

**The Determinants and Evolution of Major Inter-firm
Transactions in the U.S. Apparel Sector**

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感谢我的爸爸妈妈，教会我享受生活，开心做人。

Abstract

This study provides a systematic description of the nature and evolution of major transactions in the U.S. apparel sector, using a theory that applies across sectors. This research investigates the determinants of the existence and magnitude of major inter-firm transactions, relying on a unique longitudinal dataset of over 2,000 of the largest transactional (buy-sell) relations between publicly traded firms in the U.S. apparel sector. The results indicate the importance of inter-firm complementarity, rather than inter-firm similarity, in explaining the sector architecture; thus contributing to the future improvement of industry classification systems. This study also contributes to a deeper understanding of the apparel sector focusing on the change in the relative importance of manufacturing activities versus service activities and in the involvement of firms from the outside apparel sector. Implications of inter-firm transactions are discussed regarding industry policies, and human and environmental welfare in manufacturing and raw materials industries.

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1. Introduction

Transactions are the most basic form of inter-firm relationship and are a fundamental unit of economic analysis (Williamson, 1975). Within a sector, transactions in intermediate markets serve to link and coordinate complementary activities across firms (Jacobides & Winter, 2005; Baldwin, 2008). Research on transactions has focused on the question of how a transaction will be governed. Transaction-cost economics considers the firm's decision as to whether to make or buy a particular input (Williamson, 1975). Transaction costs are the costs associated with using suppliers in the outside market rather than producing in-house. Opportunistic transaction costs have been the focus of Williamson's transaction costs economics, while Baldwin (2008) places the emphasis on mundane transaction costs. Specifically, opportunistic transaction costs plus mundane transaction costs are together equal to the total transaction costs. Baldwin (2008) illuminates the importance of mundane transaction costs, which are defined as "the costs of defining, counting and compensating for things transferred". The theory of mundane transaction costs determines whether a transaction is possible, and argues that transactions are only possible at thin crossing points between modules.

An inter-firm transaction is a basic business event and transactional relationships impact firm prospects. Cohen and Frazzini (2008) show that customer-supplier relationships generate significant co-movements in the underlying cash flows of linked firms. A growing body of studies has investigated the impact of inter-firm network structures on firm performance. Bonaccorsi and Giuri (2001) suggest that the structural dynamics of the supplier industry depend on the ways in which inter-firm transaction networks are created and distributed among vertically related supplier and buyer industries.

A related and important question is where transactions are likely to take place. Given

a pair of firms, how likely is it that they will be engaged in a buy-sell relationship and in which direction will the transaction be oriented? At an inter-industry level, economists have reversed the question such that inter-industry transactions are used to generate information on the structure of the economy. Input-Output (I-O) models produce fundamental knowledge of the structure of the economy and are used to reconcile government accounting systems. In some cases, global value chains (GVCs) indicate the likely transactional relations between firms. For example, firms are associated with relatively clear global value chain roles in sectors (e.g. automotives, apparel) that produce physical products.

The Chief Economist of Foreign Affairs and International Trade Canada considers global value chains (GVCs) to be of high importance and observes that “measurement has probably been the most significant obstacle to developing a better understanding of GVCs” (DFAIT, 2011). Similarly, in a recent report published by the Institute for Research on Public Policy (IRPP, 2012), new data are identified as the primary requirement for acquiring a better understanding of Canada’s role in GVCs.

The requirement for additional data arises as a consequence of the limitations of the standard industry classification systems used by governments. These systems group industries together into subsectors and sectors on the basis of similarities in the nature of activities performed by firms in neighbouring industries. But value chains and other self-organized networks of firms such as sectors and ecosystems are composed of firms that perform complementary activities to collectively address the demands of final user-customers. So while we know a great deal about relations between competing firms that perform similar activities in the same industry, it is difficult to obtain information about relations between firms in different industries that are engaged in complementary supplier-customer relations. Therefore, the questions remain. These include the following:

- What role do service providers play in global value chains?

- To what degree are firms outside the primary sector involved in the primary-sector value chain?
- To what degree do transactions involve pairs of firms that have an upstream-downstream relationship versus backward and cycled transactions?
- How stable are GVC relations over time?

It is of scientific importance to investigate why and where inter-firm transactions exist because they help us to reveal the persistent pattern of inter-firm relations, and to understand the structure of industry. I believe that large and persistent transactions constitute the structure of the economy in the same manner as branches, not leaves, capture the structure of trees. In the interest of developing a better understanding of industry structure, I am conducting a study on the determinants of major inter-firm transactions. In addition, it is of practical importance to know where inter-firm transactions are likely to take place since transactions are firms' fundamental economic activities and are closely related to firms' behaviours and level of commitment to corporate social responsibility. Policymakers, firms and organizations, and citizens should be aware of the impact of their economic activities on certain critical issues such as human welfare and environmental welfare. For instance, the disasters that took place in Bangladesh's manufacturing industry have implications for Western retailers and consumers in developed countries because their buying behaviours have implications for labour and safety standards, including the enforcement of building codes in Bangladesh (Strauss, 2013). Retailers and buyers, though without official data, understand that their purchasing activities have implications for other industries on which the retail industry depends; examples include human-welfare issues in manufacturing industries or environmental issues in raw materials and resource industries.

Governments have access to large quantities of data. But, because the data are organized in an unhelpful way, governments cannot easily draw conclusions about inter-industry or inter-firm relations from the data. They can only operate on the basis

of the common knowledge that consumers have, or on the basis of sensational news reported by the public media. If the data that governments have were organized in such a way as to make evident the relationships between upstream and downstream economic activities, then we would have scientific knowledge regarding the impacts of consumers' purchases on human and environmental welfare. A better understanding of inter-firm transactions would be of benefit to international trade policy (e.g., tariffs and quotas), the improvement of labour and safety standards, and the development of industrial policy.

My empirical focus will be on the apparel sector and this selection is justified for several reasons. First, the apparel sector has experienced transformation in its supply chain due to the introduction of the "fast fashion" concept and of "lean retailing" strategies, along with the adoption of new information technologies (Abernathy et al., 2000). Gereffi, Humphrey, and Sturgeon (2005) indicate that the apparel industry has shifted from a captive value chain to a more complex relational value chain. Second, the apparel sector can be considered to be one of the most global of all industries (Dickerson, 1995; Gereffi, 1999). Globalization has facilitated industrial upgrading that involves organizational learning to improve the position of firms or nations in global trade networks (Gereffi & Tam, 1998). Thirdly, many U.S. economic analysts hold the popular prognosis that U.S. apparel manufacturing is dying (Abernathy et al., 1995). Tassef (2010) points out that the United States has allowed the manufacturing sector to languish. The plight of the manufacturing sector not only is an "industry" problem but is also a "value chain" issue. Finally, since my study is at the starting point to investigate sector architecture, the apparel sector is suitable for testing a pioneering theory due to its relatively low complexity and long tradition.

This study describes the nature and evolution of major inter-firm transactions in the U.S. apparel sector. I believe that the fundamental patterns in the nature of inter-firm relations persist, notwithstanding the strategic behaviours of different firms, the presence and absence of certain firms over time, and the diversity in business

environments. Specifically, I will investigate the existence and magnitude of major inter-firm transactions and will examine the structure and evolution of the U.S. apparel sector over time.

My study sample relies on a unique longitudinal dataset of over 2,000 of the largest transactional (buy-sell) relations between publicly traded firms in the U.S. apparel sector over the last 35 years. This dataset allows me to characterize the determinants and evolution of transactional networks. The data are available because the U.S. Securities and Exchange Commission requires firms (including foreign firms) that are publicly traded in the U.S. to report the percentage of their revenues that is attributable to sales to a specific customer, in cases where those sales exceed 10% of total revenues. I did not consider the minor inter-firm transactions because in general large firms, rather than small firms, are more likely to construct and change the structure of transactional networks. Moreover, small firms tend to follow the general patterns and lack the capability to change the structure of industries.

This study only focuses on the apparel and apparel-related industries. Based on the North American Industry Classification System (NAICS), I identify the following subsectors: 313 (Textile Mills), 315 (Apparel Manufacturing), 316 (Leather and Allied Product Manufacturing), 4243 (Apparel, Piece Goods, and Notions Merchant Wholesalers), and 448 (Clothing and Clothing Accessories Stores); I also identify observations where either the seller or the buyer operates in one of the above-mentioned subsectors. Additional data on firms' revenues are extracted from Research Insight. The second dataset contains firm-year observations from 1992 to 2010.

My research questions are as follows:

- What factors predict the existence and magnitude of major inter-firm transactional relationships?
- How does the U.S. apparel sector evolve over time?

My results clearly show that inter-firm complementarity predicts both the existence and magnitude of major inter-firm transactions better than inter-firm similarity. My thesis is the first study that responds in a scientific manner to the need to examine major transactions between firms and that employs a theory that is replicable across different sectors. This study also contributes to a deeper understanding of the apparel industry by focusing on changes in the relative importance of manufacturing activities versus service activities and in the involvement of firms from outside the apparel sector.

The thesis is organized as follows. Chapter 2 provides a brief review of five strands of literature. Then I develop my theories and derive hypotheses in Chapter 3. In Chapter 4, a description of my data and methodology is presented. In Chapter 5, findings and results are presented and discussed. The last chapter discusses the contributions, limitations, and implications of my study.

2. Literature Review

In this section, I provide a brief review of five strands of literature: 1) theories that explain firm scope, 2) industry architecture, 3) transaction, 4) global value chains (GVCs), and 5) industry classification. Each strand provides explanations for a better understanding of industry architecture and its evolutionary path.

2.1 Theories that Explain Firm Scope

Vertical integration is a form of organizing from a firm-level perspective. Researchers study vertical integration in terms of its theoretical issues and operational approaches. It is relevant to my research because it deals with firm's integration versus specialization in terms of firm boundaries and it brings back the question of the division of labor. Adam Smith (1776) argued that the division of labor is limited by the extent of the market. The emergence of vertically integrated firms will redefine the boundaries and generate re-division of labor among firms, and therefore transform the architecture of industry as well as the whole economy. The overall trend is towards specialization, although re-integration does occur.

Transaction cost economics. Transaction cost economics (TCE) theory particularly focuses on the concept of vertical integration. As noted by Williamson (1975), the main case in TCE is the issue of vertical integration. The core thesis of TCE is that firm boundaries and the resulting levels of vertical integration are explained by governance cost. Firms can choose to make the products that they need in-house or buy them from outside suppliers. Transaction costs are the costs of governing make or buy relationships. If government costs are high, the firms choose to make what they need in-house, thus becoming more integrated. If the government costs are low, then firms will buy from the outside market.

Transaction costs largely depend on the risk of opportunistic renegotiation (Williamson, 1975). The risk of opportunism occurs when a firm involved in a transactional relationship has to make dedicated and long-term investments to ensure the relationship works well but this investment will only be supportive to this relationship but not in other environments. The firm is likely to be 'held up' by the firm from the other party when it makes asset-specific investments. Knowing the potential risk, it is difficult for any firm to make such a durable but asset-specific investment and get the valuable return of such a risky investment unless the firms on the other side guarantee no risk of opportunism. However, firms behave opportunistically, and are unlikely to guarantee no opportunism. So, the main way to achieve specialized investments is vertical integration (Williamson, 1985). According to the TCE theory, when asset specificity is high, and hence transaction costs resulting from risk of opportunism are high, firms will chose to become vertically integrated. TCE scholars consider market failures owing to asset specificity as the main reason to explain firm's decision of vertical integration (Williamson, 1985). Numerous studies have found positive influence of asset specificity on vertical integration and asset specificity has shown to be the most significant TCE-based determinant of vertical integration (Gulbrandsen et al, 2009).

Resource-based theory. Resource-based theory focuses on the unique internal resources of a firm's sustained competitive advantage. Firms will tend to specialize in activities that their capabilities offer some competitive advantages (Richardson, 1972). Barney (2000) created a resource-based model of sustained competitive advantage and suggested that sources of sustained competitive advantage are firm's resources that are valuable, rare, imperfectly inimitable and nonsubstitutable. RBV assumes that firms develop by integrating activities that are related to existing activities (Richardson, 1972). In addition, Richardson (1972) is very specific about the relationship amongst the types of activities firms will do internally and the types of activities that will be done by the firms with whom they transact. Winter (1988) points out the notion that firms grow by vertical integration through developing 'something

closely related' instead of 'more of the same'. He argues that where integration takes place relies on the 'degree' of relevant resources and knowledge that firms already had. Firms over time add activities that relate to some aspect of existing activities (Teece et al, 1994). Based on RBV, as firms expand by vertical integration they grow in the direction of something closely related to their existing resources, activities, knowledge, experience and competency.

Following Winter (1988), the firm's decision of integration should be assessed in terms of the extent to which current resources and existing knowledge can be applied to integrate a new activity. Coherence is a measure of relatedness proposed by Teece et al (1994) and is exhibited by multi-product firms developing related lines of businesses. It has shown that firms grow more diverse but that the level of coherence between neighboring activities is keeping constant (Teece et al, 1994). Even though a firm becomes more diverse by performing more new activities, its level of coherence is maintained.

