade competition has influenced the incentives for firms to signal their commitment to quality via ISO 9000.

ISO 9000 prescribes broad principles for establishing firms' quality management systems; it does not mandate specific quality control standards for products and technologies firms must adopt in their production processes, or even outcomes they must achieve (such as maximum number of defects per production run). The rationale for focusing on management practices instead of product standards or technologies is that if appropriate practices are adopted, high-quality products will follow. Firms seeking the ISO 9000 certification must establish a written quality assurance policy with approval by senior management. Along with the broad policy, firms must specify internal targets, regularly review their progress via internal audits, provide training to their employees, and designate a manager to oversee the implementation of their quality assurance programs. For most firms, these management systems are quite extensive, requiring substantial investments in personnel, training, and, most critically, documentation (Sanders, 1996).

Finally, having established the management systems, to get the ISO certificate, facilities need to get external validation via an audit by an accredited external auditor. The ISO does not supply auditing services. It has accredited national-level organizations that provide formal recognition to auditing or certification organizations. There are about 720 accredited auditing organizations around the world that can be hired to serve as third-party auditors (IAF, 2010). To ensure that the requirements imposed by the national-level accreditation organizations on the auditors are equivalent, the ISO has formulated detailed guidelines for conformity assessment (ISO, 2010b).

Typically, a facility seeking the ISO 9000 certificates will hire a third-party auditor for an initial assessment audit. This visit is supposed to clarify mutual expectations for the certification audit. The duration and cost of certification audits varies from facility to facility depending on factors such as a facility size, the technical complexity of the operations, and the pre-audit preparations made by the facility. It is fair to say that the costs of the certification audit alone (over and above the cost of creating and maintaining the management systems) are significant—small- and medium-sized firms routinely cite auditing costs as an important factor for not getting the ISO 9000 certification (CFIB, 2007). The cost of a certification audit can range from \$10,000 to as much as \$1 million per facility. Certification audits are performed every three years (ISOQAR, 2010). The auditor is expected to perform a surveillance audit every year. Further, the accreditation body is expected to audit the auditors to ensure that the auditors are conforming to ISO guidelines. While every governance system has problems of agency abuse, it is fair to say that the ISO has anticipated such problems and established institutional checks to mitigate them.<sup>3</sup>

To summarize, the ISO 9000 regime has been established by the International Organization for Standardization, the leading supplier of international certification standards. As a management system-based approach to quality, ISO 9000 requires participating firms to establish and document quality assurance practices, to identify managers to implement these practices and train employees, to conduct internal audits, and to get quality management systems audited by an accredited external auditor. Given that information deficits at the buyer's end regarding product quality hamper international trade, ISO 9000 enables firms to correct these deficits and improve their competitiveness. We now examine whether trade competition, while controlling for an exporting country's embeddedness in other types of international networks and its domestic context, creates incentives for firms to adopt ISO 9000.

<sup>3</sup> Arguably, it has not done so for charitable reasons: To protect the reputation of its product, the ISO must signal to various stakeholders that it has established mechanisms to ensure that firms or the auditors do not ride free.

## TRADE COMPETITION AND ISO 9000 DIFFUSION

We are most interested in examining how competition between structurally equivalent sellers influences ISO 9000 adoption. We observe structural equivalence in the context of “network position,” a concept central to social network analysis. Borgatti and Everett (1992, pp. 2–3) note that “actors who are connected in the same way to the rest of the network are said to be equivalent and to occupy the same position.” Two countries might be geographically distant and have little direct contact with each other in the global economy, but if they are connected to the rest of the world market in a similar fashion—that is, they export the same goods to the same foreign markets—they occupy a similar network position. Their similar network position is likely to induce competition between them because, from a buyer’s perspective, they are substitutable. From a network perspective, two actors (countries in our case) are said to be structurally equivalent if they have the same pattern of connections with other actors.

In the context of international trade, sellers seek to signal quality via ISO 9000 adoption in order to secure or maintain access to a buyer’s market; recent studies have indeed revealed the export-enhancing effect of ISO 9000 (Clougherty & Grajek, 2008; Potoski & Prakash, 2009). If their structurally equivalent competitors located abroad have joined ISO 9000, then sellers located in a given country will have strong incentives to do so as well. This is analogous to a regulatory race in which structurally equivalent competitors carefully note each other’s practices and mimic the important ones to ensure that they are not competitively disadvantaged. In sum, our key hypothesis is the following: ISO 9000 adoption will be encouraged if a country’s structurally equivalent competitors have a high number of certifications.

In the context of binary relationship networks (non-valued networks), Burt (1987) defines a set of structurally equivalent nodes as a set of nodes connected by the same relations to exactly the same people. The actor’s position in the network is only determined by who she is connected to. Two actors may be said to be structurally equivalent if they have the same pattern of ties with other actors. In other words, they are substitutable; as Hanneman and Riddle (2005) vividly put it, “Whatever opportunities and constraints operate on one member of a class are also present for the others.” It is rare to observe exact structural equivalence in large networks of binary relationships, and even harder to find it in valued networks where the tie is a measurement of the strength of a relationship. Therefore, we are often more interested in examining the degree of structural equivalence. A correlation of the two actors’ profiles of connections is often used to capture the degree of their structural equivalence (Snyder & Kick, 1979; Nemeth & Smith, 1985; Smith & White, 1992; Mahutga, 2006; Cao & Prakash, 2010).

## ALTERNATIVE ISO 9000 DIFFUSION MECHANISMS

In addition to trade competition, ISO adoption may be influenced by a variety of other diffusion mechanisms. First, we control for ISO 9000 diffusion via the so-called “California effect”: ISO 9000 adoptions in exporting countries are influenced by ISO 9000 adoption levels in their export destinations. Vogel’s (1995) California effect suggests that there is cross-jurisdictional diffusion of importing countries’ standards and practices via bilateral trade to exporting countries. The preference of customers with market power at the end of supply chains for ISO 9000 can create an ISO 9000 multiplier across countries whose firms are embedded in these networks. In sum, the adoption of ISO 9000 in a given country is likely to be encouraged if its salient export markets have high levels of ISO 9000 adoptions (Prakash & Potoski, 2006).

High levels of trade openness could encourage or discourage firms’ joining ISO 9000. All else equal, high levels of trade openness suggest that exporters face low levels of information problems in global markets. If so, higher levels of trade openness will be associated with lower levels of ISO 9000 adoption. Moreover, if foreign buyers

are sourcing products from abroad to reduce their costs, firms in exporting countries might have incentives to keep their operating costs low. Because joining ISO 9000 has a non-trivial cost, exporting firms might be unwilling to invest in ISO 9000 simply because such investment might not have a payoff. On the other hand, exporters might focus on both quality and cost—after all, poor quality increases cost. Furthermore, if exports are highly salient in a country's economy, governmental bodies (Chinese Business World, 2007) and industry associations (Srinivasan, 2002) are likely to encourage the adoption of ISO 9000. Thus, while the directionality is not clear, exposure to international trade is likely to influence ISO 9000 adoption in a given country.

Previous research on other ISO standards, such as ISO 14001, suggests that foreign direct investment (FDI) influences ISO 9000 adoption in two ways (Prakash & Potoski, 2007). First, the aggregate levels of inward FDI stock influences ISO adoption in the host country. Regardless of the source of FDI, with high salience of inward FDI in their economy, local firms may seek to present themselves as competent partners that the multinational enterprises could do business with. Adopting ISO 9000 could be one way of conveying that information.

