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TEMPORARY CLUSTERS AND KNOWLEDGE EXCHANGE: TRADE FAIR EDUCATIONAL PROGRAMS AND ACCESS TO REMOTE KNOWLEDGE

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I am submitting herewith a thesis written by Jonathan David German entitled "TEMPORARY CLUSTERS AND KNOWLEDGE EXCHANGE: TRADE FAIR EDUCATIONAL PROGRAMS AND ACCESS TO REMOTE KNOWLEDGE." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Geography.

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(Original signatures are on file with official student records.)

**TEMPORARY CLUSTERS AND KNOWLEDGE
EXCHANGE: TRADE FAIR EDUCATIONAL
PROGRAMS AND ACCESS TO REMOTE KNOWLEDGE**

A Thesis Presented for the
Master of Science
Degree
The University of Tennessee, Knoxville

Jonathan David German
May 2018

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ABSTRACT

Knowledge is one of the most desirable commodities within any industry. Due to a continually globalizing marketplace, firms seek new venues to access pertinent information that will aid in their success. Significant sources of knowledge for industrial markets can be found in the temporary agglomerations that have been around for years: international trade fairs. The goal of this paper is to explore how firms in the solar photovoltaic (PV) industry use educational programs during trade fairs. Specifically, how firms use these programs to access remote knowledge (i.e. tacit information unavailable in local context) in these temporary, localized environments. Analysis of firm-level survey data gathered at Solar Power International revealed that there is a significant effect of educational program participation on accessing remote knowledge. The results provide evidence that firms participate in trade fair educational programs to access remote knowledge critical to success in the global economy. Moreover, the analyses intimate that firms according high levels of importance for knowledge exchange with customers and competitors also place high levels of importance on educational program attendance. Finally, relationships between the importance of exports, trade fairs as export strategies, and the importance of educational programs are also examined. This study finds that firms whom concentrate on exports were less likely to view educational programs as a beneficial opportunity.

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CHAPTER ONE

INTRODUCTION AND GENERAL INFORMATION

The dynamics of economic activity often lead to the evolution of clusters of inter-linked firms that aim to take advantage of co-location (e.g. Porter, 2000). The proximity afforded by clusters offers cost- and time-efficient information exchange, while at the same time making it more difficult for firms outside these localized agglomerations. Firms choose to participate in trade fairs (as proxies for permanent economic agglomerations) to cope with the challenges of distance. Research on geographic clusters has recently underscored the importance of knowledge in the global economy. International trade fairs are uniquely structured to offer many of the same benefits as larger, more permanent agglomerations and some would argue that these events have become positioned in the global economy as central pathways to access new trends, technology, and knowledge (see Maillat, 1998; Bresnahan *et al.*, 2001; Bathelt and Schuldt, 2010). A shift toward knowledge-based trade in most advanced industrialized economies indicates that the exchange of knowledge is vital and is becoming a major source of economic growth (Chlodnicki *et al.*, 2011). This shift motivates firms to participate in temporary clusters to access useful, cost-effective knowledge.

Success in the global economy requires firms to transition out of regionally-focused markets by establishing international pathways of economic exchange (Bathelt *et al.*, 2004). Developing pathways to access the positive externalities associated with permanent industrial agglomerations has been at the forefront of economic geographical research for decades. Previous trade fair research has examined how these professional gatherings emulate temporary agglomerations of economic activity by providing short-term access to customers, partners, and competing firms (Bathelt and Schuldt, 2008, 2010). In addition to their usual functions (i.e. sales, exhibiting new products/services), trade fairs have become venues for conducting various educational programs such as workshops, seminars, and technical symposiums.

Considering these comparatively new functions, this paper aims to complement existing works on the geographies of trade fairs and knowledge exchange by examining how firms use educational programs through a study at Solar Power International (SPI), the largest North American trade fair for the solar industry. Exploring the use of educational programs at trade fairs may offer insights on how firms access remote knowledge during temporary clusters.

Through research into cluster literature, and guidance from my advisors, I was able to develop a series of questions addressing specific characteristics of trade fair participation. The subsequent four research questions aim to analyze the relationships between the importance of knowledge exchange, of access to remote knowledge, and of educational programs with firm-level indicators.

RQ(1): How do firms in the solar PV industry use trade fairs to access tacit knowledge that is associated with industrial agglomerations (i.e. clusters)?

RQ(2): Is the importance accorded to firm-level knowledge exchange and trade fair educational programs related to the frequency of trade fair attendance?

RQ(3): Are firm-level indicators such as importance of knowledge exchange and access to remote knowledge related to the frequency of educational program attendance?

RQ(4): Do relationships exist between knowledge exchange, access to remote knowledge, the importance of educational programs, and the importance of exports?

By exploring these questions, this paper hopes to add to the literature on the roles trade fairs play as temporary economic agglomerations by building on previous work in face-to-face communication and “global buzz” at international trade fairs (Bathelt and Schuldt, 2010), the role of trade fairs in knowledge exchange (Maskell, 2014), and trade fairs as an export marketing strategy (Kalafsky and Gress, 2013). This paper offers a unique perspective on trade fairs by examining how educational programs at SPI offer a significant venue for firms to access remote knowledge and establish pathways of knowledge exchange.

Backgrounds on the Solar Industry and its Geographies

The solar PV industry is one of the fastest growing energy sectors in the world. Due to the current and anticipated effects of climate change, many nations have pledged to speed up their investment and deployment of renewable energies, with solar at the top of the list. This sector is driven by four strong national markets (Germany, Spain, Japan, and the United States), where support of policies benefitting the solar industry have become commonplace (Kirkegaard *et al.*, 2010). While these major markets are at the forefront of the solar PV sector, the global market has drastically expanded in recent years to include Taiwan, India, South Africa, and the United Arab Emirates. In the US, the solar PV sector employs more than 780,000 people and accounted

for an addition of 84 billion USD to US Gross Domestic Product (GDP) in 2016, making it a significant and growing part of the national economy (Solar Foundation, 2016). Solar employment grew by 25 percent from 2015, with California, Massachusetts, Texas, Nevada, and Florida having the greatest solar employment levels (Solar Foundation, 2016).