To summarize, TCE and RBV jointly provide the theoretical framework for issues of vertical integration. TCE focuses on the firms' trade-off between using outside market resources and producing in-house, while RBV emphasizes firms' unique capabilities to create competitive advantage. According to TCE, firms become vertically integrated due to the high transaction costs owing to high asset specificity and risk of opportunism; whereas RBV explains that a firm's decision of integrating new activities is largely dependent on the relatedness of existing capabilities and the capabilities required by performing new activities.

2.2 Industry Architectures

The concept of industry architecture literature examines the relationship between firms and the industrial environment with regard to managerial strategy and the

performance of firms. As firms grow and evolve under the economic environment, they may also contribute to the shaping and changing of industry architecture.

In the traditional Bain/Mason industrial organization paradigm, industry structure was defined as the relatively stable economic and technical dimensions of an industry that provided the context in which competition occurred (Bain, 1972). It is suggested that industry structure (the degree of seller and buyer concentration, product differentiation, and barriers to entry) determines the behavior or conduct of firms, whose joint conduct then determined the collective performance of the firms in the marketplace (Bain, 1968; Porter, 1981). The underlying notion is that industry structure determines the behavior of firms, and hence determines the firm performance, which was known as the structure-conduct-performance view. Scholars who are concerned with firm performance must be concerned with industry structure. The limitation of traditional industry organization paradigm is that it gives full priority to the importance of the outside economic environment, but neglecting the firms' capabilities to change the structure. Brusoni et al (2011) explain what drove particular industry participants to change the vertical structure, showing how firms transform their industry environment, as opposed to merely reinforcing it.

Traditionally, industry structure is identified as number and size distribution of firms with regards to concentration and barriers to entry. Industries were understood in an atomistic sense as “a group of sellers or of close-substitute outputs who supply a common group of buyers.” In that sense, industry structure refers to the nature of product markets in terms of the concentration of seller and buyer, product differentiation and barriers to entry (Bain, 1968; Porter, 1981). Homogeneous sector, consisting of firms undertake similar activities, is the primary unit of analysis for industry structure in an atomistic sense. Since inter-firm relations are widely observed among various industry groups and products are supplied by large networks of manufacturers and service providers, attention should be paid to the heterogeneous sector that comprises firms engaged in complementary activities. From this relational

sense, industry structure is defined as the architecture of these relationships (Jacobides et al., 2006).

Researchers who study industry architecture are interested in vertical integration and vertical specialization. Jacobides (2005) provides an inductive theoretical framework to explain how and why vertical disintegration happens, showing that transaction costs are an incidental feature of industry evolution. He suggests that the real drivers for vertical disintegration are benefits from specialization and potential gains from trade. Jacobides and Winter (2005) argue that firms do not take their transactional environment as given; rather they can operate on and change it. Transaction costs theory does not address how industries or value chain structures evolve and does not ask the question of whether firms can choose to make or buy (Jacobides, 2005). Another work by Jacobides, Knudsen, and Augier (2006) qualifies Teece's predication, by positing that firm can create an "architectural advantage" in terms of high levels of value appropriation without the need to engage in vertical integration and concludes that firms can benefit from innovation by managing the industry's architecture carefully so they become the "bottlenecks" of their industry. Cacciatori and Jacobides (2005) develop a framework to provide explanations that industries may shift to vertical reintegration after long periods of vertical specialization. They observe that as various groups shape and change the nature and boundaries of industries towards vertical specialization, they create distinct knowledge bases in the industry. Specialization of firms coupled with increasing distinct knowledge bases, firms in such environment will suffer difficulties in coordination management across boundaries and establishment of inter-firm relations. Reintegration is advanced by firms seeking to protect their capabilities, through strategically changing their institutional environment to create new all-in-one, integrated markets (Cacciatori & Jacobides, 2006).

Besides vertical integration and disintegration, Jacobides and Billinger (2006) examine permeable vertical architectures that are partly integrated and partly open to

the markets along a firm's value chain. They indicate that firms can make, buy, and ally by enabling upstream units to sell to other manufacturers and downstream units to buy intermediate products from other firms in the same sector. The firm therefore designs a "vertically permeable boundaries".

Luo and Magee (2010) develop metrics and methods to measure the degree of hierarchy in transactional relationships among firms in two large industrial sectors in Japan: automotive and electronics. The findings indicate that there is an absence of hierarchy in transaction networks within electronic sector, because firms in electronic sector exhibit two characteristics: 1) they participate in multiple stages of industry value chains and hence are vertically integrated, but also 2) they purchase inputs from and sell products to other firms in the sector (Luo et al., 2012).

While firms often trade off economizing on transaction costs versus access to dispersed knowledge stocks and enhanced flexibility in marketing these important governance decisions, many firms are partially integrated and simultaneously outsource some activities (Harrigan, 1984). These firms seek to identify the most effective balance in both organizing alternatives to leverage their benefits and mitigate their costs (Rothaermel et al., 2006). This organizing approach is labeled as taper integration, following Harrigan's theoretical contribution that firms taper integration "when firms are backward or forward integrated but rely on outsiders for a portion of their suppliers or distribution" (Harrigan, 1984). Bonaccorsi and Giuri (2001) develop the argument that the long term structural evolution of an industry depends on the evolution of a vertically-related downstream industry. They claim that the evolutionary dynamics of the downstream industry, in terms of number of firms and products, entry, exit and concentration, is transmitted to the upstream via the structure of the network of vertical exchange relations (Bonaccorsi & Giuri, 2001).

2.3 Transactions

Transactions are the most basic form of inter-firm relationship and are a fundamental unit of economic analysis (Williamson, 1975). Within a sector, transactions in intermediate markets serve to link and coordinate complementary activities across firms (Jacobides & Winter, 2005; Baldwin, 2008). Williamson (1985) defined a transaction as “a transfer across a technologically separable interface”, though he did not specifically explain what “technologically separable interface” is. To address the question of why transactions occur in a particular place, Baldwin (2008) develops a theory of location of transactions and the boundaries of firms in systems of production (viewed as networks of tasks), drawing on modularity theory. Transactions are defined as “mutually agreed-upon transfers with compensation, are located within the task network and serve to divide one set of tasks from another” and are “designed to match their locations” (Baldwin, 2008). Here, transaction is no longer the primary unit of analysis and is more than a simple “transfer” indicated by Coase (1937) and Williamson (1985), instead it is a “reciprocal exchange” (Baldwin, 2008) rooted in a complex network structure.

Opportunistic transaction costs have been the focus of Williamson’s transaction costs economics while Baldwin (2008) lays the emphasis on mundane transaction costs which are defined as the “costs of defining, counting and compensating for things transferred.” Specifically, opportunistic transaction costs plus mundane transaction costs together equals to the total transaction costs. Drawing on modularity theory, modules are loosely coupled at thin crossing points where transfers are fewer and less complexity in comparison to transfers at thick crossing points within modules. Therefore, placing transactions at module boundaries – thin crossing points – generally achieve the lowest mundane transaction costs. When the network structure is fixed and transactions are placed at thick crossing points, transaction designers should make a tradeoff between mundane and opportunistic transaction costs to

achieve an optimal transaction. Also, the task network structure can be changed through the process of modularization to make a thick crossing point become thinner. Modularizations create new module boundaries with relatively low transaction costs and thus make transactions feasible where they were previously impossible or very costly (Baldwin, 2008). And the new module boundaries (new locations of transactions) enable new entry of firms and upgraded competition, contributing to changes of industry structure. There exist transaction-free zones where transfers occur without the burden of costs. Baldwin (2008) indicates that the thin crossing points between transaction-free zones constitute “breakpoints” that firms and industries become partitioned.

2.4 Global Value Chains

In business management, the concept of the value chain was first introduced by Michael Porter (1985). Value chain explains how value flows and consists of activities that create value. According to Porter’s theory, firms should create sustainable competitive advantage in order to survive and thrive. To achieve competitive advantage, firms should develop a superior value chain or at least a more advanced one than their competitors. At the firm level, the value chain represents a set of activities and processes that firms are involved in. Those activities and processes provide values to final customers in the form of product or service. But Porter’s value chain was a series of intra-firm activities and concerned with the value flowing within a single firm.

The current interpretation of a value chain refers to a series of sequential and sometimes parallel activities conducted by multiple firms with complementary capabilities. At an industry level, value chain is a physical representation of sequential processes from design to distribution - starting with raw materials to manufacturing and ending with final products and services.

The emergence of global value chains (GVCs) is a consequence of the global integration of industries. A growing body of literature concerns the governance and evolution of GVCs. GVCs can exhibit buyer-driven and producer-driven governance patterns. Gereffi (2002) indicates that in the producer-driven GVCs, large transnational manufacturers exert control over backward linkages with raw material and subcomponent providers, and forward linkages into distribution and retailing. In buyer-driven GVCs, large retailers, marketers and branded manufacturers play the vital roles in setting up decentralized production networks (Gereffi, 2002). The apparel industry is an example of buyer-driven global value chain. Three factors determine the governance and transformation of global value chains: 1) the complexity of transactions; 2) the ability to codify transactions; and 3) the capabilities in the supply-base (Gereffi et al., 2005). The concept of GVCs contributes to understanding three features of a particular industry or group of industries: 1) the geography and character of linkages between tasks in the chain of value added activities; 2) power distribution among firms in the chain; and 3) the role that institutions play in structuring business relationships and industrial location (Sturgeon et al., 2008).

Gereffi, Humphrey, and Sturgeon (2005) identify five basic types of value chain governance as follows: market, modular, relational, captive and hierarchical characterized by vertical integration. And their work indicate that apparel industry has shifted from a captive value chain to a more complex relational value chain, and such migration is mainly driven by increasing supplier competence. This notion is consistent with findings from other studies that there has been a shift among apparel suppliers in developing countries from providing basic assembly to offering more flexible and efficient services, such as full-package production and lean or agile manufacturing (Abernathy et al., 2000, 2006; Gereffi, 2001).

Imagine a simplest value chain ranging from raw material suppliers, to manufacturers, to product distributors and service providers, where each stage is associated with

higher value-added than its former stage. Conventional wisdom suggests that firms who want to capture the most value, the best strategy is to position downstream in the value chain and by the same token, countries who want to achieve economic prosperity should encourage national firms to occupy the downstream positions and leave the less value-added upstream positions to less developed countries. In the United States, manufacturing sector has been offshore to less developed countries in response to trends in creating and sustaining comparative advantage and efforts to gain economic superiority on a global scale by capturing the downstream positions in global value chains. However, there is skeptical view on the dominant growth strategy, for instance, Tasse (2010) points out that United States has let the manufacturing sector languish. The plight of the manufacturing sector is not only an “industry” problem but also a “value chain” issue. He argues that the policy of prospering by specializing in services ignores both the co-location synergies with manufacturing and the fact that other economies are aggressively integrating forward into high-tech services (Tasse, 2010).

In conclusion, global value chains capture value-flowing in the global economy. With a thorough understanding of the direction of value flows, firms, organizations and countries would tend to develop strategic policies to govern and adapt the value chains for their advantage.

2.5 Industry Classification

Industry classification is an important criterion for researchers who aim to analyze industry architecture. The works on identifying and investigating industry architectures will be much easier if a standard industry classification is shared. Such classification schemes as the US-based Standard Industrial Classification (SIC) and North American Industry Classification systems have been introduced for a long time and updated periodically. NAICS was developed under the auspices of the Office of

Management and Budget (OMB), and adopted in 1997 to replace the Standard Industrial Classification (SIC) system (U.S. Census Bureau). However, studies on industry classification have questioned the reliability and capability of those schemes to correctly reflect industry architectures since those industry classification systems have not changed correspondingly to the increasing complexity of industry activities. Hicks (2011) examines the relationship of structural change in the economy and industrial classification and indicates that the understanding of structural change is compromised because scholars do not clearly articulate the limit of the classification infrastructure that shapes empirical analysis. Dalziel (2007) proposes an alternative systems-based approach to classification, taking the view that understanding industry structure is not understanding competition among firms that conduct similar activities, but understanding cooperation among firms that undertake complementary activities. Dalziel (2007) distinguishes the traditional and current views of industry architecture as “atomistic” and “relational”.

The conceptual foundations of firm classification schemes have two dimensions: supply/demand orientation and structural assumption (Hicks, 2011). The supply orientation shows a production basis while the demand orientation indicates a market basis. From supply/production orientation, firms are grouped into a particular industry based on the similarity of their production activities and processes. Measures of inter-industry relatedness capture the similarity of firm activities and resources. Bryce and Winter (2009) developed a general inter-industry relatedness index that contributes to empirical assessments that rely upon the concept of relatedness between resources to characterize the direction of growth of the firms. Such a relatedness index provides economic rationale for a firm participating in industry A to perform and integrate activities of industry B. Whereas from demand/market orientation, firms are clustered into an industry based on the complementarities of their production processes and activities engaged in. In a production orientation, an industry is a group of business establishments supplying similar outputs in the form of product or service, and performing similar production activities; while in a market

orientation, an industry is a group of business establishments producing close substitutes and involved in complementary activities.

The current dominant industry classification systems (e.g. NAICS) are from a supply orientation and the underlying criterion for grouping is “similarity”. Building on the “similarity” criterion, for example, apparel manufacturers are grouped in one industry in that they are engaged in apparel-making activities, and the complementary firms who supply textiles, sewing machines, information systems, transportation and logistics services, and marketing and branding are grouped into other industries because those firms are involved in different sets of activities. However, from a macro level, all those firms collectively address consumer’s demand for clothing even though they undertake different sets of activities.