The second mechanism by which FDI might influence ISO 9000 adoption is via the transfer of management practices from home countries of multinational enterprises to their host country subsidiaries; in other words, the FDI source and origin matters for ISO 9000 diffusion. The country-of-origin school (Porter, 1990; Sethi & Elango, 1999) contends that home country institutions, norms, and management practices not only differ across advanced industrialized countries—there are various types of capitalism (Hall & Soskice, 2001)—but also shape the activities and decisions of the multinationals abroad. Corporations are not stateless entities immune from home country influences (Pauly & Reich, 1997). Rather, corporate practices, strategies, and philosophies are strongly influenced by their home country environments. If the country-of-origin argument holds, inward FDI originating from home countries with high levels of ISO 9000 will be associated with high ISO 9000 adoption in host economies. While multinational enterprises are likely to ensure that their subsidiaries' management practices cohere with the ones adopted in their home operations, the effect of FDI on host economies may be larger because subsidiaries are likely to create externalities in the local economy (Moran, Graham, & Blomstrom, 2005). In sum, we expect that ISO 9000 adoption will be encouraged if the inward FDI in a given host country originates from home countries with high levels of ISO 9000 uptake.

Quality concerns and management practices prevalent in a given country could be influenced by the practices of a firm in its neighboring countries (Kopstein & Reily, 2000). Contiguous neighbors might share similar cultures and norms. Their managers are likely to frequently cross the border for economic and noneconomic reasons. In addition, they are likely to watch television shows or tune in to radio shows produced and telecast in neighboring countries or read newspapers, journals, and magazines published in neighboring countries. Thus, management practices embodied in ISO 9000 might diffuse simply because of geographical proximity. We speculate that ISO 9000 uptake in a given country will be encouraged if firms in contiguous countries have joined this program.

## DATA

### Response Variable

Although ISO 9000 was launched in 1987, systematic country-level data are available only from 1993. In 1993, on average, there were about 170 ISO 9000 certified facilities per country. By 2001, the number of per country ISO 9000 certified facilities had grown to about 3,383, with China having the most certifications at 75,755. In 1993

about 71.3 percent of the countries in the sample did not yet have an ISO 9000 certified facility; by 2001 only 10 countries had no ISO 9000 certified facilities.

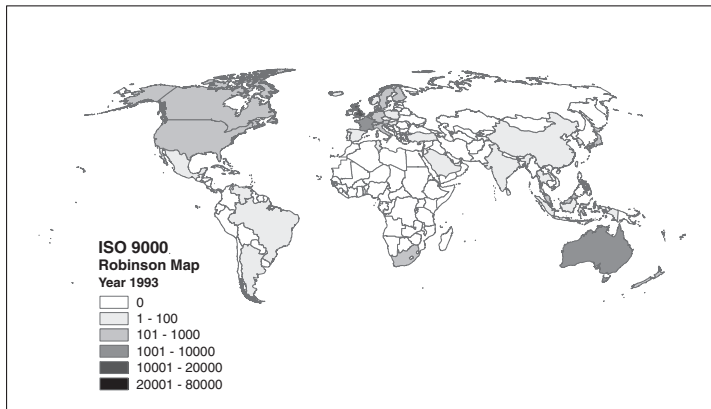
In order to get a visual sense of the diffusion process over time, Figure 1 shows the adoption levels in the starting year (1993), the middle year (1997), and the second to last year (2001) of our sample. We color each country to reflect the total ISO 9000 certificates at a given year and project them in a Robinson world map. Six variations of gray shadings are used to mark the levels of certificates (see legend for details). Figure 1 reveals some interesting patterns: In 1993, ISO 9000 certificates were “luxuries” and concentrated in developed countries. While firms in major developing countries such as China, India, Mexico, Brazil, and Argentina had begun to adopt ISO 9000, the average overall level was less than 100 certificates, and no country had more than 20,000 certificates. Four years later, more and more developing countries had adopted ISO 9000, including the majority of the African continent. Certifications in major developing countries such as China, India, South Africa, Thailand, and Brazil started to take off. Britain and Germany, among developed countries, passed the overall count of 20,000 ISO certificates. In 2001, ISO 9000 had diffused to the whole world except for a few countries in Africa: China, Australia, Italy, and United States had reached >20,000 ISO 9000 certificates by 2001, as shown by Figure 1(c). In sum, Figure 1 suggests that although the signaling value for ISO 9000 was initially attractive for developed country firms, its signaling value has begun to be appreciated across the world.

To investigate how trade competition influences country-level ISO 9000 adoption rates, we examine a panel of about 130 countries from 1993 through 2002. Our key dependent variable is the number of ISO 9000 certified units per billion dollars GDP (constant U.S. dollar, 2000). One advantage of this way of operationalizing our key dependent variable is that it enables us to control for the scale of the economy. Table 1 displays the changes in the mean of ISO 9000 certified units per billion dollars of GDP for all countries, the OECD countries, and the non-OECD countries, and for years 1993 to 2002. It further provides detailed information for the standard deviations (in parentheses) for each group of countries and for each year. On average, the OECD countries’ per-GDP ISO 9000 adoptions have increased at a much faster rate than non-OECD countries’. Moreover, for both the OECD and the non-OECD countries and for almost every year between 1993 and 2002, the standard deviations of per-GDP ISO 9000 certified units are often higher than or at least close to the mean values (see Table 1). For example, in 2002, the average of ISO 9000 adoptions is 10.10 per billion dollars of GDP for the non-OECD countries; the standard deviation is 14.30. This implies that there is a very high level of heterogeneity in terms of adoptions even within each group of countries. It also suggests that the distribution of this variable—that is, the number of ISO 9000 certified units per billion dollars GDP—is often skewed toward lower values. However, by taking the logarithm of this variable, we are able to approximate a normal distribution in our empirical analysis. It also allows us to employ the OLS estimator, which facilitates the interpretation of our findings.<sup>4</sup>

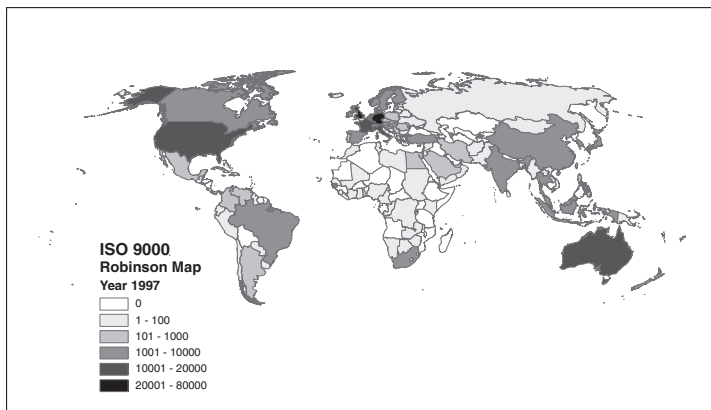
Before we proceed further, it is useful to note two potential shortcomings stemming from data limitations. First, while a substantial literature examines competitiveness at the country level (Porter, 1990; Thurow, 1992; Commission of the European Communities, 1993) and governments routinely broadcast their national level competitiveness in venues such as the World Economic Forum (Chinese Business World, 2007), some scholars believe that competitiveness should be measured at the firm level (Krugman, 1994). Measuring competitiveness at the firm level requires cross-national, firm-level export data that are not available. Second, while ISO 9000 adoption data are generated at the firm level, we aggregate the data and explain ISO 9000

<sup>4</sup> As we report subsequently, our key findings regarding the positive and statistically significant relationship between trade competition and ISO 9000 hold when we employ other modeling strategies, namely, a Tobit model and a negative binomial model.