Figure 1 shows the distribution of solar PV firms throughout the United States, with high concentrations in the Northeast, Southeast, and West Coast. Recent trade disputes between some of the largest players in the solar PV sector (i.e. China, Germany, and the United States) have resulted in global market volatility. While the newly imposed tariffs on solar imports to the US have potentially harmful outcomes for the national solar industry, the true impacts remain to be seen. One thing is certain; the global solar PV sector is showing no signs of slowing down. Global competition in the solar PV industry makes it important for firms to explore new markets, hence their interest in trade fairs as potential venues for information exchange. With this in mind, the following section offers context for this research in terms of clusters, trade fair (i.e. temporary cluster) geographies, and knowledge exchange. The next section reviews the methodology and survey used for this research, followed by analyses that explore educational programs at SPI and the roles they may play in international trade fair participation. The final sections of the paper then review the findings, the implications for the literature, and provide topics for future research. It concludes by providing limitations of this study and potential remedies for future inquiry.

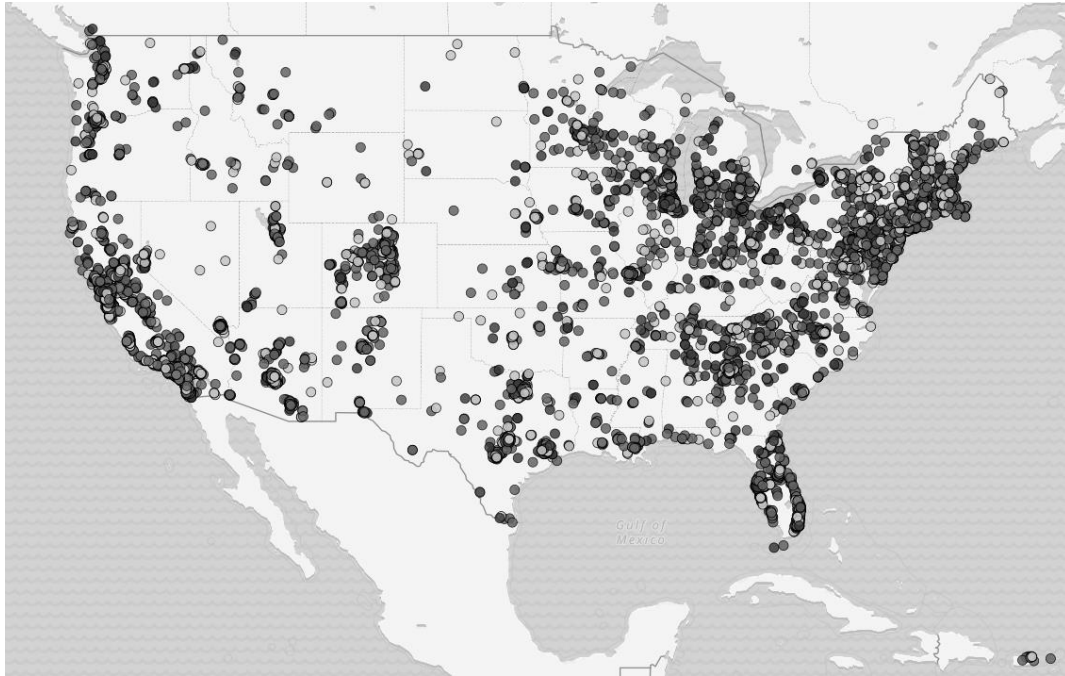


Figure 1. Distribution of solar industry firms within the United States.
Source: Solar Energy Industries Association (SEIA) – National Solar Database
Map created by SEIA

CHAPTER TWO

LITERATURE REVIEW

Research Framework: Clusters, Trade Fairs, and Information

Clusters, Co-location, and Localized Information

Geographical industrial agglomerations, or clusters, are described by Porter (2000: 254) as “a geographically proximate group of inter-connected companies and associated institutions in a particular field, linked by commonalities and complementarities.” Often, the implied reasons for clusters to exist are the reduction of the expenses of gaining access to and exchanging goods, services, and knowledge (e.g. Malmberg, 1996, 1997; Maskell, 2001; Malmberg and Maskell, 2002). Globalization has become a driving factor in contemporary cluster research as local economies face challenges including increasing competition between firms located around the world. With more firms participating in permanent agglomerations, companies are faced with the task of finding innovative solutions to problems in their local economies. That being said, within clusters of similar economic activity, firms are usually well informed about the dealings of other firms; making the strengths and weaknesses of each firm apparent (Malmberg and Maskell, 2002). This association gives each firm incentive to innovate, dynamics that were captured by Porter’s (1990) model of competitive advantage. Firms participating in economic agglomerations often develop similar technological traditions and views through shared daily routines and historical interactions. When people and firms work within these clusters, novel information or technologies developed are easily understood between them (Bathelt and Turi, 2011). Clusters help to “provide firms with [the] instruments to obtain and understand even the most subtle, elusive and complex information of possible relevance” and often “become increasingly engaged in the process of learning and continuous improvement, on which their survival depends” (Maskell, 2001: 929). When many aspects of business are becoming ubiquitous, agglomerations must turn their attention from simple cost analysis to a model of innovation and growth through global pathways of knowledge exchange.

Temporary Clusters: Knowledge Access at International Trade Fairs

Firms embed in industrial agglomerations and engage with various actors (suppliers, buyers, competitors) to reap the benefits of co-location, including decreasing the costs associated with doing business. Subsequently, firms must invest in international resources to build global partnerships in order to prosper in a globalizing marketplace. With high costs of establishing these global pipelines (see Owen-Smith and Powell, 2002), a comparatively new venue for local and global communication has emerged: temporary clusters (i.e. trade fairs). It is common practice for firms to send representatives to conferences, expositions, or other professional gatherings to initiate contact with potential consumers, evaluate competitors, and find future partners. As Maskell *et al.* (2006) notes, clusters that exist in “short-lived and intensified form” (999) may “provide a rich arena for processes of knowledge exchange and acquisition where small observations...may lead firms into new lines of thinking” (1001), in other words, supporting the combination of existing knowledge with new information.