There are three limitations of the traditional activities-based approach. First, they fail to reflect industry structure. Specifically, they fail to provide indication of relationships between firms since “the firms classified in a given category are no more likely to have relationships with the firms in the neighboring categories, than they are to have relationships with firms in other sectors” (Dalziel, 2007). Second, they group firms that serve similar purposes/demands into different industries simply by identifying their production activities. Dalziel (2007) suggests that competitors may employ different technologies and conduct different activities to meet similar demands, but they do not serve for fundamentally different demands. It should be noted that supply-based systems may group firms that supply very different demands together, but a demand-based systems may group firms that perform very different activities together. Finally, the boundaries between manufacturers and service providers have become blurred as a result of technological innovation. Since most industries are doing business with the support of computer and information technology, it is hard to distinguish the role of an IT firm between manufacturer and service provider by just considering their production activities. The question of industry classification is not so much how to group similar firms into industries but

how to group industries into sectors in a meaningful way.

Dalziel (2007) proposed a system-based approach to industry classification that takes demand as the primary organizing principle, and the sector as the primary unit of analysis, as opposed to the activities-based approach. She shifted the traditional focus on ‘activities’ conducted by firms to ‘demand’ that multiple firms collectively respond to and provided an application in communication equipment subsector to show that the systems-based approach perform better reflects the industry structure and inter-firm relations than the traditional North American Industry Classification system. Dalziel (2007) points out that as a variety of complementary firms work together to collectively address similar fundamental demands, the classification system’s unit of analysis must accommodate firms that are different from one another, both in terms of the nature of the specific demand to which they individually respond, and in terms of the activities they undertake. This notion calls attention to the vertical sector that start with fundamental demands, sequenced by interdependent layers of industries collectively addressing the demands. The principle of the systems-based approach lies in the dependency relationships. This means that final customers depend on service providing firms to fulfill their needs and by the same token, service providers depend on other complementary firms to supply input products/services. This hierarchical dependency structure is consistent with the architecture of global value chain.

To summarize, the supply-oriented classification systems fail to consider the purpose for which firms conduct activities and to whom and from whom they sell and buy products/services. In addition, activity-based classification may blur the inter-firm relations and isolate individual firms from the “network” by simply focusing on their production activities. The conventional industry classification systems fail to capture the division of labor and the network of firms. Industry structure has changed correspondingly with the dense network of inter-firm relations, hence, industry classification systems should change accordingly for the purpose to provide a holistic view of economy for researchers and policy makers. Suggestions are given as follows:

1) considering heterogeneous sector rather than homogeneous industry as the primary unit of analysis; 2) focusing on cooperation and complementarity rather than competition and similarity among multiple firms; 3) taking a demand view to understand the hierarchical dependency relationship of firms.

3. Theoretical Development

My theory is based on two concepts: inter-firm similarity and inter-firm complementarity. In Section 3.1, I introduce these two concepts, and in Section 3.2, I develop my hypotheses regarding the determinants of major inter-firm relations, and evolution of the apparel sector over time.

3.1 Theory

Richardson (1972) considers industry as carrying out a large number of activities that need to be carried out by firms with appropriate capabilities. He distinguished activities as similar versus complementary. Activities that require the same capability for undertaking are called similar activities while activities are complementary when they represent different phases of a process of production and require coordination (Richardson, 1972). The concept of inter-industry similarity mainly addresses the “distance” between two industries (that the firms belong to) by calculating their similarities (Teece et al., 1994; Bryce & Winter, 2009). The notion of inter-firm complementarity refers to the inter-industry dependencies as indicated by input-output tables, or as indicated by firms’ sector roles. In this study, inter-firm relatedness is operationalized as the NAICS proximity, while inter-firm complementarity is operationalized as the firms’ sector roles dependency (Dalziel, 2007).

3.1.1 Similarity

Several researchers have studied the degree to which firms’ engage in similar or related activities. Especially for multi-product firms, they are active in many industries that share common characteristics regarding production technologies (Neffke & Henning, 2008). According to the prevalent industry classification systems (e.g.NAICS), firms that perform similar activities are classified in the same industry.

The knowledge about similarity between industries is important to understand economic transformation, firm growth and diversification, and firm performance (Penrose, 1959; Rumelt, 1974). Given the importance of similarity or relatedness between industries, research from strategic management area has developed different measures to capture the degree of inter-industry relatedness between firms in different industries.

Rumelt (1974) captures the concept of relatedness in his study on firm diversification. Four broad categories of firm diversification are identified as single product firm, dominant product firm, related product firm, and unrelated product firm. Three ratios are used for classification as follows: 1) the specialization ratio which is defined as the proportion of a firm's revenues that is attributable to its largest discrete product-market activity; 2) the related ratio which is defined as the proportion of its revenues that are attributable to the largest group of businesses that are related in some way to one another; 3) the vertical ratio which is defined as the proportion of a firm's revenues attributable to all of the by-products, intermediate products, and final products of a vertically integrated sequence of manufacturing operations (Rumelt, 1974). However, this procedure measures relatedness on a nominal level, only allowing comparisons within group averages (Lien & Klein, 2009).

The majority of studies has been focused on firm diversification, but much less has been directly emphasized on inter-industry relatedness. Recently, researchers have constructed inter-industry relatedness indices based on the frequency with which pairs of industries appear jointly in firm portfolios (Teece et al., 1994), technological relatedness as measured by the technologically related of products produced by different plants in Sweden (Neffke & Henning, 2008), or the joint industry participation decisions of U.S. manufacturing firms (Bryce & Winter, 2009). Teece et al (1994) develop a corporate coherence measurement to explain the similarities and differences in the nature of coherence across firms and industries, drawing on the survivor principle. They assume that "activities which are more related will be more

frequently combined within the same corporation". Teece et al. (1994) count the frequency of joint occurrences of pairs of industries in firm portfolio and standardize this frequency to identify linkages between pairs of industries that exceed the expected random assignments of industries. Following Teece et al.(1994), Bryce and Winter (2009) upgrade the measurement and develop a general inter-industry relatedness index which is a useful tool for assessing inter-industry relatedness in any context requiring such measure (Bryce & Winter, 2009).They infer inter-industry relatedness from the aggregate activity combinations of firms from both supply side and demand side and such approach provides a strong resource-based measure of relatedness because it reflects the unobservable ways that firms share resource among industry activities (Bryce & Winter, 2009). However, the major limitation is that the general relatedness index is currently computed only for manufacturing industries. It is not applicable for studies that investigate industries from service provider sectors. Neffke and Henning (2008) measure technological relatedness from a production perspective between industries based on the dataset of products produced in plants in all manufacturing industries in Sweden. However, they did not provide any real quality assessment of their relatedness measure and their measure is also only for manufacturing industries.

Relatedness based on SIC system is easily available. The 2-, 3-, and 4-digit levels of SIC system are used as points on an underlying scale of relatedness, and arithmetic values are assigned to the distances (Lien & Klein, 2009). However, the SIC-based measures rely on the assumption that industries are homogeneous within category levels which can be problematic when the breadth of the industry classifications varies (Robins & Wiersema, 2003). More importantly, the SIC-based measurement does not consistently reflect relationships among valuable resources in the ways that firms actually combine them to create value (Bryce & Winter, 2009).

In general, the different measures can be classified into three categories: categorical measures, RBV-based measures with regard to survivor principle, and SIC-based

measures. All of the studies that consider inter-industry relatedness employ similarity in firm activities as their relatedness criterion.

3.1.2 Complementarity

There is a growing body of research that considers the importance of complementarity in the firms' knowledge resources and production activities. The landmark article of Teece (1986) introduces the concept of "complementary assets" to explain the failure of innovating firms to take the lion's share of profitability. To successfully commercialize an innovation, besides core technical know-how, there is need for complementary capabilities. Such complementary requisites include services such as distribution, marketing and branding, competitive manufacturing and after-sales customer services. It is demonstrated that when imitation is easy, the significant economic returns may accrue to the owners of such complementary assets, instead of the innovators (Teece, 1986). Aspiring to extend Teece's framework, Jacobides, Knudsen, and Augier (2006) investigate how innovating firms can benefit from value creation and appropriation with a focus on industry architectures, by treating complementarity and mobility as two distinct components of co-specialization. The study suggests that firms can strategically reshape the architecture of their sector by encouraging competitions in complementary activities and restricting mobility and competitions in their own segment (Jacobides et al., 2006).

A wide range of studies examine the inter-firm alliance formations and firm performance with regard to complementarity. Arora and Gambardella (1990) investigate the complementarities among strategies of external linkage of the large biotechnology firms with different parties (e.g. universities, small/medium sized research-intensive firms). They further indicate that the locus of innovation should be a "network" of inter-organizational relations. Rothaermel (2001) focuses on the inter-firm cooperation between incumbents and new entrants when the incumbents have complementary assets within their firm boundaries that are critical to

commercialization. His study shows that, at the industry-level, incumbents exhibit a preference towards alliances that leverage complementary assets over alliances that focus on building new technological competencies. A study by Lin, Yang, and Arya (2009) investigates firm performance as a consequence of firms' alliance partner selections. Combining the RBV and institutional perspectives, this study explores the interactions of resource complementarity and institutional associations between the firm and its alliance partners and demonstrates that having alliance partners with high resource complementarities will boost firm performance.

Complementarity of firms' knowledge resources is also crucial to firm performance. Studies have investigated the impact of cross-business knowledge synergies in terms of relatedness and complementarity on performance of multi-business firms. The results indicate that synergies from product, customer, or managerial knowledge relatedness do not improve firm performance, while synergies arising from the complementarity of the three aforementioned types of knowledge relatedness significantly improve both market-based and accounting-based performance of the multi-business firms (Tanriverdi & Venkatraman, 2005).

The aforementioned studies have operationalized complementarity in terms of firm resources (e.g. knowledge resources, tangible assets, and R&D capabilities) to predict firm performance and profitability, inter-firm alliances, and firms' decisions on vertical integration. In my study, complementarity is operationalized as the degree of dependency of firms' different sector roles to predict the likelihood of inter-firm transactions.

	Similarity	Complementarity
Intra-firm	<ul style="list-style-type: none"> -Firm diversification in terms of product relatedness to explain the performance differences of firms (Rumelt, 1974, 1982) -Coherence to explain firms' growth (Teece et al., 1994) -Technological relatedness to explain the composition and change of a regions portfolio of manufacturing industries (Neffke & Henning, 2008) - Relatedness index to predict entry mode (Bryce & Winter, 2009) 	<ul style="list-style-type: none"> -Complementary assets to successfully commercialize an innovation (Teece, 1986) -Complementarities among strategies of external linkage of firms (Arora & Gambardella, 1990) -Complementarities in terms of firms' knowledge resources (Tanriverdi & Venkatraman, 2005)
Inter-firm	<ul style="list-style-type: none"> - Predicting inter-firm relations in the same industry (Schilling & Steensma, 2001) -Survivor-based relatedness to predict firms' decisions to enter new markets (Lien & Klein, 2009) 	<ul style="list-style-type: none"> -Incumbents prefer alliances that leverage complementary assets (Rothaermel, 2001) -Encouraging competitions in complementary activities can help firms reshape the sector architecture (Jacobides et al., 2006) -Having alliance partners with high resource complementarities will boost firm performance (Lin et al., 2009)

Figure 3.1 Quadrant for Similarity, Complementarity, Intra-firm and Inter-firm Relations

3.2 Hypothesis Development

In the following part, I derive hypotheses for the major inter-firm transactions. The hypotheses focus on the significance of inter-firm similarity and inter-firm complementarity in predicting the existence and magnitude of a major transaction between firms. In addition, I provide evidence on the nature and evolution of the U.S. apparel sector on a macro level.

3.2.1 The Determinants of Major Inter-firm Transactions

Inter-firm Relatedness

Industries are comprised of groups of similar firms; therefore, inter-firm relatedness is the relatedness of pairs of industries that firms belong to. One of the core concepts of corporate strategy is inter-industry relatedness, which is considered important to explain the performance differences of firms in terms of profitability (Rumelt, 1982), to determine the direction of firm growth and diversification (Rumelt, 1974; Teece et al., 1994), and to predict firms' decisions to enter new markets (Lien & Klein, 2009). Inter-industry relatedness takes "similarity" as the criterion for identifying major inter-firm relations.

A large volume of studies have investigated the effects of inter-industry relatedness on firm diversification, growth, entry mode, organizational choice, and acquisition and merger performance. To show the relationship between diversification strategy and firm profitability, Rumelt (1982) introduced categorical degree of relatedness to capture the product diversity. He finds that the highest levels of profitability were exhibited by firms diversifying primarily into related areas that share common core skill and resources with current production activities. Bryce and Winter (2009) predict the mode of entry of an expanding firm and find that the relatedness index is significant in predicting the choice between acquisition and organic expansion. Neffke and Henning (2008) measure technological relatedness between manufacturing industries in Sweden and indicate that relatedness has significant explanatory power for the composition and change of a regions portfolio of manufacturing industries. Lien and Klein (2009) construct a survivor-based measure of inter-industry relatedness to predict firms' decisions to enter new markets.