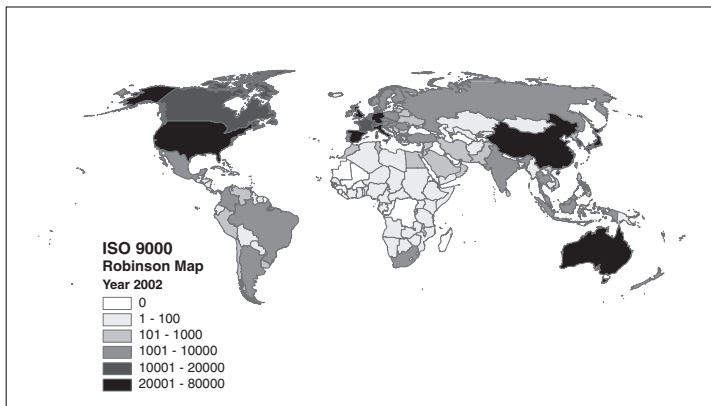




(a) 1993



(b) 1997



(c) 2001

**Figure 1.** ISO 9000 Diffusion, 1993, 1997, and 2001.

**Table 1.** Means and Standard Deviations (in Parentheses) of ISO 9000 Adoptions per Billion Dollars GDP, 1993 to 2002.

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
All countries	0.40 (1.70)	1.30 (3.90)	2.40 (6.00)	3.60 (7.20)	5.50 (9.00)	7.20 (10.40)	9.30 (12.50)	11.70 (16.00)	13.20 (18.50)	14.80 (23.30)
OECD	1.50 (3.10)	4.70 (7.20)	8.60 (10.70)	11.00 (11.40)	15.30 (12.20)	18.00 (13.20)	20.70 (16.90)	24.80 (21.20)	28.90 (27.10)	33.80 (38.80)
Non-OECD	0.10 (0.80)	0.40 (1.50)	0.90 (2.30)	1.70 (3.90)	3.10 (5.90)	4.50 (7.50)	6.50 (9.30)	8.50 (12.50)	9.40 (13.20)	10.10 (14.30)

adoptions at the country level. Both objections have merit. In response to these concerns, the standard approach that we follow (Guler, Guillen, & MacPherson, 2002; Neumayer & Perkins, 2005; Prakash & Potoski, 2007; Albuquerque, Bronnenberg, & Corbett, 2007) is to control for the scale of the economy. In doing so, some concerns about ecological fallacy and the aggregation process might be addressed.

Having said this, we want to emphasize that our paper goes well beyond replicating the standard methodological approach in policy diffusion studies. We push the work further on the diffusion of ISO standards than previous studies, including the paper by Guler, Guillen, and MacPherson (2002). Both conceptually and empirically, the most salient difference is that while Guler, Guillen, and MacPherson emphasize “role equivalence” as a measure of trade competition, we measure trade competition in terms of “structural equivalence.” Role equivalence captures the similarity between countries’ trade profiles by industry. In contrast, structural equivalence captures the similarity in trade defined by both industry and trade destinations. As we pointed out before, role equivalence can be a misleading measure of trade competition simply because countries with similar export profiles might be exporting to different destinations. Furthermore, given that international networks are conveyor belts for policy diffusion, our model controls for a wider range of theoretically plausible diffusion networks in relation to Guler, Guillen, and MacPherson, including FDI, trade, and proximity in geography.

### Constructing a Structural Equivalence Measure

This paper examines how trade competition as measured in terms of structural equivalence influences country-level ISO 9000 adoption. To calculate pair-wise structural equivalence based on sectoral level, bilateral data, drawing on the United Nations’ Standard International Trade Classification (SITC), we identified ten broad sectors (at the one-digit SITC) in international commerce.<sup>5</sup> We calculated structural equivalence by taking the correlation between two countries’ exports at both bilateral and sector levels. A given country’s export profile is composed of  $k \times (n - 1)$  elements in which  $n$  is the total number of countries ( $n - 1$ , therefore, is the number of potential export destination countries) and  $k$  is the number of trade sectors. Data for dyadic sector-level trade are from the United Nations’ Comtrade online database (United Nations, 2008). This data set covers international commerce at the dyadic level since the 1960s and across different commodities to the level of the five-digit Standard International Trade Classification (SITC). Aggregating bilateral trade to the one-digit level yields the ten distinct sectors just described. To capture structural

<sup>5</sup> The ten broad sectors are food and live animals directly for food; beverages and tobacco; crude materials, inedible, except fuels; mineral fuels, lubricants, and related materials; animal and vegetable oils, fats, and waxes; chemicals and related products; manufactured goods, classified chiefly by material; machinery and transport equipment; miscellaneous manufactured articles; and commodities and transactions not classified elsewhere.

similarity in export profiles, we generated a correlation matrix of each country's export profile across the ten sectors and to all other countries in the world (Snyder & Kick, 1979; Nemeth & Smith, 1985; Smith & White, 1992).

Specifically, calculating the first (Pearson) correlation between country  $i$ 's and country  $j$ 's export profiles, we constructed a correlation measure capturing the structural equivalence between any two countries  $i$  and  $j$  at year  $t$ , that is,  $se_{i,j,t}$ , in the network of global trade. The value of the correlation is bounded between  $-1$  and  $1$ , with  $1$  representing completely structurally equivalent positions between two countries, that is, exact profiles of bilateral exports across ten sectors of trade. On the other hand,  $-1$  captures the situation where two countries share the most dissimilar export profiles.

While countries compete in different export markets, only those exporting the same products in the same export market are likely to be considered competitors. We assume, therefore, that for any country  $i$  in year  $t$ , export-induced competitive pressures only come from countries that have a positive score of structural equivalence with  $i$ , that is,  $se_{i,j,t} > 0$ .<sup>6</sup> The decision of firms in country  $i$  to adopt ISO 9000 in response to competitor country  $j$ 's level of ISO 9000 certificates is influenced by the overall level of competition between these countries ( $se_{i,j,t}$ ). Therefore, for country  $i$ , the influence (to adopt ISO 9000) from a fellow exporter  $j$  can be summarized

as  $w_{se:i,j,t} = \frac{se_{i,j,t}}{\sum_{j \neq i}^n se_{i,j,t}}$ , where  $se_{i,j,t}$  is the structural equivalence in exports between country  $i$  and  $j$  at year  $t$ . Note that we have standardized  $se_{i,j,t}$  by  $\sum_{j \neq i}^n se_{i,j,t}$ , that is, the total competitive pressure faced by country  $i$ .  $w_{se:i,j,t}$ , i.e.,  $\frac{se_{i,j,t}}{\sum_{j \neq i}^n se_{i,j,t}}$ , can be considered

a spatial weight in a spatial model context: It is not defined by proximity in geography (which is time-invariant), but by the levels of structural equivalence in exports (Beck, Gleditsch, & Beardsley, 2006). Further, we weight structural equivalence by ISO 9000 adoptions (per billion GDP dollars) in country  $i$ 's competitor countries:

$\sum_{j \neq i}^n \frac{ISO_{j,t}}{GDP_{j,t}} \times w_{se:i,j,t}$  is the weighted average of country  $i$ 's competitor countries' ISO 9000 adoptions (per billion GDP dollars). Notice that  $\frac{ISO_{j,t}}{GDP_{j,t}}$  is a competitor country

$j$ 's ISO 9000 adoptions per billion GDP dollars (constant U.S. dollar, 2000). This is consistent with the operationalization of the dependent variable in which we standardize ISO 9000 adoptions by GDP to control for the scale of the economy.