Trade fairs create an environment conducive to robust information flows by joining core representatives from firms participating in similar economic activities (Maskell *et al.*, 2006). Through regular participation at trade fairs, firms can work with current and future partners that are normally out of reach for frequent face-to-face (F2F) communication (Maskell *et al.*, 2004). Scheduled meetings or informal interactions on the trade floor between firms have been found to result in robust inter-firm collaboration and aid in the co-construction of knowledge (Maskell *et al.*, 2004). In a salient work on international trade fairs, Bathelt and Schuldt (2010: 5), discuss the “practices of global buzz and their mechanisms” and have designed studies to “analyse the information and communication ecology between exhibiting firms and their suppliers, customers, competitors, and complementary firms.” Studies such as those from Bathelt and Schuldt provide examples of methodologies used by researchers to examine the co-construction of knowledge, innovation, and networking at international trade fairs.

Research on how representatives participate in the co-construction of knowledge at international trade fairs is often limited to the direct, face-to-face communications that take place in scheduled meetings, on the exhibition floors, or at informal social events (e.g. Maskell, 2014; Schuldt and Bathelt, 2011). International trade fairs, particularly for newer industries such as solar PV or renewable energies, recognize the need to expand the way in which firms can participate in knowledge exchange. Solar Power International is an example of a broad trade fair,

referring to any trade fair that offers educational programming such as innovative sessions, workshops, sponsored trainings, or education in the exhibit halls. Complementary to the current consensus, this paper aims to support that educational programs offered during trade fairs are an important, yet previously undiscussed, medium for firms to access and share remote knowledge that may be unavailable at their permanent locations.

Knowledge, Buzz, and Pipelines

Recent literature has turned its attention to how the co-location of firms in economically similar clusters (specifically, temporary clusters) may facilitate the exchange of knowledge (see Rinallo and Golfetto, 2006; Skov, 2006; Bathelt and Zakrzewski, 2007) but work on agglomerations extends much further back in the literature (see Marshall, 1890; Porter, 1990; Maskell *et al.*, 1998; Maskell and Malmberg, 1999b). In general, much of the research in economic geography proceeds with the perspective that geographical locality is still vital to understanding economic activity because it is a central facet of how people and firms come together to share knowledge (i.e. Dicken, 2011). That said, firms within industrial agglomerations must move outside the typical local markets to find new partners and resources to endure globalization, and continue to create knowledge (Bathelt and Glückler, 2011; Malmberg and Maskell, 2006). The awareness of the creation of knowledge, learning and innovation within clusters brings up the issue of knowledge in its own right. How should innovative knowledge in an economy be measured, if at all? According to Carter (1998: 205), “if we fail to measure it, we are overlooking an important part of current economic activity and thus distorting our measures of the whole.” The knowledge that firms exchange among economic agglomerations has become a key aspect of doing business, both on a local and international level, but how different types of knowledge are transferred across space merits further discussion.

The emergence of knowledge acquisition as an economic incentive raises discussions on the spatial characteristics of knowledge exchanged by firms. Generally, knowledge is divided into two categories: codified and tacit. Codified means that the knowledge has been reduced and converted into information that is easy to verify, exchange, store and reproduce, making it easily articulated and transferred to others across distance (Neef *et al.*, 1998). Most codified knowledge can be stored or inscribed on media such as books, digital files, etc., and with improvements in information and communication technologies, this type of knowledge has been able to move

more freely throughout the world. This improved movement implies “that knowledge, once codified, is almost instantly available to all firms at zero cost regardless of their location” (Bathelt *et al.*, 2004: 32). Of course, it is assumed that for firms to use any codified information, they must find the pertinent information available, evaluate it for usability, and then adapted so it can be used in combination with existing knowledge. With each of these steps, firms seek the most efficient ways to obtain and use codified knowledge (Bathelt *et al.*, 2004). On the other hand, tacit knowledge can be described as any knowledge that is not easily articulated or written down, this could be in the form of skills, shared beliefs, or information that is subjective or complex in nature, but is invaluable to firms that want to compete in economic markets. Tacit knowledge embedded in industrial agglomerations is imperative for firms to create novel “external knowledge,” which can aid firms with innovation by not relying on local resources, instead discovering new resources in the global marketplace (Bathelt *et al.*, 2004; Scott, 1988; Maillat, 1998).

Spatial clusters of similar economic activity give firms an opportunity to participate in the exchange of tacit knowledge, creating local buzz. Buzz is a term that refers to the face-to-face communications and knowledge transfer that transpire between people within similar industries in close spatial proximity. Various economic and social circles exist within industry clusters where communication between actors is programmed into daily interactions and provides access to local buzz with little to no cost. Given that local buzz is a characteristic of clusters, this does not suggest that all buzz is germane to individual participating firms (Bathelt *et al.*, 2004). Firms that have difficulty obtaining pertinent information through local, face-to-face interactions may turn to making new connections outside regional clusters (e.g. by attending trade fairs).

Thus far, this paper has discussed permanent clusters and the importance of local, face-to-face interactions, but the idea that localized learning is a more efficient form of innovation and economic growth has lost traction in recent literature, partially due to the lack of research on tangible learning processes between firms. Oinas (1999) confers that clustering of successful firms of similar economic activity should not, itself, be construed as empirical evidence supporting localized learning. Additionally, “it seems evident that the creation of new knowledge might be best viewed as a result of a ‘combination’ of close and distant interactions” (365). It

appears, then, that the spatial dichotomy of knowledge creation is a balancing act between local processes and deliberate international partnerships.