Transaction costs economics provides theories on firms' make or buy decision and views the governance decision as dichotomous (Williamson, 1985). Another strand of

literature indicates that the choice for firms to integrate or to transact is not binary. Parmigiani (2007) examines firms' decision on simultaneously make and buy the same good, instead of solely making or solely buying. Firms will employ concurrent sourcing strategy because they desire to simultaneously monitor suppliers, produce efficiently, and improve processes (Parmigiani, 2007). Recent studies (Parmigiani, 2007; Parmigiani & Mitchell, 2009) examine the concurrent sourcing strategy employed by firms and suggest that concurrent sourcing resolves the coordination versus flexibility quandary. Jacobides and Billinger (2006) introduces the concept of "permeable vertical architectures" that are partly integrated and partly open to the markets along a firm's value chain, and such architectures enable firms to concurrently use both internal and external suppliers and customers. Permeable boundaries allow firms to selectively participate at multiple points along the value chain (Jacobides & Billinger, 2006), and therefore engaging in tapered integration (Harrigan, 1985). The concurrent sourcing strategy and the design of vertically permeable boundaries relieve the tension between the traditional make-and-buy view and modularity theory. Modularity theory predicts that firms tend to outsource complementary activities to achieve flexibility (Sanchez & Mahoney, 1996; Baldwin & Clark, 2000; Brusoni et al., 2001).

Several studies expect inter-firm relations between firms in the same industry, that is to say, in the firms that undertake same activities. Schilling and Steensma (2001) investigated three primary ways for firms to substitute tightly integrated activities with loosely coupling activities and they are contract manufacturing, alternative work arrangements, and alliances, with the purpose to test the significance of several forces that drive the use of modular organization forms. The main argument for their study is that there is a positive relationship between heterogeneity in the production process (inputs and demands) for an industry and the use of flexible modular forms. However, all their hypotheses are only partially supported, indicating either theoretical or empirical difficulties. I believe the difficulties can be empirical because firms may be less likely to contract and ally with firms in the same industry than with firms in other

industries. Tomlinson (2010) investigates relationship between inter-firm cooperative ties and innovation in five UK manufacturing industries. This paper finds out that vertical cooperative ties are significant in explaining firms' level innovation performance while horizontal cooperation between firms (i.e. cooperative with competitors) does not appear to be significant in explaining innovation. Another study by Lamprinopoulon and Tregear (2010) focuses on the inter-firm relations in small and medium sized firm (SMEs) and explores the links with marketing performance. The findings of their analysis suggest that the configuration of horizontal relationships between producer SMEs has little bearing on marketing performance, unless accompanied by strong vertical connections between key members of the SME cluster and other actors in the supply chain. Therefore, I expect that transactions take place between firms in the related industries, not between firms within the same industry.

Accordingly, I propose that a major inter-firm transaction is associated with inter-firm similarity. But I expect an inverted-U relationship between inter-firm similarity and major inter-firm transaction. Firms are more likely to transact with firms from similar or related industries, but will be less likely to transact with firms from unrelated industries where there is no supply-demand relationship or with firms from the same industry where there is more competition than cooperation.

Hypothesis 1:

There is an inverted-U relationship between inter-firm similarity and the existence and magnitude of major inter-firm transaction.

Inter-firm Complementarity

Even though “complementarity” was widely examined by studies in the areas of firm boundaries, profitability of innovators, industry architectures, strategic alliances, and firm performance, there is no applicable measure of complementarity. For inter-firm complementarity, it is difficult to systematically identify complementarity and even in

vertical value chain, there is absence of general means of identification.

One approach to identify the inter-firm complementarity is to use Input-Output (I-O) tables. I-O analysis was first proposed by the Nobel Prize laureate Wassily Leontief and describes inter-industry transactions as a proportion of total industry inputs and outputs. I-O analysis tracks the interdependence among various producing and consuming sectors of an economy (BEA, 2012). Input-Output tables indicate inter-industry and therefore inter-firm complementarity. The bigger the proportion of industry *i*'s input that is procured from industry *j*, the more likely that there will be a buy-sell relations between firms in industry *i* and *j*. However, the I-O tables are not sufficiently fine-grained to indicate the likelihood of inter-firm transactions across all industries. In addition, the I-O tables are produced infrequently and usually with a lag of thirty months for national tables, failing to keep up with the recent trends in several industries and the changing economy.

Another approach is to use the concept of “sector role” in value chain and operationalize complementarity as firms’ sector role dependencies (Dalziel, 2007). From a demand perspective, there exist dependency relations between sector roles. For instance, as service providers depend on manufacturers to provide inputs, by the same token, manufacturers depend on material providers to supply materials. Sector roles are defined on the basis of complementarity in activities. Within the vertical structure of value chain, inter-firm relations will be hierarchically ordered from firms providing services to final customers at the highest level, firms manufacturing products at intermediate level, and firms supplying raw materials at the lowest level. Consistent with the structure of global value chains, sector roles are ordered from upstream sellers to downstream buyers. Dalziel (2007) proposed a theory-based approach to identify the most important inter-industry complementarity. Her concept of sector role is based on the modularity theory (Baldwin & Clark, 2000) that identifies two sector roles – systems integrator and component supplier. She identifies sector roles and distinguishes between service and manufacturing subsectors and

between central firms and complementary firms.

Previous studies have investigated the impact of a firm's sector role on firm performance and profitability. Sector role is important to explain why firms in the same sector may experience the same environmental conditions differently (Dalziel & Zhang, 2010). Accordingly, I propose that the existence and magnitude of a major transaction between two firms is positively associated with their inter-firm complementarity (dependency relation between sector roles).

Hypothesis 2:

There is a positive relationship between inter-firm complementarity and the existence and magnitude of major inter-firm transaction.

3.2.2 The Evolution of the Apparel Sector

Recent studies have described inter-firm network structure and tried to explore variation in network structure across industries. Rosenkopf and Schilling (2007) compare alliance networks in 32 industries and demonstrate substantial differences in network structures. They identify three types of networks: 1) disconnected with low connections; 2) spider-webs with a high level of connections; and 3) hybrids with a moderate level of connections. They further explain this variation by referring to technological uncertainty and dynamism, product modularity and architectural control that characterize the industries. Luo (2009) measures the degree of hierarchy of transaction networks among firms in Japanese automotive and electronics sectors and the empirical results show that the electronics sector exhibits a significantly lower degree of hierarchy than the automotive sector, due to the presence of many transaction cycles. It is worth reporting that the cycles in the electronics industry disappear if the largest firms are taken out of the sample.

Since my data contains information at an industry level and the NAICS codes enable

me to identify the four apparel sector roles¹, I expect to provide evidence on structure of the U.S. apparel sector on a macro level. My first assumption is that there will be a shrinking proportion of manufacturer firms involved in transactions in the U.S. apparel sector. This expectation is consistent with Tasseey's (2010) view that the U.S. outsources and offshores its manufacturing activities to less-developed countries because U.S. firms are more willing to capture the downstream positions that take the most value-added to gain economic superiority. The second expectation is that there will be an increase in the diversification of multiple players that serve as external firms from non-apparel industries and undertake complementary activities to apparel firms, because nowadays products and services are provided by networks of firms. Abernathy et al (1995) provide empirical results that apparel supplier have made increasingly investment in information technologies, distribution systems, and other associated services.

Hypothesis 3:

Over time, there will be a shrinking proportion of manufacturing firms relative to service providers involved in major transactions in the U.S. apparel sector.

Hypothesis 4:

Over time, the proportion of major transactions that involve firms outside the apparel sector will increase.

Luo and Magee (2011) present a metric and technique to quantitatively assess the extent to which self-organizing directed networks exhibit a flow hierarchy. In the appendix, they differentiate all the links of a network into four different types:

- 1) Regular: the link connects from anode on a pre-defined low level (i) to a node on its adjacent higher level (i-1)
- 2) Level-Skipping: the link connects from a node on a pre-defined lower level (i) to a node on a level (j) higher than its adjacent higher level (i-1), i.e. $j < i-1$;

1 Apparel sector roles comprise of Textile provider, Apparel manufacturer, Wholesaler, and Retailer.

- 3) In-layer: the link connects between nodes on the same level (i)
- 4) Backward: the link connects from a node on a predefined high level (i) to a node on a lower level (j), i.e. $i < j$

Following Luo and Magee (2011), I classify the transactions in the apparel industry into four types: 1) Regular (one-level up), 2) Level-skipping, 3) Same-level, and 4) Backward. My expectation is that regular transactions will be more likely to occur than the other types of transaction. For example, within the apparel sector, a preponderance of links will be found between textile providers and apparel manufacturers or between apparel manufacturers and retailers while relatively less links will be found between textile providers and retailers. The directions of links are expected to be consistent with the value flows in global value chains. The majority of links will start from upstream sector roles and travel to downstream sector roles.

However, there can be backward links and cycles because of the existence of vertically and tapered integrated firms and the fact that firms develop permeable boundaries and employ concurrently sourcing strategy. While vertical disintegration may be the long-term trend; over short time periods both the bicycle components industry (Fixson & Park, 2008), and the British building industry (Cacciatori & Jacobides, 2005) experienced vertical re-integration as a consequence of strategic choices made by firms. Firms are partially integrated and concurrently sourcing in order to achieve the most effective balance in both organizing alternatives to leverage benefits and mitigate costs (Rothaermel et al., 2006). Harrigan (1984) defines this organizing approach as taper integration that firms are backward or forward integrated but also relying on outsiders for a portion of their supplies or distribution. Jacobides and Billinger (2006) conducted a longitudinal study of a major European apparel manufacturer and documented its redesign into permeable vertical architecture that allows firm units to both make and buy, and transfer downstream or sell. It is indicated that increased permeability enables more effective use of resources and capacities, better matching of capabilities with market needs, and benchmarking to

improve efficiency (Jacobides & Billinger, 2006).

Hypothesis 5:

Over time, the proportion of the level-skipping, same-level and backward transactions relative to transactions between vertically related pairs of industries will increase.

4. Methodology

In this section, I first provide information about my data and identify my study sample to test hypotheses. In the following part, I introduce my analytic approaches and measures of dependent variables, independent variables and control variables. The last part presents the results of descriptive statistics.

4.1 Data

I am fortunate to have access to a dataset of over 60,000 observations of major transactional relations in the U.S. from 1976 to 2010. Cohen and Frazzini (2008) have used this dataset for their award-winning research in finance area to explore the customers' impact on suppliers. Hertz et al (2008) also use this dataset to study bankruptcy spillover effects on the stock prices of customers, suppliers, and strategic alliance partners. Even though this dataset provides a holistic view of transaction networks over time, it has not been used to investigate the transaction networks' structure. The data depends on the fact that the U.S. Securities and Exchange Commission requires firms (including foreign firms) that are publicly traded in the U.S. to report the percentage of their revenues that is attributable to sales to a specific customer, in case where those sales exceed 10% of total revenues.

4.1.1 Data Preparation

The data preparation consists of two major tasks: 1) Standardizing company names, and 2) Identifying customer industry NACIS codes. The seller names are identified, so the task of standardization is to standardize the buyer names. The first criterion is to remove observations where the customer types are not "company" and where customer (buyer) names are incomplete. Because firms report their buyer names by various formats such as a full name, a full name plus Corp, or an abbreviation, a same company can be identified

by different company names. Therefore, with the help of a fuzzy string name-matching algorithm to compare names, firm names with different reporting formats are identified as the same firm in the whole dataset. The second task is to identify the missing NAICS codes for buyers. The first step is to identify the unique buyer names and then to connect those unique firm names with the dataset of Research Insight to find the corresponding NAICS codes.

The result dataset includes 61,036 data records with gvkey codes for sellers, seller names, NAICS codes for sellers, customer identifiers, unique identifier for buyers, buyer names, NAICS codes for buyers, company type, geographic area code, geographic area type, annual sales, segment identifiers, segment type, and reporting date of data records.

4.1.2 Data of Apparel Sector

Since my main interest lies in the apparel sector, I filter the data from the original dataset that contains 61,036 data records. Each record is one row, presenting information (e.g. name, NAICS Code) on a given seller, the corresponding buyer, and the transaction that links the two. Of my research interest, data are extracted only from the apparel and apparel-related industries. Therefore, based on North American Industry Classification System (NAICS), I identify subsectors as follows: 313 (Textile Mills), 315 (Apparel Manufacturing), 316 (Leather and Allied Product Manufacturing), 4243 (Apparel, Piece Goods, and Notions Merchant Wholesalers) and 448 (Clothing and Clothing Accessories Stores), and identify observations where either the seller or the buyer operates in areas of the above selected subsectors. Same as my approach, Baldwin and Clark (2000) identified new emerging sub-industries based on the SIC 4-digit codes to investigate the changing structure of the computer sector.

As a result, the newly-extracted apparel industry dataset contains 2431 unique observations in total from 1976 to 2010. Through filtering the “firm names” column, we identify 277 different sellers and 135 different buyers. In case that there are overlapping

firms appearing in both sellers and buyers, we identify 381 unique firms while there are 31 firms serving as both a seller and a buyer.