$\sum_{j \neq i}^n \frac{ISO_{j,t}}{GDP_{j,t}} \times w_{se:i,j,t}$ , therefore, is a spatial lag term, with space defined by structural equivalence in exports (*Trade Competition*).<sup>7</sup>

Also, to be consistent with the operationalization of the dependent variable, we

<sup>6</sup> We therefore replace  $se_{i,j,t}$  with 0 if  $se_{i,j,t} < 0$  before computing the weights subsequently described.

<sup>7</sup> We have tried additional ways to operationalize the Trade Competition variable. For example, first, we calculate trade competition without row-standardization, that is, without dividing  $se_{i,j,t}$  by  $\sum_{j \neq i}^n se_{i,j,t}$  (the total competitive pressure faced by country  $i$ ). Second, we operationalize the trade competition variable as the absolute ISO adoptions times structural equivalence in trade—this is essentially structural equivalence weighted by GDP of the competitor country. We consistently find a positive and significant relationship between trade competition and ISO adoptions using these alternative specifications. We want to thank the reviewers for suggesting these alternative operationalizations.

use the logarithm of  $\frac{ISO_{i,t}}{GDP_{j,t}}$  in this spatial lag variable (*Trade Competition*) as well as the other three spatial lag terms presented in the following section (California Effect of Trade, Bilateral FDI, and Proximity in Geography) in the empirical analysis. For all countries between 1993 and 2002, the average of the trade competition variable is  $-0.9206$  and the maximum is  $2.7570$ . Because these are values after taking the logarithm, we take the exponentials, and the mean becomes  $1.95$  and the maximum is about  $15.75$  (with a standard deviation of  $2.95$ ). Substantially, this suggests that the mean of the weighted average number of a random country  $i$ 's competitor countries' per (billion dollars) GDP ISO 9000 adoptions is about  $1.95$  and the maximum of these weighted averages is about  $15.75$ .

### Measuring Alternative Diffusion Mechanisms and Domestic Control Variables

Our model controls for several theoretically plausible factors, international (that is, alternative diffusion mechanisms) and domestic, which might influence ISO 9000 adoption. We control for countries' overall *Trade Openness* (the sum of imports and exports as a percentage of GDP). We also control for the *California Effect*: For country  $i$ , the California effect can be captured by calculating country  $i$ 's bilateral exports weighted by ISO 9000 adoption, that is, bilateral exports weighted by ISO adoption =

$\sum_{j \neq i}^n \frac{ISO_{j,t}}{GDP_{j,t}} \times \frac{Exports_{i,j,t}}{Exports_{i,t}}$ , where  $\frac{ISO_{j,t}}{GDP_{j,t}}$  is the (logged) number of ISO certifications in country  $j$  per billion dollar GDP in year  $t$ , that is, ISO certifications in country  $i$ 's export market  $j$ .  $Exports_{i,j,t}$  is country  $i$ 's exports to country  $j$ ,  $Exports_{i,t}$  is  $i$ 's total exports to the world in year  $t$ .  $\frac{Exports_{i,j,t}}{Exports_{i,t}}$  can be considered a spatial weight in a

spatial model context, defined by the strength of export ties in international trade networks, to capture the relative importance of importing country  $j$  to exporting country  $i$  as an export market. (We can therefore use a simpler notation,  $w_{i,j,t}^{cal}$ , to replace  $\frac{Exports_{i,j,t}}{Exports_{i,t}}$  to capture the California effect of bilateral exports from coun-

try  $j$  on country  $i$  in year  $t$  in terms of ISO 9000 adoption.) Therefore, the whole

$\sum_{j \neq i}^n \frac{ISO_{j,t}}{GDP_{j,t}} \times \frac{Exports_{i,j,t}}{Exports_{i,t}}$ , becomes a typical spatial lag term in a spatial autoregres-

sive model to capture the California Effect of Trade.<sup>8</sup>

Our model includes two measures to examine the effect of inward FDI on countries' ISO 9000 adoption levels. We measure a host country's overall dependence on FDI (*FDI Stock*) based on the argument that, irrespective of the FDI's source, higher levels of inward FDI influence host countries' ISO 9000 adoption. *FDI Stock* is calculated as a host country's total inward FDI stock. Moreover, FDI's influence on ISO 9000 adoption may be contingent on ISO 9000 uptake in FDI's home countries. In other words, the source of FDI matters for ISO 9000 diffusion. We measure each country's bilateral FDI context based on its inward FDI stock (*Bilateral FDI*) from

<sup>8</sup> Guler, Guillen, and MacPherson (2002) and Prakash and Potoski (2007) employ a similar measure but they have squared the weights. Although our results hold even when we square the weights, we think that a linear relationship is a simpler and more intuitive way to explore interdependence between units of analysis.



various home countries to capture the long-term effects of inward FDI. This measurement is weighted by home countries' ISO 9000 adoption levels: bilateral FDI

weighted by ISO adoption =  $\sum_{j \neq i}^n \frac{ISO_{j,t}}{GDP_{j,t}} \times \frac{FDI_{i,j,t}}{FDI_{i,t}}$ , where  $\frac{ISO_{j,t}}{GDP_{j,t}}$  is the (logged)

number of per-GDP ISO 9000 certifications in FDI sending country  $j$  in year  $t$ ,  $FDI_{i,j,t}$  is the FDI stock that country  $i$  received from country  $j$  in year  $t$ , and  $FDI_{i,t}$  is country

$i$ 's total inward FDI stock.  $\frac{FDI_{i,j,t}}{FDI_{i,t}}$ , therefore, is a spatial weight ( $w_{i,j,t}^{FDI}$ ) defined by

bilateral FDI investments that reflects the relative importance of country  $j$  for country  $i$  as a sender of FDI.<sup>9</sup>

Geography may also influence ISO adoption levels. Information about managerial practices is likely to flow more readily between contiguous entities than between non-contiguous countries. Our model controls for the neighborhood effect, which we capture in terms of the average number of ISO 9000 certifications per billion GDP dollars in countries that share contiguous borders or are separated by 400 miles of water or less (*Proximity in Geography*).<sup>10</sup>

Regarding domestic control variables, we first control for per capita GDP (*GDP per capita*): Wealthier citizens might expect that firms provide quality products. Second, because ISO 9000 signals a firm's commitment to quality management, it is likely to appeal more to firms operating in competitive domestic markets.<sup>11</sup> We capture the competition effect in the domestic economy by controlling for the regulatory context as reported by the Heritage Foundation's Index of Economic Freedom (Heritage Foundation, 2003) (*Regulation*).<sup>12</sup> Moreover, we control for the level of government consumption (as a percentage of GDP) as a proxy for the salience of the state in the economy, because governments might encourage ISO 9000 adoption through their procurement policies or by virtue of owning economic enterprises (Guler, Guillen, & MacPherson, 2002).<sup>13</sup>

Finally, the domestic industrial structure can influence levels of ISO 9000 adoption levels. Ideally, we would have to control for sector-level profile for domestic production. Unfortunately, such data for a large enough panel of countries are not available. Furthermore, sectoral distribution of industrial production is likely to be sticky, at least for the short period that our study covers, and collinear with country fixed effects that we include in our model.<sup>14</sup> We, therefore, believe that the inclusion of country fixed effects responds to the issue of controlling for domestic industrial profile.