For firms to prosper in growing global markets, the need for essential additions to knowledge flows is often generated by extra-regional collaborations. Owen-Smith and Powell (2002), introduce the term “pipelines” to describe the paths of knowledge creation and transmission across interregional or international collaborations. These pathways of established relationships between distant firms grant access to new pools of information yet they do not come without costs. Selecting external partners, building relationships, and planning business aspects in advance all require specific and careful investments (Bathelt *et al.*, 2004). It is reasonable to assume that firms must innovate and expand their markets to survive and one important way to accomplish this is through these global pipelines. Explicitly, in a knowledge-based economy, success depends on local interactions but also how well firms in industrial agglomerations access peripheral knowledge pools located around the world (Storper and Walker, 1989; Scott, 1999; Maillat, 1998; Bresnahan *et al.*, 2001; Bathelt, 2003). Establishing regional and international pipelines involves various steps of investment from firms in industrial agglomerations, from finding and selecting potential partners to initiating contact and negotiating deals. Due to the immense expenses they can impose, firms seek the most efficient channels to establish extra-regional or international partnerships. In recent history, firms have turned to temporary clusters such as international trade fairs to locate prospective partners (Maskell *et al.*, 2006). Much of the previously discussed literature has established that the spatial limits and increased economic intensity of trade fairs makes them ideal settings for firms to connect with potential partners and consumers, gauge their competition, and participate in general exchange of ideas on the trade floor. With this in consideration, this paper examines how educational programs at trade fairs may offer a unique platform for the exchange of knowledge during temporary economic agglomerations, and how they serve as a medium for the establishment of international pathways.

Participation in economic clusters provides benefits of proximity; this paper is interested in the use of trade fairs (especially their education-based elements) as temporary clusters to establish international pathways for the devolution of knowledge. By examining the influence of educational programs on trade fair participation, this study offers to fill a gap in contemporary

literature pertaining to the shift towards a knowledge-based global economy (see Kalafsky and Gress, 2014).

CHAPTER THREE

MATERIALS AND METHODS

Exploring Educational Programs and Knowledge Exchange at a Trade Fair

Methods and Data

As outlined above, it is commonplace for firms to send representatives to international trade fairs with the intention of establishing new linkages with potential customers and partners. In line with this, trade fairs have become important locations in which to conduct research on knowledge exchange, they are uniquely structured to offer many of the same benefits as permanent clusters (see Amin and Cohendet, 2004; Entwistle and Rocamora, 2006). International trade fairs are particularly situated to provide researchers with access to a more robust sample of firms than would be normally feasible via research within a traditional agglomeration (Kalafsky and Gress, 2013).

The present study is based on a survey of firms in the solar PV industry that attended Solar Power International (SPI), the largest industry-related trade fair of its type in North America; this event was held in Las Vegas, Nevada, from 10–13 September 2017. SPI was established in 2004 to create an annual event for professionals and firms from all areas of the solar industry. It has grown from less than 5,000 attendees in 2004 to more than 20,000 in 2017; US-based firms typically make up a majority of attendees, but there is increasing participation by firms from China, Japan, central Europe, and South Korea. Solar Power International is unique in that it offers conference sessions and educational programs that are separated into tracks such as finance, policy, and utility. Data were collected from 72 firms via a structured survey instrument distributed to firm representatives during the trade fair (see Appendix A). The survey instrument contained 18 questions with 43 individual responses pertaining to goals of participation, knowledge exchange, educational programs, and firm characteristics (e.g. type, size). For eight of the survey questions, firm representatives were asked to answer via a Likert-scale where

responses ranged from one (least important) to seven (most important). Firm representatives were approached in the exhibit hall and on the second level of the convention center where the educational programs were held in an attempt to collect a representative sample of attendees with regards to firm size, type, and origin. SPI offered attendees a reserved area on the second level with tables, seating, and refreshments, an area that allowed the distribution of the survey instrument in a setting that was conducive for obtaining pertinent data.

Table 1 provides descriptive statistics for the sample. Among the reporting firms, almost 90 percent of them originated within the US, with the remaining based in Australia, Canada, China, Costa Rica, Taiwan, and South Korea. As an emerging industrial sector, firms in solar PV may use trade fairs in a somewhat different manner from those in established industrialized markets (Tafesse and Korneliussen, 2011). This may explain why more than a third of respondents reported that they only attend SPI, and why more than 80 percent of the firms were small- to- medium enterprises or SMEs. For the purposes of this study, the definition by the Organization for Economic Co-operation and Development (OECD) of SME is used: firms with fewer than 500 employees (OECD, 2005).

Table 1. Descriptive statistics for the sample.

Solar Power International attendance	Percentage of responding firms
Attend only SPI	33.3
Attend 2–3 trade fairs every 2 years	59.7
Attend 4 + trade fairs every 2 years	6.9
Firm size (by number of employees)	
Small to medium firms (1 – 499 employees)	83.3
Large firms (500+ employees)	16.7
Firm headquarters	
US	88.9
Non-US	11.1

Source: Author's survey

N = 72

CHAPTER FOUR

RESULTS AND DISCUSSION

The Role of Educational Programs at SPI: Insights into Trade Fair Participation

So why then did firms choose to participate in SPI? Recalling the first research question (Q1), determining how firms in the solar PV industry are accessing knowledge generally associated with permanent clusters is an essential starting point. The structure of the survey question on firm participation was developed using examples from previous trade fair literature to create unique responses pertinent to this study (Kalafsky and Gress, 2013). The survey presented firms with eight possible responses and the results are provided in Figure 2. Nearly 90 percent of responding firms selected knowledge exchange as a main goal of participation, fitting well into the context that trade fairs have shifted their focus from making sales to being catalysts of knowledge exchange (Bathelt and Spigel, 2012). With majority of previous research on trade fairs emphasizing that knowledge is exchanged on exhibition floors, in private meetings or face-to-face contacts (e.g. Bathelt and Schuldt, 2010), exploring the importance and utility of educational programs at trade fairs provides a new line of research. Firms reporting knowledge exchange as the number one goal for participating in SPI also reinforces contemporary literature on the creation of knowledge within temporary clusters and how buzz plays a key role during face-to-face interactions at international trade fairs (see Porter, 1990; Malmberg *et al.*, 1996). According to the survey results 40.3 percent of firms chose to participate in SPI to attend educational programs, making it the third most important aspect of trade fair participation overall. These newly captured findings on the importance of educational programs adds a unique layer of complexity to the trade fair literature and the role these programs play in the exchange of knowledge, which will be discussed in a later section.