As the above-mentioned dataset is only about the inter-firm transaction relationships, further data is expected to indicate firm attributes. I extracted the data about firm revenues from Research Insight using the unique firm names. The new dataset is about 3142 records of firm information from 1992 to 2010 and the earliest data records in Research Insight started from 1992. I fail to find all the unique firms identified from the original apparel dataset because some firms may be acquired or closed before the year 1992, resulting the missing and changing of firm names in the dataset of Research Insight software. Totally, there are 289 unique firms in the dataset of firm information while the total unique firms identified from my original apparel dataset are 381. Figure 4.1 shows the number of unique firms having information about revenues from 1992 to 2010. It is worth mentioning that there are different firms for each year and it is rarely possible for a particular firm appearing for the whole period.

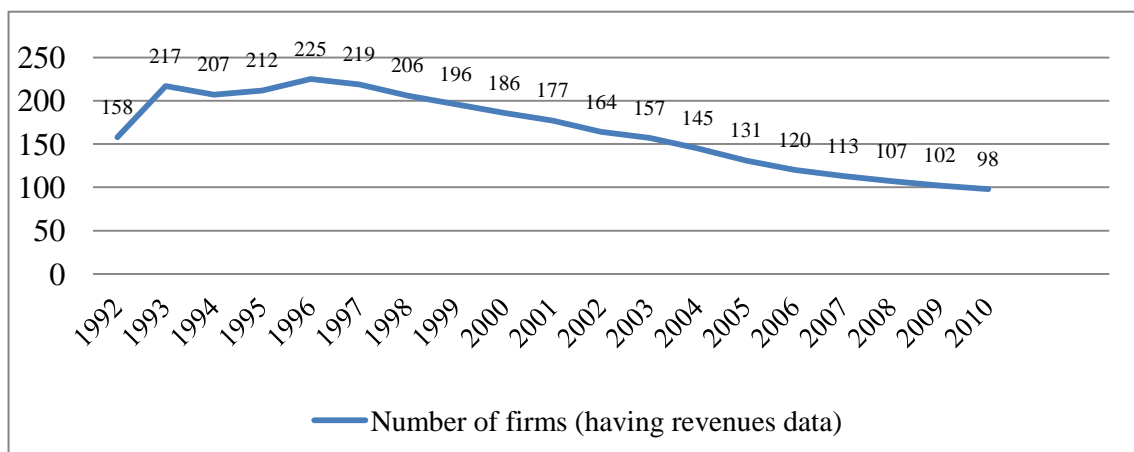


Figure 4.1 Number of Unique Firms with Revenues

4.1.3 Apparel Sector Roles

I identify four major sector roles within the apparel sector: 1) Textile provider, 2) Apparel manufacturer, 3) Wholesaler, and 4) Retailer. For sector roles, there is a “dependency”

(Dalziel, 2007) pattern that retailers depend on wholesaler to supply inputs, wholesalers depend on apparel manufacturers to provide inputs, and apparel manufacturers rely on the textile providers to offer inputs. From a demand perspective, firms are positioned by the relation of dependency.

In an industry level and based on the NAICS codes (4-digit level), textile provider includes business establishments from industry groups of 3131, 3132, 3133, and 3141; apparel manufacturer contains business establishments from industry groups of 3151, 3152, 3162, and 3169; the wholesaler is the industry group of 4243; and the retailer contains business establishments from industry groups of 4481, 4482, 4483, 4511, 4521, 4529, and 4541. Other left firms that undertake facilitating activities are categorized as external roles and they are from non-apparel sectors. External firms from other sectors (e.g. lessors of real estate, electronics and appliance stores) facilitate the operation of the apparel sector, but they are not necessary for the apparel sector. In Table 4.1 below, I present the classification of NAICS (4-digit level) industry groups in the apparel sector according to their sector roles. Table 4.2 provides the information for non-apparel industries that appear more than 20 times.

Table 4.1 Central Roles in Apparel Sector

Apparel sector roles (Associated with 4-digit NAICS codes)
Textile provider
3131:Fiber, Yarn, and Thread Mills
3132: Fabric Mills
3133: Textile and Fabric Finishing and Fabric Coating Mills
3141: Textile Furnishing Mills
Apparel manufacturer
3151:Apparel Knitting Mills
3152:Cut & Sew Apparel Manufacturing
3162:Footwear Manufacturing
3169:Other Leather and Allied Product Manufacturing
Wholesaler
4243: Apparel, Piece Goods, and Notions Merchant Wholesalers
Retailer
4481:Clothing Stores

4482:Shoe Stores
4483:Jewelry, Luggage, and Leather Goods Stores
4521: Department Stores
4529: Other General Merchandise Stores
4541: Electronic Shopping and Mail-Order Houses

Table 4.2 External Roles with Frequencies of Appearance over 20

External roles	Frequency
3256: Soap, Cleaning Compound, and Toilet Preparation Manufacturing	25
3342: Communications Equipment Manufacturing	23
3361: Motor Vehicle Manufacturing	34
3399: Other Miscellaneous Manufacturing	26
4461: Health and Personal Care Stores	21
4511: Sporting Goods, Hobby, and Musical Instrument Stores	39
5311: Lessors of Real Estate	87
5416: Management, Scientific, and Technical Consulting Services	21

The external roles exist due to the fact that firms in the apparel sector have transactions with firms from external sectors (e.g., Lessors of real estate, and Electronics and appliance stores). The justification for identifying sector roles and external roles can be explained that a complete structure of the apparel sector cannot be outlined by only looking at groups of business establishments within the apparel sector especially when the boundary between different industries is becoming blurry and the vertical cooperation among complementary firms is overwhelmingly intense.

4.1.4 Transactional Networks in Apparel Sector

To have a better understanding of the transactional (buy-sell) relations in apparel sector, I present graph visualizations created by Netdraw to show the transactional networks of sellers and corresponding buyers. A graph presenting the information among relations can efficiently provide visual evidence on the overall structure of networks. Netdraw is a visualization tool from the social network analysis software package UCINET and it allows graphic representation of networks including relations and attributes. Network analysis uses graphic display that consists of nodes to represent actors and lines to

represent ties or relations (Borgatti, Everett, & Freeman, 2002). Each node has a set of attributes and each tie can be directed by the arrow. Coloring the nodes by attributes is a powerful way of exploring general patterns of network.

To construct my transactional network, I use nodes to represent unique firms involved in major transactions in apparel sector and lines to represent the existence of a transactional relation. The direction of a buy-sell relation is shown by the arrow. According to value chains, firms are ordered from textile providers, manufacturers, wholesalers, to retailers from upstream to downstream. I create a single node named “universal customer” and create ties that link retailers to this “universal customer”. By doing so, all retailers will be positioned near the center. I also include the transactional relations between external firms² (non-apparel firms) and apparel firms. In the following, I show the graph visualizations of transactional network identified by node attributes, namely, NAICS code (2-digit and 3-digit) and sector role. Different NAICS codes and different sector roles are distinguished by the unique colors as presented in graphs.

Figure 4.2 shows the transactional network identified by the node attribute: NAICS code (3-digit). The dark pink in the center is the universal customer that connected with all retailers. Overall, nodes by different colors are sparsely scattered. The color with the most frequency of appearance is the sandwash pink that represents NAICS code 315, reporting that the majority of apparel firms involved in major transactions are from NAICS subsector 315 (apparel manufacturing). Besides, it is difficult to visually identify any particular patterns of interest from the messy graph.

² External firms are from non-apparel industries but are involved in transactions in apparel sector.

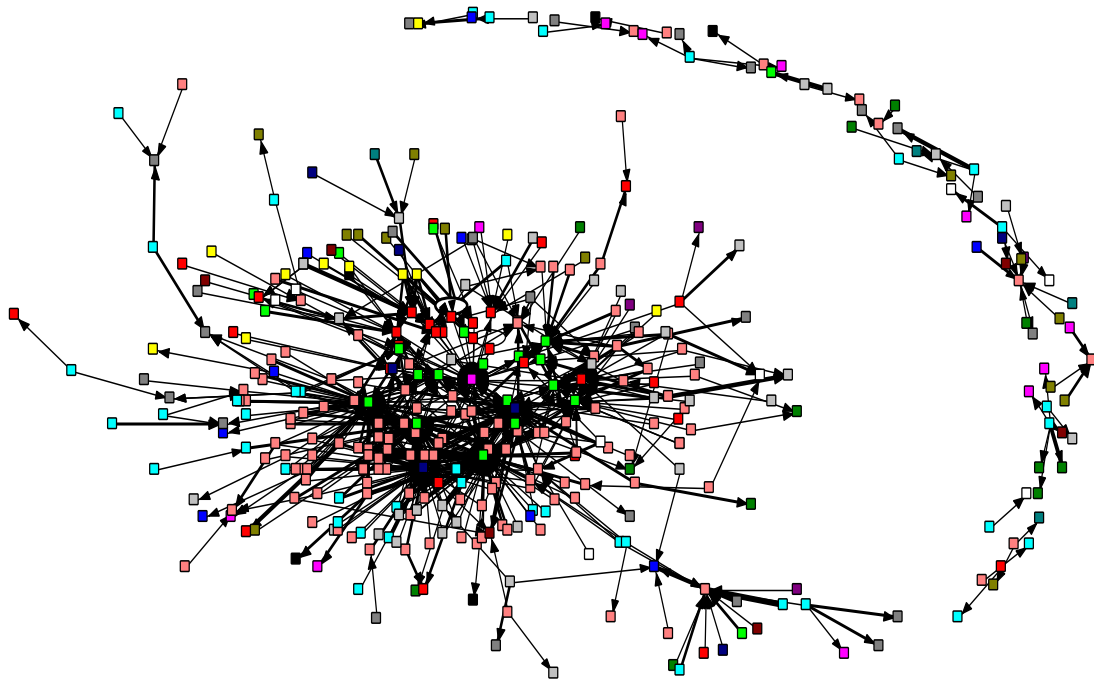


Figure 4.2 Transactional Network by NAICS Code (3-digit)

Figure 4.3 shows the transactional network identified by the node attribute: NAICS code (2-digit). The dark blue is the universal customer created to link with all retailers. The colors with the most frequencies of appearance are the orange that represents the NAICS sector 31 (Manufacturing), the lemon and the red that represents the NAICS sector 44-45 (Retail Trade). Generally, there are certain clusters in the central part of the network in terms of the relations between firms from manufacturing sector and firms from retail trade sector. But it is hard to clearly identify general patterns.

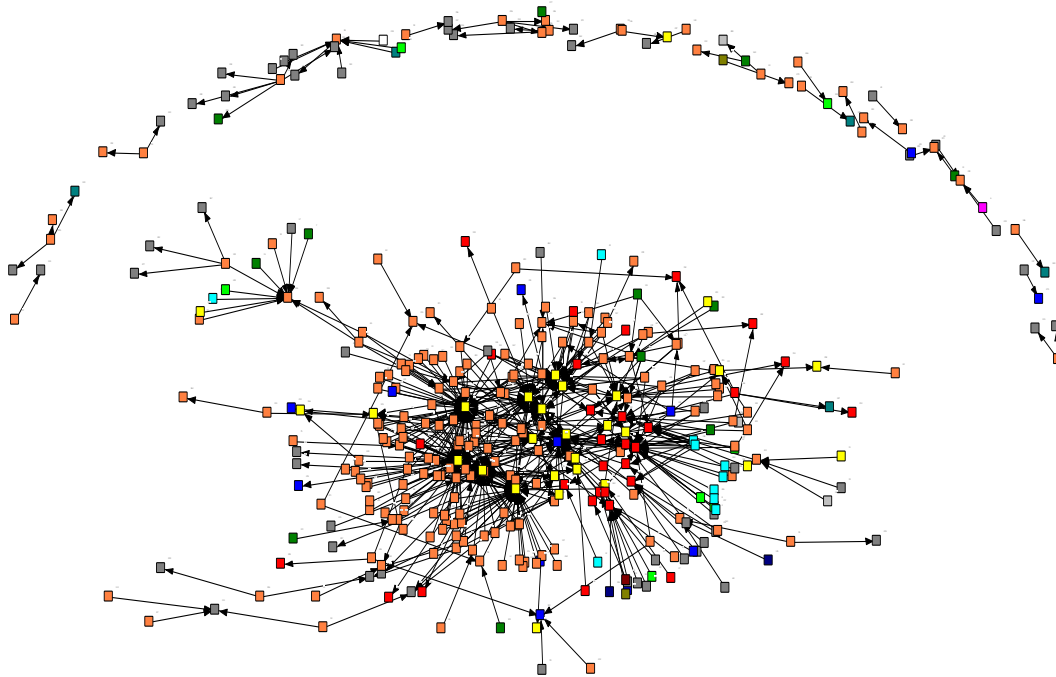


Figure 4.3 Transactional Network by NAICS Code (2-digit)

Figure 4.4 presents the transactional network identified by firm attribute sector role. Here, I classify four different sector roles, namely, textile provider, apparel manufacturer, wholesaler, and retailer in apparel sector, and I also include external role to represent firms from non-apparel industries. The dark green in the center is the universal customer created. The red nodes are retailers that are closely circled around the universal customer. The lemon nodes are apparel manufacturers and the pink nodes are textile providers. The three dark blue nodes are wholesalers that appear rarest in the apparel transactional network. The grey nodes represent external firms and they circle the periphery of the transactional network. Overall, the different clusters by color can be identified obviously from the graph. And there are tiers by color from the center to the edge of the transactional network, which is consistent with the successive stages of value chains. The graphs collectively indicate that sector role concept better captures the transactional relations between firms than NAICS-based measure.