## MODEL AND EMPIRICAL FINDINGS

We model ISO 9000 adoption levels in country  $i$  in year  $t$  as a function of trade competition and a range of controls which include other types of diffusion variables and country-specific variables. The model can be written as:

$$y_{i,t} = \beta_0 + \varphi y_{i,t-1} + \mathbf{x}_{i,t} \beta + \rho \mathbf{w}_{t-1} * \mathbf{y}_{t-1} + C_i + \varepsilon_{i,t}$$

<sup>9</sup> FDI data are from the UNCTAD (<http://www.unctad.org>) and OECD (<http://www.sourceoecd.org>) databases.

<sup>10</sup> Data on geography are from the Correlates of War project (<http://www.correlatesofwar.org/datasets.htm>).

<sup>11</sup> We are aware of macroeconomic issues such as exchange rate movements and therefore used constant (2000) dollars.

<sup>12</sup> Higher values in the Economic Freedom Index indicate more economically free and competitive markets.

<sup>13</sup> Data for per capita GDP and government consumption are from the World Development Indicators.

<sup>14</sup> International trade literature also makes a strong case for using fixed effects in panel analyses in response to endogeneity problems (Baier & Bergstrand, 2007; Potoski & Prakash, 2009).

where  $y_{i,t}$  is a country  $i$ 's ISO 9000 adoptions per billion GDP dollars (constant U.S. dollar, 2000) in year  $t$  (that is,  $\frac{ISO_{i,t}}{GDP_{i,t}}$ ), and we take the logarithm to scale extreme

values and approximate a normal distribution.<sup>15</sup> We include a lagged dependent variable,  $\varphi y_{i,t-1}$ , for theoretical reasons as well as to mitigate serial correlation (Beck & Katz, 1995).<sup>16</sup>  $\mathbf{x}_{i,t}\beta$  captures the effects of country-specific characteristics,  $C_i$  are country fixed effects, and  $\varepsilon_{i,t}$  are random errors.<sup>17</sup>

$\rho\mathbf{w}_{t-1}^*\mathbf{y}_{t-1}$  represents the four spatial lag terms to test diffusion effects: *Trade Competition* (that is, structural equivalence in exports,  $\rho_{se}\mathbf{w}_{t-1}^{se}\mathbf{y}_{t-1}$ ), *California Effect* induced by bilateral exports ( $\rho_{cal}\mathbf{w}_{t-1}^{cal}\mathbf{y}_{t-1}$ ), inward *Bilateral FDI* ( $\rho_{FDI}\mathbf{w}_{t-1}^{FDI}\mathbf{y}_{t-1}$ ), and *Proximity in Geography* ( $\rho_{geo}\mathbf{w}_{t-1}^{geo}\mathbf{y}_{t-1}$ ).<sup>18</sup> To avoid simultaneity bias in the estimation of spatial models, the spatial lags ( $\rho\mathbf{w}_{t-1}^*\mathbf{y}_{t-1}$ ) are lagged by 1 year (Beck, Gleditsch, & Beardsley, 2006). The assumption here is that whatever happened in countries that are closely connected to country  $i$ —connections defined by ties of trade, FDI, and shared borders—it takes a time lag (1 year) to influence the outcome in country  $i$ .

Lagging the spatial lag has become a common practice in some of the recent studies of policy diffusion and neighborhood effects on policy choices (Lee & Strang, 2006; Elkins, Guzman, & Simmons, 2006; Swank, 2006; Cao & Prakash, 2010; Cao, 2010), because it provides a much simpler and more flexible way to estimate the strength of interdependence (by simple OLS regression) than the spatial maximum likelihood approach (spatial ML) and the spatial two-stage-least-squares instrumental variable approach (2SLS).<sup>19</sup> However, this strategy of lagging the spatial lag terms is based on a strong assumption of the absence of instantaneous effect. Meanwhile, lagging the spatial lags and estimating the spatial lag model by simple OLS can only be a sound solution to the simultaneity bias if the errors,  $\varepsilon_{i,t}$  in the model, are serially independent. Including a lagged dependent variable ( $\varphi y_{i,t-1}$ ) often helps to mitigate serial correlation in the errors, but there is no guarantee. Therefore,

<sup>15</sup> In the spatial lag terms ( $\rho\mathbf{w}_{t-1}^*\mathbf{y}_{t-1}$ ),  $\mathbf{y}_{t-1}$  is also in log scale to be consistent with the operationalization of the dependent variable.

<sup>16</sup> We understand that including a lagged dependent variable introduces a simultaneity problem as the lagged dependent variable is correlated with the error term by virtue of its correlation with the time-invariant component of the error term. When country fixed effects are included, the lagged dependent variable will still be correlated with the error term. The usual approach for dealing with this problem is to first-difference the data. Then, since the first-differenced lagged dependent variable is correlated with the first-differenced error term, it is necessary to instrument for it. In practice, however, it is often difficult to find good instruments for the first-differenced lagged dependent variable, which can itself create problems for the estimation. For example, Kiviet (1995) shows that panel data models that use instrumental variable estimation often lead to poor finite sample efficiency and bias. Fortunately, the literature suggests that as  $T$  (number of years) gets larger, this bias becomes less of a problem. We have a time series of 10 years, and we believe this is still a relatively large  $T$ . We also ran similar models without the lagged dependent variable and with AR1 (replacing the lagged dependent variable), and we have similar findings regarding the relationship between trade competition and ISO adoptions.

<sup>17</sup> Arguably, ISO 9000 adoption might be influenced by country-specific factors such as corporate governance, which are either sticky or change slowly over time (Gourevitch & Shinn, 2005). Data on corporate governance are not available for a large cross section of countries for a meaningful large- $n$  study. Further, because variables such as corporate governance tend to be sticky, the inclusion of country fixed effects serves to control for non-varying country-specific factors, which are not captured in other covariates. Indeed, the estimates of country fixed effects are almost all highly significant, revealing high-level cross-country heterogeneity that is not captured by the variables included in our regression analyses. This further justifies the inclusion of country fixed effects in our empirical analysis.

<sup>18</sup> Notice that the weight matrix for proximity in geography is time-invariant; therefore we do not subscript  $\mathbf{w}^{geo}$  by  $t - 1$ .

<sup>19</sup> Recent efforts have made the spatial maximum likelihood approach (spatial ML) easier to implement for time-series-cross-sectional data (Franzese & Hays, 2006, 2008). Other estimators such as Arrellano and Bond's estimator also exist to model spatial effect or interdependence in general (Perkins & Neumayer, 2008).