Due to SPI being held in Las Vegas, the location lends itself to attracting a large amount of national attention where majorities (88.9 percent) of firms are headquartered in the US. Likewise, SPI's location could account for the differences between

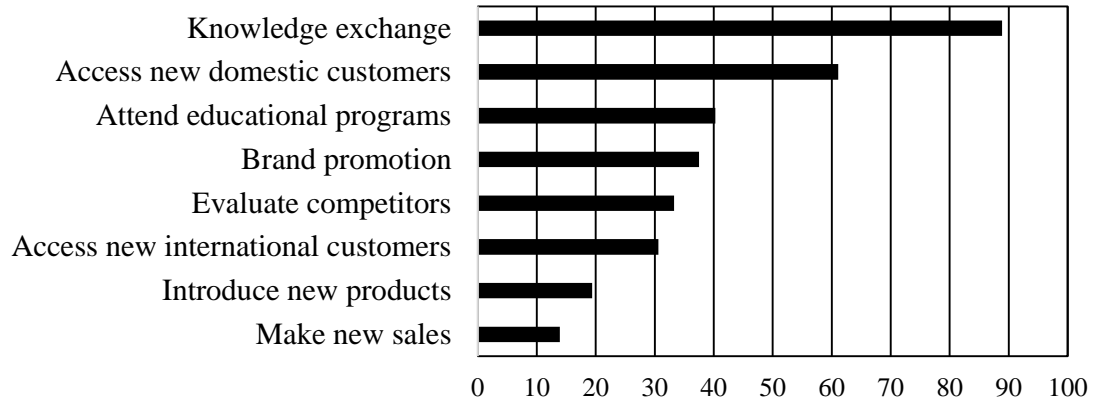


Figure 2. Reasons for trade fair participation (by percentage of responding firms).
 (Source: Author's survey). Note: Firms could select more than one response.
 N = 72

emphasis on domestic and international customer access where the results show accessing new domestic customers as important to more than half (61.1 percent) of the total responding firms. For the purpose of this study, the term remote knowledge is used to reference non-ubiquitous, tacit information that firms secure across geographic space (Maskell, 2014). In the following sections, the relationships between educational programs and knowledge exchange are further examined with regards to various firm-level indicators. The aforementioned results emphasize the use of trade fairs as temporary proxies for permanent economic agglomerations where daily, face-to-face relationships are maintained (Bathelt and Schuldt, 2008) and as a venue to access remote knowledge pools (Scott, 1999; Maillat, 1998; Besnahan *et al.*, 2001; Bathelt, 2003).

Much of the remainder of this section explores potential relationships between frequency and educational characteristics within the wider context of trade fair dynamics. First, firms were asked to rate the importance of knowledge exchange with customers, knowledge exchange with competitors and partners, the importance of educational programs, and how important educational programs are for accessing remote knowledge. These questions were presented to support that firms were participating in SPI for the explicit use of knowledge exchange. They describe where firms found knowledge exchange to be valuable and if educational programs were facilitating exchange. The first Kruskal-Wallis H tests were performed to determine if the frequency of trade fair attendance had any effect on the importance of knowledge exchange with customers and competitors, educational programs or accessing remote knowledge at trade fairs (see Table 2). The tests showed that there were no statistically significant differences in ranking between the levels of trade fair attendance frequency.

These analyses indicate that the number of trade fairs that a firm attends has no statistically significant relationship with the importance that firm attributes to knowledge exchange, educational programs, or access to remote knowledge. Previous trade fair literature (e.g. Maskell, 2014; Schuldt and Bathelt, 2011) suggests that firms participate in trade fairs to establish and continue business relationships, including knowledge exchange. Results of analysis presented here suggest that trade fair attendance has no effect on the level of importance firms place on knowledge exchange, educational programs, and accessing remote knowledge. Although many firms may attribute importance to some characteristics individually, there is no statistical relationship present with regards to the number of trade fairs attended. Tentatively this may suggest that regardless of the number of trade fairs

Table 2. Kruskal-Wallis H tests for trade fair frequency effect on reasons for attendance.

Measure	Kruskal-Wallis H	Mean	Std. Dev.	Asymp. Sig.
Knowledge exchange with customers	0.965	6.11	0.797	0.617
Knowledge exchange with competitors & partners	3.223	6.10	1.224	0.200
Educational program attendance	0.456	2.31	0.725	0.796
Educational program importance	0.453	4.81	1.589	0.797
Access to remote knowledge	2.201	5.08	1.599	0.333

Source: Based on data from author's survey

Note: Ratings based on a seven-point scale, from 1 (least important) to 7 (most important).

Trade fair attendance responses range from 1 (only attend SPI) to 3 (attend 4 or more trade fairs).

Educational program attendance responses range from 1 (none) to 4 (attend 4 or more programs).

N = 72

attended by firms, they accord similar importance to many information-related motives for participation.

Until now, trade fair research has lacked much discussion of educational programs with regards to knowledge exchange. With more than 40 percent of participants in this study reporting that educational programs were a main reason for attendance, further investigation into their relationships with knowledge exchange and access to remote knowledge during trade fairs is essential. Table 3 presents the results of Kruskal-Wallis H tests showing the effects of educational program attendance at SPI on the importance level reported for knowledge exchange, educational programs, and access to remote knowledge. The results intimate that there is no significant effect on the importance accorded to knowledge exchange with customers, competitors, or partners. These results support previous notions that temporary clusters such as trade fairs provide a robust venue for the processes of knowledge exchange (Maskell *et al.*, 2006), but fail to accord that quality with educational programs in this instance. On the other hand, the test showed that there was a statistically significant difference in mean rank between the levels of educational program attendance and importance, $H = 28.667$, $p = 0.000$, with a mean rank of 3.50 for Attending no educational programs, 32.62 for Attending 1 – 2 educational programs, 51.57 for Attending 2 – 4 educational programs, and 56.08 for Attending more than 4 educational programs. The results support a significant effect by the frequency of educational program attendance on the importance attributed to educational programs ($p = 0.000$). The higher the number of educational programs a firm intended to participate, the bigger the effect on

Table 3. Kruskal-Wallis H tests for the frequency of educational program attendance on firm-level indicators.