The network analysis yields a visualized presentation of the structure of apparel sector. It provides visual support to the proposition that firms' sector role dependency will predict

major inter-firm transactions. In addition, my results further imply that the theoretical sector role dependency concept will better predict the inter-firm relations than the empirical relatedness measure based on NAICS.

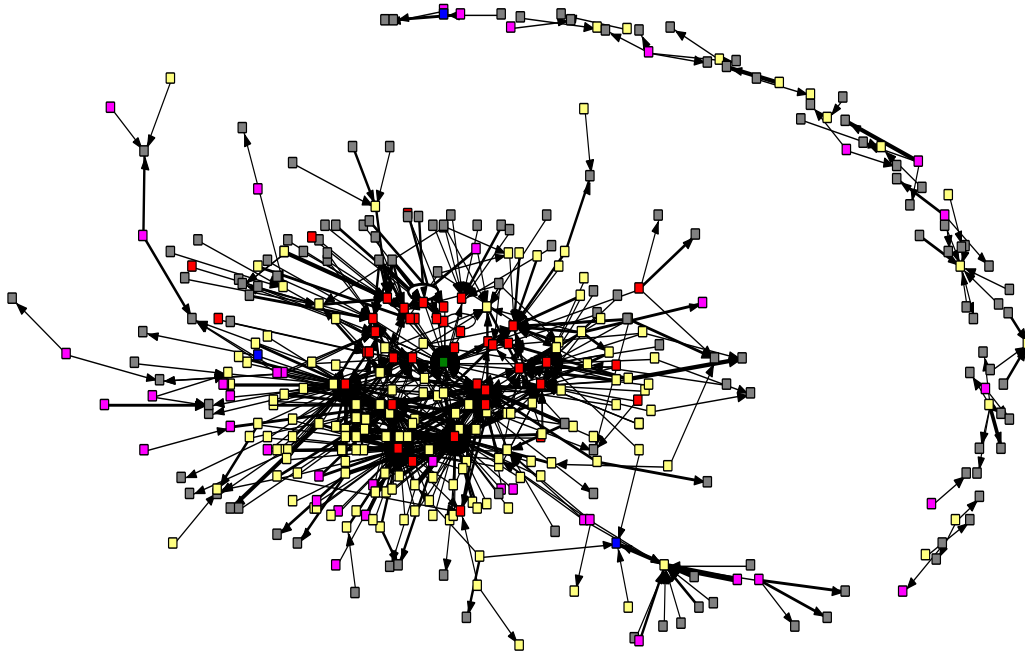


Figure 4.4 Transactional Network by Sector Role

Figure 4.5 presents the seller-buyer design matrix structure (DMS). The X axle and Y axle are all unique firms ranging from retailers, wholesalers, apparel manufactures, to textile providers from upstream to downstream. Retailers are taking the numbers from 1 to 33. The following numbers 34 and 35 are wholesalers. Apparel manufacturers are taking the numbers from 36 to 190, and the rest numbers from 191 to 214 are textile providers. Each pink dot represents the existence of a major inter-firm transaction. The DMS graph reports the preponderance of the one-level skipping transactions from apparel manufacturers to retailers. There are also several level-skipping transactions from textile providers to retailers. Also, there is presence of same-level transactions between apparel manufacturers themselves and between retailers themselves. The DMS graph suggests the presence of vertical or tapered integration of firms.

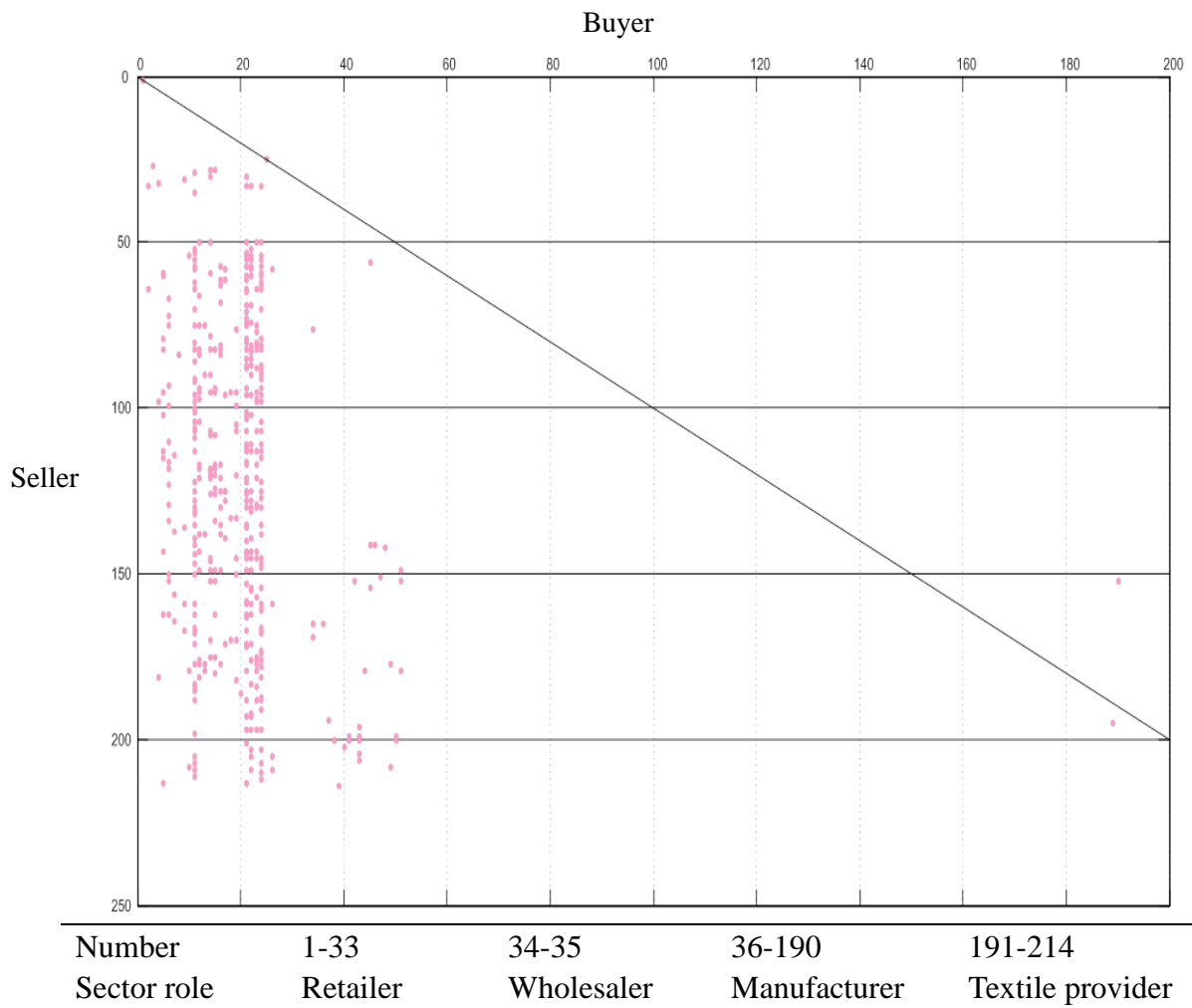


Figure 4.5 Seller-Buyer Design Matrix Structure

4.1.5 Study Sample

The study sample for testing the determinants of the magnitude of major transactions includes 599 dyads of firms that have major transactions with each other in U.S. apparel sector from the year 1992 to 2010. It is a panel data contains observations both on firm-level attributes and dyad-level attributes.

To address the determinants of the presence of major transactions, I need to construct a transactional network and compute all the possible pairs of firms that have transactions with each other. In terms of the existence of major inter-firm transactions, in essence, the empirical component is a transactional network of linkage establishments between firms.

I model the possibility that a firm will have transactions with another firm and construct adjacency matrixes to capture the relationships between firms in a transactional network. I also include the reverse-directed dyads, that is, firm A sells to firm B is different from firm B sells to firm A, because the transactions are directed in my study. Such a broad definition of the dyads of firms at risk of having transactions is essential to producing unbiased results, though; including a large number of dyads of firms that never have transactional relations may create their own set of biases (Gulati, 1995).

Similar to my study on transactional networks, previous social network studies of tie formation analyze every possible dyad (Podolny, 1994; Gulati, 1995; Stuart, 1998), because they do not have any additional criteria to determine which dyads are likely to exist and which dyads are not. Such strategy has been criticized for not accounting for non-independence problem as each firm enters the analysis for numerous times (Sorenson & Stuart, 2001). In addition, this strategy has another practical problem, that is, to compute all the possible dyads is burdensome. For example, I have to create an adjacency matrix with over one hundred thousand cells for consideration of all the possible pairs. Sorenson and Stuart (2001) solved the problem by creating a matched sample of potential dyad ties that did not exist while including all dyads of relations that appear in the data. However, their results can be biased because the proportion of positive outcomes in the sample does not match the positive outcomes in the population (Sorenson & Stuart, 2001). In my panel data, most dyads of firms appear for certain periods and then disappear in later years. There is no need to produce a redundant matrix using all the unique firms appearing in the panel data over 18 years. Therefore, my solution is to compute all the possible dyads of firms year by year, that is, to create annual matrix (cell*cell calculation) only using unique firms for each year. My approach substantially reduces the numerous entries of the same firms and the sample size is only over 20,000 as opposed to 100,000. The only problem is that my sample is an unbalanced panel data that may entail some computational and estimation issues, but most software packages (e.g.STATA) are able to handle both balanced and unbalanced data.

4.2 Measures

In the following section, I introduce the dependent variables, independent variable and control variables in this study. In Table 4.4, I summarize the variables and measures.

4.2.1 Dependent Variables

My dependent variable is a measure of inter-firm transaction; I envision two alternatives to this measure: 1) Existence of a major inter-firm transaction; 2) Magnitude (value) of a major inter-firm transaction. The first alternative is a binary variable while the second one is a continuous variable.

Existence of a major transaction

The first dependent variable is the existence of the link (transaction relationship) between two firms. It is measured by the existence of a link between a seller firm and a buyer firm. It is reported as a binary variable that takes the value of 1 when there is existence of a link between two firms and 0 otherwise.

Magnitude of a major transaction

The second dependent variable is the size of the link measured by the value of a major transaction between firms. The second dependent variable is a continuous variable. It is reported as the magnitude of transaction between firm *i* and firm *j*.

4.2.2 Independent variables

Inter-firm similarity

Inter-firm similarity is measured by the proximity of 4-digit NAICS codes of two firms that have transactions with each other. This is a categorical variable taking the value of 3 when the 4-digit NAICS codes of seller firm and buyer firm are totally the same, or

taking the value of 2 when the 4-digit NAICS codes of seller and buyer are the same in their first three digits, or taking the value of 1 when the 4-digit NAICS codes are the same in their first two digits, and taking the value of 0 when the 4-digit NAICS codes of seller and buyer are different. It is worth note that in NACIS classification, the 2-digit codes 31-33 (31, 32, and 33) are all classified under manufacturing sector and the 2-digit codes 44-45 are both classified under retail trade sector. In addition, the broadest valid NAICS codes are at 2-digit level. Therefore, for instance, the proximity of NAICS codes between a firm in industry 4481 and a firm in industry 4521 is taking the value of 1 instead of 0.

Inter-firm complementarity

Inter-firm complementarity is measured by the degree of dependency of firms' sector roles. This is a categorical variable taking the value of 1 when there is direct dependency between sector roles, or taking the value of 0.5 when there is one-level indirect dependency between sector roles, or taking the value of 0.25 when there is two-level indirect dependency, taking the value of 0 when there is absence of dependency between sector roles, taking the value of -1 when there is a direct backward link from downstream to upstream, taking the value of -0.5 when there is one-level indirect backward link, taking the value of -0.25 when there is two-level indirect backward link between two firms. The direction of dependency relation between sector roles is supposed to from upstream seller to downstream buyer, but there are also reversed-directional links between firms partially due to the presence of firm integration. The following table 4.3 presents the classification of the seven different categories.