**Table 2.** Testing ISO 9000 Diffusion Mechanisms

	Model 1: all countries		Model 2: non-OECD		Model 3: non-EU	
	Coef.	$\sigma$	Coef.	$\sigma$	Coef.	$\sigma$
Trade competition: $\rho_{se}$	0.25	0.09***	0.34	0.11***	0.30	0.10***
California effect of trade: $\rho_{cal}$	-0.06	0.09	-0.05	0.11	-0.02	0.10
Bilateral FDI: $\rho_{FDI}$	-0.01	0.09	-0.00	0.10	-0.01	0.09
Proximity in geography: $\rho_{geo}$	0.12	0.06*	0.10	0.07	0.10	0.07
Trade openness	-0.02	0.01***	-0.02	0.01**	-0.02	0.01***
FDI stock (% of GDP)	0.12	0.06*	0.11	0.06*	0.12	0.06*
Gov. consumption (% GDP)	-1.76	1.62	-2.03	1.94	-2.49	1.76
Regulation	0.04	0.02***	0.04	0.02 *	0.04	0.02**
GDP per cap	-0.09	0.05	-0.17	0.12	-0.08	0.07
Intercept	-3.85	1.03***	-3.91	1.23***	-3.95	1.12***
Lagged dependent variable	0.44	0.03***	0.42	0.04***	0.43	0.03***
Adjusted $R^2$	0.815		0.773		0.796	
N. of observations/countries	1039/134		796/104		915/120	

Note: Country fixed effects are estimated for all models but not reported because of space limit.

\* $p < 0.05$ ; \*\* $p < 0.01$ ; \*\*\* $p < 0.001$ .

using a Lagrange multiplier test, we tested for serial correlation in error terms after estimating the model by OLS. We found no serial correlation in the empirical models reported in the following section.

Table 2 reports the findings from three model specifications.<sup>20</sup> The first model specification uses all countries with available data (134 countries). The second model limits the panel to non-OECD countries (104 countries), and the last model specification focuses on non-EU countries (120 countries). Across the three panels, we find that competition among structurally equivalent exporting countries drives ISO 9000 diffusion. This is indicated by a positive and statistically significant spatial coefficient associated with the spatial lag of trade competition,  $\rho_{se}$ . As for the first model specification, if the weighted (by the level of structural equivalence in exports) average per-GDP number of ISO 9000 among country  $i$ 's trade competitors were to be increased by 1 point (in log scale) in year  $t - 1$ , the difference in the logs of expected per-GDP counts of ISO 9000 for country  $i$  would be expected to increase by 0.25 units from year  $t - 1$  to year  $t$ , while holding the other variables in the model constant. Because both the trade competition and the dependent variable are logged, the coefficient of the trade competition variable can also be interpreted in terms of elasticity, that is, the percent change in the dependent variable produced by a 1 percent change in the independent variable. Therefore, a coefficient of 0.25 suggests that a 1 percent increase in trade competition (the structural equivalence-weighted average number of per-GDP ISO 9000 adoptions) is associated with a 0.25 percent increase in ISO 9000 adoptions for the focal country.

Note that the positive effect of trade competition on the diffusion of ISO standards consistently is not only significant across different model specifications, but the magnitude of this diffusion effect is also important. Importantly, we find that the magnitude of the spatial coefficient  $\rho_{se}$  associated with trade competition is larger for non-OECD countries (Model 2; 0.34) and non-EU countries (Model 3; 0.30) in relation to the full panel (Model 1; 0.25), which is consistent with the argument that information problems about product quality are likely to be more salient for

<sup>20</sup> Country fixed effects are estimated but not reported because of space limitations.

developing countries (Clougherty & Grajek, 2008; Potoski & Prakash, 2009).<sup>21</sup> This suggests that for developing countries, trade competition offers a stronger motivation for adopting ISO 9000 standards in relation to developed countries.

Although prior literature suggests that California effect (Vogel, 1995) is an important driver of ISO 14001 environmental standards, we find no evidence that ISO 9000 adoption is influenced by a California effect. This lack of influence might be because quality is less politically salient for global businesses as opposed to environmental issues for which ISO 14001 has been developed (Prakash & Potoski, 2007).

We find no statistical evidence across any model specification that *Bilateral FDI* ( $\rho_{FDI} \mathbf{w}_{i-1}^{FDI} \mathbf{y}_{t-1}$ ) induces ISO 9000 adoption. Finally, *geography* ( $\rho_{geo} \mathbf{w}_{i-1}^{geo} \mathbf{y}_{t-1}$ ) is statistically significant in the full panel (Model 1), but it loses significance when we consider non-OECD (Model 2) and non-EU countries (Model 3) only, suggesting a weaker role for diffusion through physical proximity in the developing world.

We find that the overall *trade openness* reduces ISO adoptions; this is consistent with the idea that the ISO 9000 is a means of quality signaling, because, all else equal, more open economies are likely to face lower levels of informational asymmetries and are therefore less in need of ISO 9000 as a quality signaling mechanism.<sup>22</sup> In contrast, inward FDI (*FDI Stock*) encourages ISO 9000 adoptions. We suspect that this is because with high salience of FDI in the domestic economy, local firms adopt ISO 9000 as a way to present themselves as competent partners.

Among domestic control variables, government consumption (*Gov. Consumption*) has no significant effect on ISO adoptions in any model. On the other hand, levels of domestic competition (*Regulation*) have a consistent and positive effect on ISO 9000 adoption across model specifications. This suggests that while governments may not be able to encourage ISO 9000 adoption via their purchases, competitive domestic markets create incentives for firms to signal their commitment to quality products via ISO 9000. Moreover, the wealth of a country (*GDP per Capita*) seems to have no clear effect on ISO adoption, even when only non-OECD and non-EU countries are included in the analysis (Models 2 and 3).

## ROBUSTNESS CHECKS

### Negative Binomial and Tobit Specifications

We have used an OLS estimator, which is flexible and allows for an easy interpretation of the findings. There are, however, alternative ways of modeling ISO 9000 adoptions (Guler, Guillen, & MacPherson, 2002; Prakash & Potoski, 2007). These include using a count specification, ISO 9000 certified units per country-year, and estimating a negative binomial model.<sup>23</sup>

Table 3 presents the findings from three models from a negative binomial model estimator with the same set of covariates as in Table 2. Here, the trade competition variable is still positive and statistically significant. Interestingly, the effects of proximity in geography are estimated to be consistently significant for all three groups

<sup>21</sup> To test the equality of these coefficients, we add to Model 1 (Table 2) a non-OECD dummy variable plus its interaction with the Trade Competition variable. The coefficient of this interaction term is positive and significant, which indicates that the magnitude of the spatial coefficient  $\rho_{se}$  associated with trade competition is indeed larger for non-OECD countries. Additional analyses suggest that the coefficient of the interaction term, *Non-EU\*Trade Competition*, is also positive and significant. This suggests that the magnitude of the spatial coefficient  $\rho_{se}$  associated with trade competition is also larger for non-EU countries.

<sup>22</sup> Our results hold when we use exports as a percentage of GDP.