Measure	Kruskal-Wallis H	Mean	Std. Dev.	Asymp. Sig.
Knowledge exchange with customers	2.268	6.11	0.797	0.519
Knowledge exchange with competitors & partners	4.020	6.10	1.224	0.259
Educational program importance	28.667	4.81	1.589	0.000
Access to remote knowledge	26.375	5.08	1.599	0.000

Source: Based on data from author's survey

Note: Ratings based on a seven-point scale, from 1 (least important) to 7 (most important).

Educational program attendance responses range from 1 (none) to 4 (attend 4 or more programs).

N = 72

educational program importance. Although this relationship may seem reciprocal, it further reinforces the validity of the sample where firms conferring importance to educational programs are also likely to attend a higher number of educational programs.

The Kruskal-Wallis H test also showed that there was a statistically significant difference in mean rank between the levels of educational program attendance and accessing remote knowledge, $H = 26.375$, $p = 0.000$, with a mean rank of 4.00 for Attending no educational programs, 34.22 for Attending 1 – 2 educational programs, 43.87 for Attending 2 – 4 educational programs, and 62.67 for Attending more than 4 educational programs. Table 4 offers a pair-wise analysis to further investigate how educational program attendance affected the importance of accessing remote knowledge. The results show that there is a significant difference between groups that reported attending no educational programs and the groups that reported attending any number of educational programs ($p = 0.008$, $p = 0.001$, and $p = 0.000$ respectively). This significant difference provides evidence that the more educational programs a firm attends, the more they value access to remote knowledge. With previous research suggesting that trade fairs offer firms access to remote knowledge (Scott, 1999; Besnahan *et al.*, 2001; Bathelt, 2003), this analysis provides evidence that educational programs are useful in that regard. This further supports the hypothesis of this research that firms are using educational programs at trade fairs to access remote knowledge. In contrast, the comparison shows that there is no significant difference between groups that attended 1 – 2 and 2 – 4 educational programs ($p = 0.617$) or those that attended 2 – 4 and 4 or more educational programs ($p = 0.303$). The comparison of groups attending 1 – 2 and 4 or more educational programs ($p = 0.006$) shows something in opposition. The data intimate that although groups attending a similar number of educational programs show no differences, when groups attending a small number of programs (1 – 2) are compared to those attending 4 or more programs; there is a significant difference in the value attributed to accessing remote knowledge. These significant results infer that firms chose to participate in SPI to utilize educational programs for access to remote knowledge that would prove difficult to obtain within their permanent agglomerations (Maskell and Malmberg, 1999a; Bathelt and Henn, 2014; Maskell, 2014). Such findings introduce a new perspective to trade fair literature on how temporary clusters facilitate knowledge acquisition among firms by presenting a unique way trade fairs provide access to remote knowledge. Firms choosing to attend SPI with the intent to participate in educational programs can access remote knowledge that may aid in

Table 4. Pair-wise analysis of Kruskal-Wallis H test for the frequency of educational program attendance on Access to remote knowledge.

Sample 1 / Sample 2	Test Statistic	Std. Error	Sig.	Adj.Sig.
Attend none / Attend 1-2	-30.217	9.370	0.001	0.008
Attend none / Attend 2-4	-39.867	10.275	0.000	0.001
Attend none / Attend 4 or more	-58.667	12.049	0.000	0.000
Attend 1-2 / Attend 2-4	-9.649	5.916	0.103	0.617
Attend 1-2 / Attend 4 or more	-28.449	8.637	0.001	0.006
Attend 2-4 / Attend 4 or more	-18.800	9.612	0.050	0.303

Source: Based on data from author's survey

Note: Rows test the null hypothesis that the Sample 1 and Sample 2 distributions are the same. Asymptotic significances (2-sided tests) are displayed. The significance level is 0.05. Significance values have been adjusted by the Bonferroni correction for multiple tests.
N = 72

their success in the global economy.

Along these lines, do relationships exist between educational program importance, access to remote knowledge, and knowledge exchange among participants? Table 5 provides results from a Spearman's correlation test between educational program importance, access to remote knowledge, and knowledge exchange with customers and competitors. The significant correlation ($p < 0.001$) between educational program importance and access to remote knowledge provides further evidence that attending educational programs with the intention of gaining access to knowledge was a driving factor in firms' participation. Also, the tests provide evidence that the importance of educational programs and the importance of knowledge exchange with customers and competitors are both statistically significant ($p < 0.05$) and the introduction of educational programs to the pathways for knowledge exchange with potential customers and competitors sheds some new light on the ways firms utilize trade fair resources (Schuldt and Bathelt, 2011; Chlodnicki *et al.*, 2011; Kalafsky and Gress, 2014). These insights about the perceived value of educational programs for accessing remote knowledge add to the existing literature on the use of trade fairs for knowledge exchange (e.g. Bathelt, 2003; Bathelt *et al.*, 2004). It also provides complementary evidence supporting the idea that firms chose to move outside their typical, regional pathways of knowledge exchange to benefit from knowledge externalities that exist within temporary clusters (Boschma, 2005; Bathelt and Glückler, 2011).

As the need for knowledge exchange across international pathways increases, firms also need to find new and innovative ways to establish international export strategies. Are the educational programs offered at trade fairs similarly useful in developing export strategies? Analyses of the importance of educational programs offered during SPI has produced evidence to support that exporting may become necessary for many firms in developed economies (Kalafsky and Gress, 2013). Along with these new insights about how firms are utilizing trade fair resources for knowledge exchange, this study also makes inquiries into a common use for trade fairs: export strategies (Motwani *et al.*, 1992; Wilkinson and Brouthers, 2006; Kalafsky and Gress, 2014). So, in addition to the education-related missions of trade fairs, is there an export-related component? Recall that in Figure 2, the international marketing (i.e. export) motivation for trade fair attendance was mentioned by almost a third of the respondents. Certainly, it has been suggested that the proximity offered by trade fairs is good for firms that need access to a broader market (Torre, 2008). Previous research on trade fairs as export strategies focus on

Table 5. Correlation tests (Spearman's) between educational program importance, access to knowledge exchange, and access to remote knowledge.