Table 4.3 Degree of Dependency of Sector Roles of Firms

Category	Value	Definition	Example
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Direct	1	The dependency relation is from upstream to downstream. There is only one level-up between the two sector roles.	<pre> graph TD TP([Textile Provider]) --> AM([Apparel Manufacturer]) </pre>
Indirect (One-level skipping)	0.5	The dependency relation is from upstream to downstream. There is one-level skipping between the two sector roles.	<pre> graph TD AM([Apparel Manufacturer]) --> R([Retailer]) W([Wholesaler]) </pre>
Indirect (Two-level skipping)	0.25	The dependency relation is from upstream to downstream. There is two-level skipping between the two sector roles.	<pre> graph TD TP([Textile Provider]) --> R([Retailer]) AM([Apparel Manufacturer]) W([Wholesaler]) </pre>
Absence	0	There is no dependency relation between the sector roles. There is a link in the same layer of sector role.	<pre> graph LR AM1([Apparel Manufacturer]) --- AM2([Apparel Manufacturer]) </pre>
Backward (Two-level skipping)	-0.25	The direction of dependency relation is reversed. There is a backward link from downstream to upstream. There is two-level skipping between the two sector roles.	<pre> graph TD R([Retailer]) --> TP([Textile provider]) AM([Apparel manufacturer]) W([Wholesaler]) </pre>

Backward (One-level skipping)	-0.5	The direction of dependency relation is reversed. There is a backward link from downstream to upstream. There is one-level skipping between the two sector roles.	<p>The diagram illustrates a backward dependency where the Retailer (downstream) depends on the Apparel manufacturer (upstream). The Wholesaler is shown in a dashed oval, indicating it is skipped in this dependency relationship.</p>
Backward (Direct)	-1	The direction of dependency relation is reversed. There is a backward link from downstream to upstream. There is only one-level up between the two sector roles.	<p>The diagram illustrates a direct backward dependency where the Apparel Manufacturer (downstream) depends on the Textile Provider (upstream).</p>

4.2.3 Control Variables

Besides independent variables, I control for a number of variables to ensure that my findings are not caused by other factors that might affect the existence and the magnitude of major transactions. The first concern is that the existence and magnitude of transactions can be strengthened or weakened by the variations of firms' attributes. Firm size indicates its degree of success in the marketplace (Gulati, 1995). It is assumed that firms with large sales and high profitability are more likely to have transactions with other firms and much easier to attract potential transactional partners. Therefore, I control for firm revenues of both sellers and buyers. Besides, I also control for the in-degree and out-degree firm attributes in a major transaction.

Buyer firm revenues

Buyer firm revenue is measured by the revenue in year i for a particular buyer firm that engage in a major transaction in year i . This explanatory variable is continuous.

Seller firm revenues

Seller firm revenue is measure by the revenue in year i for a particular seller firms that

engage in a major transaction in year j . It is a continuous control variable.

Number seller outgoing links

I measure the outgoing links by calculating the number of transactions that a seller has with all other buyers in a particular year. This firm-level variable gauges the degree of a seller firm's capability to have major customers in a given year. By the number of outgoing links, I control the effect that firms with lots of customers will more likely to have a link to a specific downstream industry.

Number buyer incoming links

I measure the incoming links by calculating the number of transactions that a buyer has with all other sellers in a certain year. This firm-level variable captures the momentum of a buyer firm's capability to have major transactions with seller firms. By controlling the number of incoming links, I control the effect that firms with lots of suppliers will more likely to have a link from a specific downstream industry.

Value seller outgoing links

I measure the outgoing value by summing the total value of all transactions that a seller has with all other buyers in a certain year. This firm-level variable captures the effect that a firm with a great number of outgoing values is more capable of having transactions with other firms. Alternative interpretation is that this variable controls for issues relating to the finite capability of a seller firm to have transactions with buyer firms.

Value buyer incoming links

I measure the incoming value by summing the total value of all transactions that a buyer has with all other sellers in a certain year. This firm-level variable captures the effect that a firm with a large amount of incoming values is more likely to have transactions with other firms. Another interpretation is that this variable controls for a buyer firm's finite capability to have transactions with suppliers.

The second concern is that the prior transactions between two firms may lead to future transactions. Firms tend to have transactions with their previous transactional partners due to a variety of reasons such as established mutual trust and low communication cost. To control for this factor, I compute two variables to capture the impact of prior links between two firms on having subsequent transactions in later years. In addition, including these two variables also controls for dyad-level heterogeneity.

Previous transaction

Previous transaction is a dummy variable that indicate whether two firms have prior links, taking the value of 1 if there was previous transaction and 0 otherwise. The choice of this variable concerns the length of time during which the previous transactional relationships are likely to influence the current transactional links. One choice is to include all the previous links in the transactional networks; while another possibility is to use “moving window” (Gulati, 1995), that is to say; only transactional links established in certain previous years will have influence on current transactional links. Considering the fact that the repeated transactional relationships appeared periodically in my data and the relative shortness of period observed (Gulati, 1995), I apply the first approach to include any previous transactional link no matter when it occurred.

Previous transaction value

Previous transaction value may have influence on the existence and magnitude of inter-firm transactions. The greater the previous transaction value between two firms, the more likely that two firms will sustain their transactional relationship and increase future transaction value. This control variable gauges the total value of previous transactions between two firms.

The last concern relates to the treatment of the presence of few transactions that firms have with themselves. The presence of same-firm transactions is contrary to my expectation and may violate the regression estimates. Therefore, I include a dummy variable to control for the effect.

Same-firm transaction

Though unexpected, some firms in my study sample have major transactions with themselves, usually with a large amount of transaction value. This binary control variable captures whether firms having transactions with themselves, taking the value of 1 if firms have and 0 otherwise.

Table 4.4 Summary of Variables and Measures

Variables	Measures
Dependent variables	Y1: Existence of major transaction Y2: Magnitude of major transaction
Independent variables	X1: Dependency degree X2: NAICS proximity
Control variables (Firm-level)	C1: Number seller outgoing links C2: Number buyer incoming links C3: Value seller outgoing links C4: Value buyer incoming links C5: Seller revenues
Control variable (Dyad-level)	C6: Buyer revenues C7: Previous transaction between firms C8: Previous transaction values between firms C9: Same-firm transaction

4.2.4 Descriptive Statistics and Correlation Matrix

Table 4.5 presents the descriptive statistics and correlation matrix for all the variables involved in each of the two sets of regression. The data indicates the diversity of firms. Especially for firm attributes, the ratios of “seller revenues”, “buyer revenues”, “outgoing links (values)”, “incoming links (values)” suggest significant variance across firms included in my sample, notwithstanding the fact that they are all large firms involved in major transactions. The data on “previous transaction values” points to the significant variance across different dyads. Generally, buyers are much larger than sellers regarding the ratio of firm revenues.

The correlation matrix suggests that “seller revenues” is highly correlated with the

dependent variable “magnitude of major transactions” and with the dyad-level variable “previous transaction values” between firms. And “buyer revenues” is moderately correlated with the “value buyer incoming links”. Firms have transactions with larger values in previous years are more likely to have transactions with larger values subsequently. Despite high correlations in some cases, the correlations between independent variables and control variables are generally low (below 0.3).

Table 4.5 Descriptive Statistics and Correlation Matrix

Variables	Mean	S.D.	Min	Max	DV	IV1	IV2	C1	C2	C3	C4	C5	C6	
Model 1 (N=23586)														
DV: Existence of transaction	0.03	0.15	0	1	1.00									
IV1: Dependency	-0.00	0.45	-1	1	0.17	1.00								
IV2:NAICS Proximity	1.29	1.19	0	3	-0.16	-0.00	1.00							
C1:Outgoing values	104.28	208.67	0	1725	0.05	0.09	0.06	1.00						
C2:Incoming values	109.16	333.69	0	3008	0.34	0.25	-0.23	0.05	1.00					
C3:Seller revenues	5117.55	13809	0.221	137634	-0.05	-0.24	-0.24	-0.06	-0.01	1.00				
C4: Buyer revenues	5128.80	13813	0.221	137634	0.32	0.24	-0.24	0.01	0.56	-0.01	1.00			
C5: Previous values	7.95	121.58	0	7588	0.34	0.07	-0.06	0.15	0.16	-0.00	0.09	1.00		
C6: # previous transactions	0.02	0.15	0	1	0.75	0.16	-0.15	0.05	0.32	-0.04	0.33	0.43	1.00	
Variables	Mean	S.D.	Min	Max	DV	IV1	IV2	C1	C2	C3	C4	C5	C6	C7
Model 2 (N=599)														
DV: Value of transaction	112.82	211.45	0.02	1725.85	1.00									
IV1: Dependency	0.47	0.19	-1	1	-0.04	1.00								
IV2:NAICS Proximity	0.11	0.46	0	3	0.23	-0.32	1.00							
C1:Outgoing links	1.78	0.88	1	5	-0.13	-0.19	-0.01	1.00						
C2:Incoming links	10.17	7.61	1	27	-0.12	0.03	-0.26	-0.05	1.00					
C3:Seller revenues	877.03	1843.62	0.22	19176	0.88	-0.04	0.02	-0.05	-0.13	1.00				
C4: Buyer revenues	32981	31784	194.19	137634	-0.11	-0.01	-0.22	-0.02	0.71	-0.11	1.00			
C5: Previous values	295.35	688.06	0	8065.65	0.79	0.02	0.12	-0.09	-0.16	0.79	-0.11	1.00		
C6: # previous transactions	0.78	0.41	0	1	-0.08	0.02	-0.07	-0.04	0.06	0.06	0.08	0.23	1.00	
C7:Same firm	0.01	0.09	0	1	0.45	-0.23	0.57	-0.08	-0.09	0.07	-0.09	0.25	0.00	1.00

4.3 Analytical Approach

In this section, I provide the rationale for my analytical approach and specify models that used to test the hypotheses of the determinants of the presence and magnitude of inter-firm major transactions.

4.3.1 Fixed Effect Models

Fixed-effect (FE) models completely ignore the between-group variation and focus only on the within-group variation. The major advantage of FE-methods is the ability to control for all stable characteristics of the subjects in the study, thereby eliminating potential biases caused by time-constant unobserved heterogeneity problem (Baltagi, 2001; Wooldridge, 2002). However, FE-models have three main restrictions. First, FE-regressions fail to estimate the effects of time-constant covariates. The within-group transformation applies only with time-varying covariates (Wooldridge, 2002). Second, FE-models cannot estimate coefficients for variables that have no within-subject variations. That is to say, there must be some variations in the explanatory variables, otherwise; FE-regressions cannot estimate their effects. This is a big problem if only a few observations show a change in an explanatory variable. And practically, many software packages (e.g. STATA) automatically drop off the explanatory variables with few variations in observations. Third, another disadvantage of FE-regressions is that the number of unknown parameters increases with the number of sample observations (Hsiao, 2007).

4.3.2 Random Effect Models

Random-effect (RE) models have become popular in a variety of disciplines ranging from economic studies to social network studies. The main advantage of RE-estimator is that it provides estimates for time-constant covariates. Since my study is interested

in reporting the effects of time-invariant variables, RE-methods are more appropriate than FE-methods to analyze my data.

Hausman (1978) indicates that FE-estimator is usually consistent regardless of the effects are random or fixed, while RE-estimator is only efficient and consistent when random effects are not correlated with covariates. A key assumption of the RE-estimator is that the random effects are uncorrelated with the observed time-constant and time-varying covariates in the model (Hausman, 1978). Sometimes, this assumption goes untested and may result in biased estimators. Hausman test (Hausman, 1978) is used to differentiate between FE-models and RE-models in panel data. The null hypothesis is that the coefficients estimated by the efficient RE-estimator are the same as the ones estimated by the consistent FE-estimator, while the alternative is that the RE-estimator is inconsistent and therefore the FE-estimator is preferred.

Therefore, Hausman test was applied to determine which estimator is appropriate for my panel data. For the panel data used to test the magnitude of major transactions, Chi-square is 6.76 ($p=0.56$), therefore at 95% confidence level, I fail to reject the null hypothesis. That is to say, RE-estimator is consistent in this case. Since RE- estimator is more efficient than FE-estimator (Wooldridge, 2002), I use RE-estimator to predict the magnitude of major transactions. For the panel data used to test the existence of major transactions, Chi-square is 38.01 ($p=0.00$), therefore at 95% confidence level, I reject the null hypothesis. That is to say, RE-estimator is inconsistent in this case. Therefore, FE-estimator is applied to study the existence of major transactions.

4.3.3 Statistical Technique

For studying the existence of major transactions, I use the following fixed-effect model for panel data:

$$P_{ij(t)} = \beta X_{ij(t)} + \alpha_{ij} + \mu_{ij(t)}$$

Where $P_{ij(t)}$ is the probability of a major transaction between firm i and firm j at time t; β is the parameter vector; $X_{ij(t)}$ is the time-variant vector of covariates or explanatory variables characterizing firms i and j, α_{ij} is the unknown intercept and $\mu_{ij(t)}$ is the error term.

For studying the magnitude of major transactions, I used the following random-effect model for panel data:

$$Y_{ij(t)} = \beta X_{ij(t)} + \alpha_{ij} + \mu_{ij(t)} + \varepsilon_{ij(t)}$$

Where $Y_{ij(t)}$ is the value of major transaction between firm i and firm j at time t; β is the parameter vector; $X_{ij(t)}$ is the time-variant vector of covariates or explanatory variables characterizing firm i and firm j, α_{ij} is the unknown intercept, $\mu_{ij(t)}$ is the within-group error term, and $\varepsilon_{ij(t)}$ is the between-group error term.

4.4 Descriptive Statistics

I present descriptive statistics in the following section. It provides a holistic view in terms of the nature of my data including: 1) Trends for firms (sellers and buyers) from manufacturing and service provider industries in apparel sector and from external industries; 2) Number of unique NAICS codes (4-digit level) per five-year period for sellers, buyers, and total firms; and 3) Number of transactions and value of transactions for five-year period.