<sup>23</sup> We recognize that a negative binomial model with conditional and unconditional country fixed effects (FE) can be problematic. While the unconditional model underestimates the standard errors (see Hilbe, 2007), the conditional model does not estimate a true fixed-effects model (Hilbe, 2007; Allison & Waterman, 2002).



**Table 3.** Testing ISO 9000 Diffusion Mechanisms: Negative Binomial Model.

	Negative binomial: all countries			Negative binomial: non-OECD			Negative binomial: non-EU		
	Coef.	$\sigma$	Pr(> z )	Coef.	$\sigma$	Pr(> z )	Coef.	$\sigma$	Pr(> z )
Trade competition: $\rho_{se}$	0.28	0.04	0.000***	0.37	0.05	0.000***	0.34	0.04	0.000***
California effect of trade: $\rho_{cal}$	-0.04	0.04	0.254	0.05	0.05	0.278	0.00	0.04	0.907
Bilateral FDI: $\rho_{FDI}$	0.14	0.04	0.001**	0.08	0.04	0.060	0.11	0.04	0.011*
Proximity in geography: $\rho_{geo}$	0.18	0.02	0.000***	0.11**	0.03	0.001**	0.13	0.03	0.000***
Trade openness	0.00	0.00	0.981	-0.00	0.00	0.740	0.00	0.00	0.386
FDI stock (% of GDP)	0.16	0.02	0.000***	0.15	0.02	0.000***	0.16	0.02	0.000***
Gov. consumption (% GDP)	0.95	0.71	0.178	-0.52	0.82	0.529	0.03	0.75	0.959
Regulation	0.02	0.00	0.006**	0.02	0.00	0.001**	0.02	0.00	0.007**
GDP per cap	-0.08	0.01	0.000***	-0.12	0.04	0.010*	-0.05	0.02	0.016*
GDP	1.61	0.36	0.000***	2.15	0.45	0.000***	1.86	0.41	0.000***
Intercept	-16.60	3.02	0.000***	-21.19	3.74	0.000***	-18.74	3.39	0.000***
Lagged dependent variable	0.00	0.00	0.101	0.00	0.00	0.649	0.00	0.00	0.422
Loglik:		-5105.6			-3011.6			-3997.1	
No. of observations/countries		1039/134			796/104			915/120	

Note: Country fixed effects are estimated for all models but not reported because of space limit.

\* $p < 0.05$ ; \*\* $p < 0.01$ ; \*\*\* $p < 0.001$ .

of countries. This is different from the estimates from an OLS estimator in Table 2, which uncovers little evidence of a diffusion process through physical proximity in the developing world (both non-OECD and non-EU countries). Other differences include that trade openness loses its significant effect in the negative binomial models and GDP per capita becomes negatively correlated with ISO adoptions. We also add one more variable—GDP to control for the scale of the economy for the negative binomial models.

Second, we estimate a Tobit model because our dependent variable, the number of ISO 9000 certified units per billion dollars GDP (constant U.S. dollar, 2000), is strictly speaking left censored at 0 (before taking the logarithm).<sup>24</sup> Table 4 presents the findings from the Tobit models. The estimates of the trade competition variable are very similar to what we report with OLS estimator in Table 2.<sup>25</sup>

### Trade Competition Measured at the Two-Digit SITC Categories

When calculating structural equivalence and structural similarity between countries' export profiles, we have used bilateral export data aggregated to the one-digit Standard International Trade Classification (SITC) level. While this level of aggregation is still quite broad, it is important to recognize that measurement errors and misclassification become increasingly problematic as researchers move to the more specific SITC categories. Moreover, more instances of missing values exist at the higher digit levels, and this causes problems when calculating structural equivalence that is a correlation measure. Nevertheless, higher-digit categorizations have the potential to improve the precision and to better capture the competitive pressure felt by individual firms. Therefore, as a robustness check, we move to the two-digit level SITC to create the structural equivalence measure.

One empirical problem with the two-digit level SITC categorizations is that there are over 60 categories. The prior literature picks up key two-digit SITC categories that represent different levels of product processing (Smith & White, 1992; Nemeth & Smith, 1985; Mahutga, 2006). Following this literature, we use 12 two-digit SITC categories representing commodities that span a continuous space between extraction based and labor intensive to production based and capital intensive (see the Appendix<sup>26</sup>). The new measure is labeled as *Trade Competition (2-Digit SITC)*.

Given the problems often associated with higher-digit SITC categorized trade data such as measurement errors, misclassification, and missing values, we use Feenstra et al.'s (2005) trade data, which is a modified version of the UN's Comtrade data, for two important reasons.<sup>27</sup> First, this data set has fewer missing observations compared to the Comtrade data. Second, Feenstra et al. have adjusted inaccurate values for some important trading countries. A disadvantage of this data set is its limited country coverage: There are about 70 countries that are fully covered by the data set. However, these 70 countries are the most important economies in the world accounting for over 90 percent of the global trade (Feenstra et al., 2005). We present our findings in Table 5.<sup>28</sup> Even with the much smaller sample sizes used for

<sup>24</sup> Tobit models are estimated by the *survreg,old* function from the *survival* package in R.

<sup>25</sup> In addition to negative binomial and Tobit models, we have also estimated other alternative models such as a first-stage Probit (to estimate the chance of having the first ISO 9000 adoption) and a second-stage negative binomial for countries that already have ISO. The positive and significant effect of the trade competition variable is robust to these alternative estimation strategies.

<sup>26</sup> All appendices are available at the end of this article as it appears in JPAM online. See the complete article at [wileyonlinelibrary.com](http://wileyonlinelibrary.com).

<sup>27</sup> Data are available at <http://cid.econ.ucdavis.edu/>. Feenstra et al.'s (2005) data are provided at the four-digit SITC level, which makes it possible to identify exports with high pollution levels.

<sup>28</sup> We do not include the variable California Effect of Trade and the variable Bilateral FDI because they consistently have shown no effect on ISO adoptions, and they are highly correlated with the Trade Competition and Proximity in Geography variable in the smaller sample size used for these new regression analyses.

**Table 4.** Testing ISO 9000 Diffusion Mechanisms: Tobit Model with Left-Censored Data (Left-Censored at 0).

	Total: all countries			Tobit: non-OECD			Tobit: non-EU		
	Coef.	$\sigma$	Pr(> z )	Coef.	$\sigma$	Pr(> z )	Coef.	$\sigma$	Pr(> z )
Trade competition: $\rho_{se}$	0.30	0.09	0.002**	0.43	0.12	0.000***	0.36	0.10	0.001**
California effect of trade: $\rho_{cal}$	-0.07	0.09	0.442	-0.05	0.12	0.682	-0.01	0.11	0.894
Bilateral FDI: $\rho_{FDI}$	-0.04	0.09	0.651	-0.05	0.11	0.660	-0.06	0.10	0.555
Proximity in geography: $\rho_{geo}$	0.15	0.06	0.017*	0.14	0.08	0.091	0.12	0.07	0.090
Trade openness	-0.02	0.00	0.000***	-0.02	0.00	0.008**	-0.02	0.00	0.001**
FDI stock (% of GDP)	0.13	0.06	0.023*	0.13	0.07	0.061	0.14	0.06	0.029*
Gov. Consumption (% GDP)	-1.93	1.77*	0.277	-2.20	2.21	0.320	-2.86	1.96	0.144
Regulation	0.05	0.01**	0.001**	0.06	0.02	0.004**	0.06	0.01	0.002**
GDP per cap	-0.10	0.04	0.040*	-0.21	0.13	0.128	-0.09	0.07	0.161
Intercept	0.47	1.16	0.684	0.36	1.45	0.804	0.46	1.29	0.721
Lagged dependent variable	0.45	0.03	0.000***	0.42	0.04	0.000***	0.43	0.03	0.000***
Loglik:		-1760.4			-1404			-1584.8	
No. of observations/countries		1039/134			796/104			915/120	

Note: Country fixed effects are estimated for all models but not reported because of space limit.