Measure	Edu imp	Remote	Ex cust	Ex comp
Educational program importance	1.00	0.685**	0.265*	0.291*
Access to remote knowledge		1.00	0.207	0.213
Knowledge exchange with customers			1.00	0.574**
Knowledge exchange with competitors/partners				1.00

Source: Based on data from author's survey

*Significant at $p < 0.05$

**Significant at $p < 0.01$

Edu imp = Educational program importance; Remote = Access to remote knowledge; Ex cust = Knowledge exchange with customers; Ex comp = Knowledge exchange with competitors/partners.

Note: Ratings based on a seven-point scale, ranging from 1 (least important) to 7 (most important).

N = 72

positive externalities including meeting new customers, obtaining information on competing firms, and distributing information about goods and services (Rolf Seringhaus and Rosson, 1991; Dicken, 2011; Kalafsky and Gress, 2013), as well as empirically supporting the generation of direct sales and product awareness.

However, there has been relatively little, or perhaps no, research looking at trade fair educational programs and their possible relationships with developing export strategies. Table 6 offers an examination of the relationships between the importance of firm-level export indicators (e.g. importance of exports), educational programs, and SPI as an export strategy. Firms that ranked trade fairs (or SPI) as highly important as an export strategy show no significant correlation with educational programs ($r = -0.028$, $r = 0.040$, respectively) suggesting that firms attending SPI did not value educational programs for the explicit use of establishing export relations. Moreover, these data support that firms that attended SPI with a strong concentration on exports were significantly less likely to attend educational programs being offered. When considering participation in an international trade fair, firms may generally choose to focus on knowledge exchange or maintain a high degree of export market orientation, but little comparison has been provided within trade fair literature. This study offers an original look at the relationships (or lack thereof) between firms choosing to attend an international trade fair to gain access to remote knowledge and those attending to make new sales. Among the reporting firms that reported a focus on exports, the data show a significant correlation with importance put on trade fairs as export strategies and SPI as an export strategy ($r = 0.917$ and $r = 0.911$, respectively).

Table 6. Correlation tests (Spearman's) between educational program importance, importance of exports, and export strategies.

Measure	Edu imp	Exports	TF Export Strat	SPI Export Strat
Educational program importance	1.00	0.029	-0.028	0.040
Importance of exports to firm		1.00	0.917**	0.911**
Importance of trade fairs as export strategy			1.00	0.958**
Importance of SPI as export strategy				1.00

Source: Based on data from author's survey

*Significant at $p < 0.05$

**Significant at $p < 0.01$

Edu imp = Educational program importance; Exports = Importance of exports to firm; TF Export Strat = Importance of trade fairs as export strategy; SPI Export Strat = Importance of SPI as export strategy.

Note: Ratings based on a seven-point scale, ranging from 1 (least important) to 7 (most important).
N = 72

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

This paper adds to the literature on trade fair geographies through analyzing the relationships between educational programs at trade fairs and their roles in providing firms with a localized environment for knowledge exchange and acquisition. In addition to providing evidence supporting previous literature regarding knowledge exchange and acquisition (e.g. Bathelt and Schuldt, 2010; Schuldt and Bathelt, 2011; Maskell, 2014), these analyses also examined firm-level metrics such as export strategy intensity and participation in knowledge exchange with customers and partners supporting other important aspects of trade fair literature (e.g. Kalafsky and Gress, 2013, 2014). It was discovered that firms attending SPI with a concentration on exports were less likely to view educational programs as a beneficial opportunity. Explicitly, the data overwhelmingly finds that firms attend international trade fairs with the intent to exchange knowledge with potential consumers and competitors. Moreover, this research reinforced much of the previous literature on the usefulness and effectiveness of trade fairs as temporary clusters of localized economic activity to provide firms access to remote, tacit knowledge that is otherwise unobtainable (Maskell *et al.*, 2004). A valuable insight ventured from this research concerns the importance attributed to the educational programs with regards to accessing remote knowledge (Maskell and Malmberg, 1999a; Bathelt and Henn, 2014) where the data show that firms in the global solar industry employ this trade fair as a temporary, localized venue to access industry-specific knowledge specifically via the attendance of educational programs.

The relationships found between educational programs offered during SPI, their importance for accessing remote knowledge, and their usefulness for knowledge exchange among participants offers a unique addition to the various approaches firms use when accessing remote knowledge across geographical distance (Bathelt *et al.*, 2004; Maskell *et al.*, 2006). The unique conclusions introduced by this paper offer a new perspective on trade fairs as temporary, localized environments for the facilitation of remote knowledge acquisition. The results suggest that a growing number of firms are seeking a spatially confined, localized environment to access and exchange knowledge that is useful in the global marketplace.

It is also pertinent to address the limitations of this study and potential future research ideas. As a follow-up for this research or perhaps future studies, it would be informative to

perform in-depth interviews with firm representatives about their perceptions of educational programs at trade fairs and how they might be useful in the local or global economies. The qualitative data might provide further evidence of the relationships and importance of educational programs with access to, and the exchange of remote knowledge. Although SPI is North America's largest solar trade fair, it proved difficult to isolate and engage individual firm representatives during the hustle and bustle of the exhibitions; a larger sample size would allow for a more robust analysis. Future research into this topic would draw from a much larger sample, including firms from more countries and representing more facets of the solar industry (or other renewable energy industries). Pertinent supplemental studies into similar, but non-related industrial trade fairs should also be explored to ascertain the existence or involvement of educational programs with regards to knowledge access and exchange in order to reinforce the findings of this research.

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APPENDIX

Appendix A. Survey Instrument

Pathways of knowledge exchange: The role of robust education programs at trade fairs
Department of Geography
University of Tennessee

This thesis research aims to explore the influence of educational programs offered at broad trade fairs on regional and international business strategies and practices. Thank you for taking the time to complete part this survey. Please answer only the questions with which you are comfortable. The information from individual surveys will be kept confidential and will only be analyzed as a group.

If you have any questions about this survey, please contact Jonathan German at jgerman3@tennessee.edu, or please contact the University of Tennessee's Office of the Research Compliance Officer at: kh@utk.edu or at 865-974-7697.

1. What type of firm do you represent?

(Please select one category)

- Academic
- Architect / Builder
- Business Services
- Commercial Solar
- Community Solar
- Construction
- Distributor
- Contractor
- Energy Storage
- Engineering
- Government
- Hydrogen / Fuel Cell
- Installation Design Services
- Investor / Financier
- Manufacturer
- Media
- Non-Profit
- Operations & Maintenance
- PV Installer / Contractor
- Project Developer
- Real Estate Developer
- Residential Solar
- Software
- Utility
- Vertically Integrated Solar Company

2. Where is your firm's headquarters?

(Please enter City, Country name)

3. What size is your firm?

(Please select one category)

- Class 1 (1 to 20 employees)
- Class 2 (21 to 50 employees)
- Class 3 (51 to 100 employees)
- Class 4 (101 to 250 employees)
- Class 5 (251 to 500 employees)
- Class 6 (501 to 1000 employees)
- Class 7 (>1000 employees)

4. What are your firm's primary export markets? (Choose all that apply)

- North America
- China
- Southeast Asia
- East Asia
- Western European
- Eastern Europe
- Central or South America
- South Africa
- Other: _____

5. How many trade fairs does your firm attend every 2 years?

- Attend 4 or more shows
- Attend 2 - 3 trade shows
- Only attend SPI

6. What are your firm's main goals of participation at SPI? (Select all that apply)
- Access new domestic customers
 - Access new international customers
 - Attend educational programs
 - Brand promotion
 - Evaluate competitors
 - Introduce new products
 - Knowledge exchange
 - Make new sales
7. How important are exports to your firm?
Least 1 2 3 4 5 6 7 Most
8. How important are trade fairs to your firm as an export strategy?
Least 1 2 3 4 5 6 7 Most
9. How important is SPI to your firm as an export strategy?
Least 1 2 3 4 5 6 7 Most
10. How important is SPI for access to knowledge exchange with customers?
Least 1 2 3 4 5 6 7 Most
11. How important is SPI for access to knowledge exchange with competitors or partners?
Least 1 2 3 4 5 6 7 Most
12. How many educational programs is your firm attending at SPI?
- None
 - Attend 1 – 2 educational programs
 - Attend 2 – 4 educational programs
 - Attend 4 or more educational programs
13. How important are educational programs at trade fairs to your firm?
Least 1 2 3 4 5 6 7 Most
14. What type of educational programs does your firm attend at SPI? (Check all that apply)
- Concurrent/General Sessions
 - Poster sessions
 - Pre/Post-Conference workshops
 - QuickTalks
 - Seminars
 - Technical symposiums
 - Walking sessions
 - Workshops (During trade fair)
15. What educational program tracks is your firm interested in at SPI? (Check all that apply)
- Commercial & Industrial Finance
 - Policy Residential
 - Energy Storage International
 - Utility / Central Scale
16. How important are educational programs for accessing otherwise remote knowledge?
Least 1 2 3 4 5 6 7 Most
17. How important are educational programs for establishing connections with new business partners?
Least 1 2 3 4 5 6 7 Most
18. What is unique about Solar Power International compared to other international trade fairs?
-

THANK YOU!

On behalf of myself and The University of Tennessee, I thank you for your participation in this research survey! If you have any questions about this survey, please contact Jonathan German at jgerman3@tennessee.edu, or contact the University of Tennessee's Office of the Research Compliance Officer at: kh@utk.edu or at 865-974-7697.

VITA

Jonathan D. German was born in Macon, Georgia on 23 October 1989. He is the youngest of two children of Joseph E. German Jr. and Wanda F. German. Due to his father being in the United States Air Force, Jonathan attended four elementary schools in three different states, moving back to his home town of Warner Robins, GA in the year 2000, where he finished his primary education and subsequently graduated with a dual-seal diploma from Houston County High School in 2008. Jonathan then studied architectural drafting at Middle Georgia Technical College in Warner Robins, GA from 2008 to 2009. In 2009 he applied and was accepted to attend Georgia College and State University in Milledgeville, GA: making him a first-generation college student. With neither of his parents nor his older brother having attended a four-year university, he made his way through his undergraduate program with high marks and graduated with a Bachelor of Arts in Sociology in 2013. Upon graduation Jonathan obtained a research position at Mercer Engineering Research Center (MERC) – an affiliate of Mercer University, in Warner Robins, GA, where he worked on projects contracted by the United States Air Force. In June 2014, Jonathan married Anastasia N. Kerr and moved to Knoxville, Tennessee. He then procured a research position at Oak Ridge National Laboratory (ORNL) at the beginning of 2015, working on research projects funded by the Department of Defense, National Geospatial Intelligence Agency, Bill & Melinda Gates Foundation, Census Bureau, among others. In August 2016 Jonathan began pursuing a master's degree at the University of Tennessee, with a concentration in economic geography. In his first semester of the program Jonathan attended the annual conference for the Southeastern Division of the American Association of Geographers (SEDAAG) and presented research on *The Shift from Rural to Urban: The Lure of China's Most Urbanized Regions*. In the spring of 2017 Jonathan welcomed his first child with Anastasia: a son named Sebastian Colin German. In the fall semester of 2017 he successfully defended his research proposal for his master's thesis research and subsequently travelled to Las Vegas, Nevada to collect data at Solar Power International: North America's largest solar industry trade show. Under the guidance of his advisor, Dr. Ronald V. Kalafsky, he wrote his master's thesis manuscript entitled *Temporary Clusters and Knowledge Exchange: Trade Fair Educational Programs and Access to Remote Knowledge*. He successfully defended his master's thesis on 5 March 2018 and graduated with a master's degree in geography in May of 2018.