\* $p < 0.05$ ; \*\* $p < 0.01$ ; \*\*\* $p < 0.001$ .

**Table 5.** Testing ISO 9000 Diffusion Mechanisms: Trade Competition and Structural Equivalence Defined at the Two-Digit SITC Code.

	Model 1: all countries			Model 2: non-OECD			Model 3: non-EU		
	Coef.	$\sigma$	Pr(> t )	Coef.	$\sigma$	Pr(> t )	Coef.	$\sigma$	Pr(> t )
Trade competition (2-digit SITC): $\rho_{se}$	0.12	0.05	0.01*	0.16	0.08	0.03*	0.15	0.06	0.01*
Proximity in geography: $\rho_{geo}$	0.16	0.03	0.00***	0.20	0.05	0.00***	0.17	0.04	0.00***
Trade openness	-0.00	0.00	0.44	-0.01	0.01	0.15	-0.00	0.00	0.96
FDI stock (% of GDP)	0.16	0.05	0.00**	0.15	0.07	0.04*	0.20	0.06	0.00**
Gov. consumption (% GDP)	-2.11	1.14	0.07	-3.25	1.59	0.04*	-3.11	1.36	0.02*
Regulation	0.01	0.01	0.24	0.01	0.02	0.71	0.01	0.01	0.52
GDP per cap	-0.03	0.02	0.09	-0.08	0.06	0.19	-0.02	0.03	0.41
Intercept	-2.42	0.80	0.00***	-1.62	1.23	0.19	-2.47	0.97	0.01*
Lagged dependent variable	0.30	0.02	0.00***	0.28	0.04	0.00***	0.28	0.03	0.00***
Adjusted $R^2$		0.934			0.907			0.924	
No. of observations/Countries		386/59			204/31			291/36	

Note: Country fixed effects are estimated for all models but not reported because of space limit.

\* $p < 0.05$ ; \*\* $p < 0.01$ ; \*\*\* $p < 0.001$ .



these new regression analyses, the new trade competition variable remains statistically significant for the samples of all countries, non-OECD, and non-EU countries.

## CONCLUSIONS

Information problems lead to governance failures. This paper examines how actors can themselves seek to respond to information problems by joining a decentralized, private solution, ISO 9000 quality certification standards. Given that trade is impeded by information asymmetries between international buyers and sellers, ISO 9000 is a mechanism by which sellers can mitigate these asymmetries, signal quality, and improve their competitiveness. Our paper demonstrates how trade competition among structurally equivalent actors induces the adoption of ISO 9000. Theoretically and empirically, we introduce a novel measure of trade competition, structural equivalence, which assesses competition at both bilateral and sectoral levels. With this measure, we believe policy diffusion scholars have a new way to test the “trade competition drives policy diffusion” argument.

Conditions under which regulatory races will create incentives for actors to signal the adoption of “good” or “bad” policies and standards is an empirical question, depending on the nature of the issue area under consideration. In our paper, competitive (and perhaps mimetic) pressures from competitors encourage exporting countries to signal the adoption of quality management practices, arguably a “good” practice. In other areas, however, such as labor standards and social policies, competitive and mimetic pressure might lead to the adoption of “negative” signals.<sup>29</sup> Our findings should therefore be interpreted carefully and should not be construed as providing unequivocal support for the positions of either the globalization optimists or the globalization pessimists.

This paper contributes to the growing public policy literature on social regulation, private regulation (Bartley, 2003), and voluntary programs (Coglianese & Nash, 2001; Darnall, Potoski, & Prakash, 2010) by examining how these arrangements shape the behaviors of actors that subscribe to them. While governments certainly remain key actors in supplying governance services, deregulation, privatization, and economic liberalization have opened opportunities for voluntary programs. Our paper contributes to this important burgeoning literature by focusing on how trade competition drives the cross-country diffusion of the most widely adopted non-governmental regime in the world: ISO 9000 quality management standards. The focus on trade competition is important because, while prior research has identified international trade as an important driver of cross-country diffusion of regulations, norms, and practices (Vogel, 1995; Guler, Guillen, & MacPherson, 2002; Prakash & Potoski, 2006), this paper offers a systematic theorizing and measurement of trade competition at both bilateral and sectoral levels.

Future research should go beyond the focus of a single case study (ISO 9000 in our case) by comparing the efficacy of a given driver across cases. Two types of cases might be interesting. The first type might be other cases of cross-country diffusion of other voluntary certification systems. The norms and practices ISO 9000 propagates are normatively appropriate, and by and large, activist groups have not opposed ISO 9000. Arguably, other nongovernmental regimes might propagate norms and practices that are controversial and opposed by activist groups. Given the claims about the power of the global civil society (Boli & Thomas, 1999), it would be instructive to compare the efficacy of trade-induced diffusion in cases where the activist community is neutral and where the activist community is actively hostile. This would shed light on the extent to which activists can dampen

<sup>29</sup> For example, if foreign direct investors shy away from areas with labor unrest, countries might want to signal stability in the labor environment by adopting anti-union laws. This is especially so if other countries that seek to attract similar types of investors have already done so.

the trade-induced competitive pressures on actors to adopt specific types of practices or codes of conduct.

A second case type might involve areas where there are clear distributional conflicts. ISO 9000 adoption does not involve significant changes in domestic social or economic policies; its adoption does not lead to obvious domestic distributional conflicts. Arguably, the ability of actors to respond to competitive threats might be more limited when significant domestic adjustment is required. Furthermore, domestic institutions might also shape both the incentives and abilities of these actors to respond to real or imaginary competitive threats, as has been debated in the social welfare literature (Garrett, 1998). Thus, the ability of a given driver (trade competition in our case) to diffuse practices, rules, or norms is likely to vary across cases, and the analytical challenge is to specify *ex ante* where this mechanism might be most effective.

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## *Growing Exports by Signaling Product Quality*

### APPENDIX

#### Two-Digit SITC Categories Employed to Calculate Structural Equivalence

##### High Technology/Heavy Manufacture:

SITC Code 71: Machinery, Other Than Electric

SITC Code 58: Plastic Materials, Regenerated Cellulose and Artificial

SITC Code 69: Manufactures of Metal

##### Extractive:

SITC Code 64: Paper, Paperboard, and Manufactures Thereof

SITC Code 25: Pulp and Waster Paper

SITC Code 34: Gas, Natural and Manufactured

##### Low Wage/Light Manufacture:

SITC Code 84: Clothing

SITC Code 85: Footwear

SITC Code 83: Travel Goods, Handbags, and Similar Articles

##### Food Products and By-Products:

SITC Code 01: Meat and Meat Preparations

SITC Code 02: Dairy Products and Birds' Eggs

SITC Code 29: Crude Animal and Vegetable Material