4.4.1 Data Records

The last column in this file tells the exact date when the data was inputted and indicates that our data is tracked from 1976/11/30 to 2010/3/31. Thanks to the date

information, Figure 4.6 demonstrates the total observations for every five years. It shows a clear rise from 1980 to 1995 and a peak from 1991 to 1995, but the following period from 1995 to 2010 witnessed continuous drops every five years.

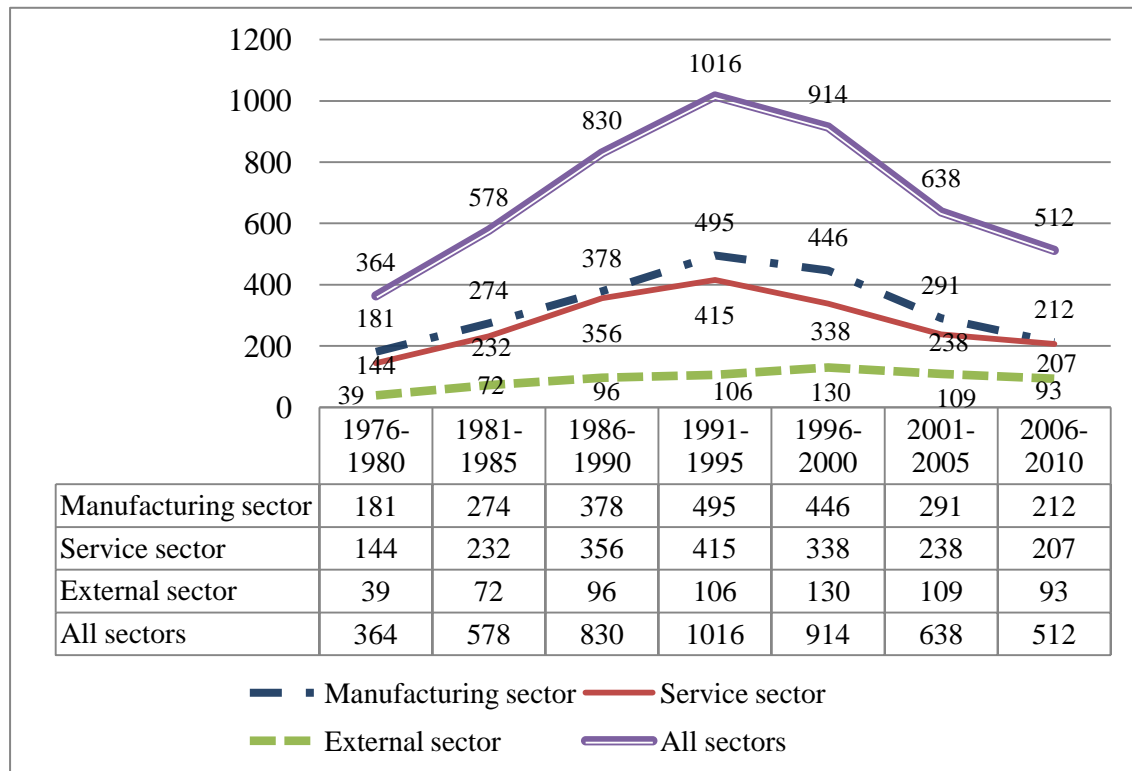


Figure 4.6 Number of All Firms and Firms from Manufacturing, Service, and External Sectors Every Five Years

Figure 4.6 also reports the number of observations from manufacturing and service sectors. Before 1995, the number of observations from manufacturing sector has increased continuously. The number of observations has increased by approximately 100 for every five-year period from 1976 to 1995. However, after 1995, the number of observations from manufacturing sector has dropped gradually. The trend of number of observations from service provider sectors is consistent with the trend of manufacturing sector. It is worth reporting that the trend line of number of observations from service sector was catching up with the trend line in terms of manufacturing sector at the period from 2006 to 2010. The number of observations from external sectors has increased all along from 1976 to 2000 and then dropped

slightly in the recent 10 years.

4.4.2 Number of Unique NAICS Codes (4-digit level) per Year

I identify number of 4-digit unique NAICS codes for sellers, buyers and total firms for every five-year in figure 4.7. The trend lines for sellers and buyers are overlapping, thus indicating that the numbers of unique NAICS codes for both kinds of firms are quite close. After 2000, the trend lines of both are nearly in parallel and the number of unique NAICS codes for buyers are always higher than the number for sellers. The trend line for total firms is much above and number of unique NAICS for each year is higher than numbers of unique NAICS for sellers and buyers, suggesting that sellers and buyers appearing for every five years are from different industries at 4-digit NAICS codes level. A limitation is that the SIC/NAICS system has evolved over this time period.

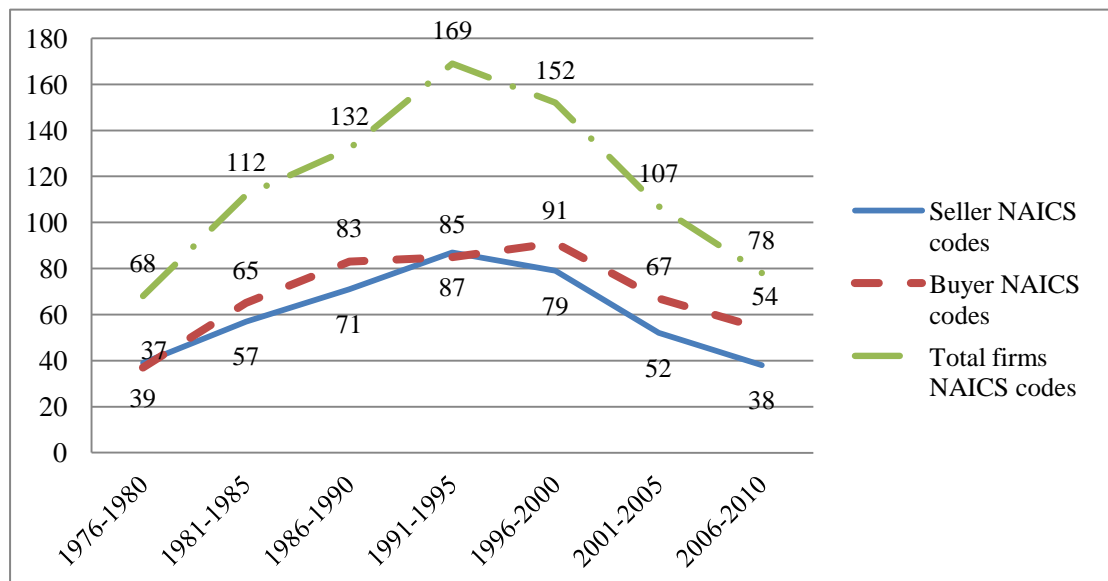


Figure 4.7 Trend per Five Years for Number of Unique NAICS Codes (4-digit level) of Sellers, Buyers and Total Firms

4.4.3 Number of Transactions and Value of Transactions

Among the identified 2431 transaction observations, there are 2030 observations

having the exact amount of transaction value. Therefore, I only include the 2030 transaction observations here to depict the trend for value of transactions in a five-year period of time in Figure 4.8. From 1976 to 1995, the trend for total value of transactions is continuously increasing. After 2003, there is a five-year rising trend for total value of transactions from 2006 to 2010. The year 1996 has the highest number of transactions with a number of 97 and the year 2008 has the largest amount of transaction value with a total value of 9567.212. It is worth noting that the value of transactions has not decreased that much even though the number of transactions dropped in the decade from 2000 to 2010.

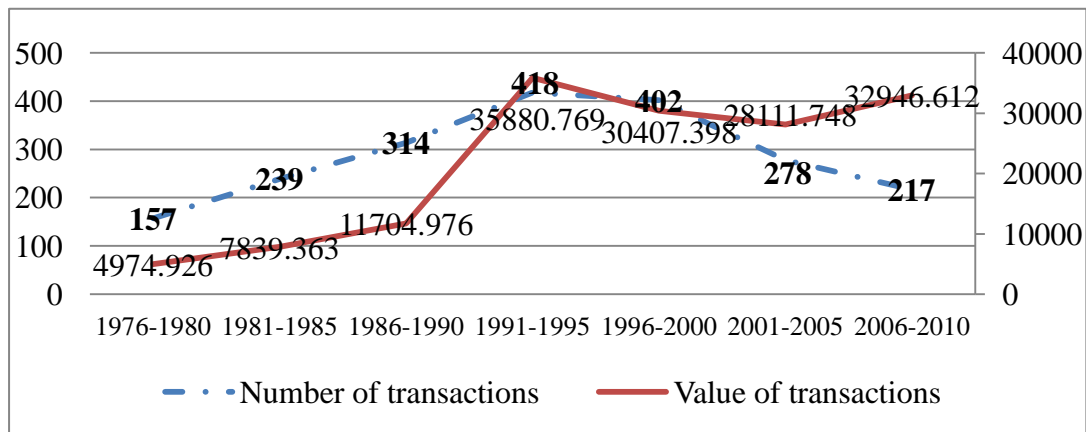


Figure 4.8 Trends for Number of Transactions and Value of Transactions

5. Results

In this section, I first provide the empirical results from the analysis in terms of the determinants of major inter-firm transactions. Then, a comparison of results from different models is discussed. Finally, I provide the descriptive statistics regarding the evolution of the U.S. apparel sector over the course of 30 years.

5.1 Determinants of the Presence of Inter-firm Transactions

The fixed-effect models are run by STATA 10.0 and the estimation results are reported in Table 5.1. In Table 5.1, the dependent variable is a dummy that indicates the existence of a major inter-firm transaction. Model 1 reports the effects of firm-level and dyad-level control variables on the existence of major transactions. Models 2-4 present the results of the sequential introduction of independent variables of interest. Model 5 is the full model including all independent variables and control variables. Specifically, Model 3 tests whether there is an inverted-U shape relationship between inter-firm similarity and the existence of major transaction.

According to Table 5.1, Hypothesis 1 is not supported. In Models 2, 3, and 5, inter-firm similarity, as measured by NAICS proximity, is statistically significant but is negatively associated with the existence of major transaction. Model 3 tests the quadratic relationship between inter-firm similarity and the existence of inter-firm transaction by introducing the squared term of NAICS proximity. It is somewhat surprising that the results indicate that there is a U-shape relationship, rather than an inverted-U shape relationship as hypothesized. Contrary to my expectation, the empirical results suggest that firms that undertake more similar activities will be less likely to have major transactions with each other. But firms within the same industry may have transactional relations, which is inconsistent with the expectation that firms in the same industry will compete – rather than cooperate – with each other.

Such inconsistency with Hypothesis 1 may be explained by the existence of firms that develop permeable boundaries that allow these firms to selectively participate at multiple points along the value chains (Jacobides & Billinger, 2006), while engaging in tapered integration (Harrigan, 1985). For example, two apparel manufacturers with permeable vertical architecture can concurrently buy, sell, and ally with each other. Moreover, an alternative explanation can be the limitation of the measure (NAICS proximity) that SIC-based measurement does not consistently reflect relationships among valuable resources in the ways that firms actually combine them to create value (Bryce & Winter, 2009).

Hypothesis 2 is supported by the empirical results set out in Table 5.1. Inter-firm complementarity, measured as firms' sector roles dependency, is positively associated with the existence of major inter-firm transaction. Furthermore, this independent variable is always statistically significant at the 99% confidence level. The results are consistent with the expectation that, from a demand perspective, there exist dependency relations between firms' sector roles that are defined on the basis of complementarity in activities. The empirical results indicate that, within the vertical structure of value chains, inter-firm relations will be hierarchically ordered with firms providing services to final customers at the highest level, with firms manufacturing products at the intermediate level, and with firms supplying raw materials at the lowest level.

The dyad-level control variables generally behave as expected. The two dyad-level variables that control for the impact of previous links between buyers and sellers are both statistically significant. The binary variable "previous transaction" (an indicator of whether there are previous major transactions between two firms) has a large positive effect on the likelihood of subsequent transaction. Similarly, "previous transaction value" is positively related to the existence of major transaction. The larger the transaction value between two firms in the past, the more likely there will be one or more subsequent transactions. This is not surprising because firms are

willing to transact with past customers due to familiarity and mutual trust. In addition, I include these two variables to capture dyad-level unobserved heterogeneity.

Table 5.1 also reports the estimation results for firm-level control variables. Not surprisingly, “value seller outgoing links” and “value buyer incoming links” are both statistically significant and are positively associated with the existence of major transaction. These two variables capture the effect that firms with a large value of outgoing/incoming links are more likely to have major transactions with customers/suppliers. I also include two variables to control for firm size, namely “seller revenues” and “buyer revenues.” All models show that the “seller revenues” variable is negatively related to the existence of major transaction. Moreover, the “buyer revenues” variable is insignificant in Models 2, 3, and 5. The results of the firm revenues variables are inconsistent with the expectation that firms with larger revenues are more likely to have major transactions and are better able to attract potential partners. One of the plausible explanations can be the nature and limitations of my data. My data are comprised of major transactions which are restricted to situations where the sales (transaction) value to a specific buyer exceeds 10% of the seller’s total annual revenues. In other words, the larger the seller’s revenues, the lower the probability that the value of a particular transaction will exceed 10% of the seller’s total annual revenues; in this situation, the transaction would not be reported in my data. Another explanation is that firm size fails to be an appropriate predictor in explaining firms’ likelihood to have major transactions, especially when compared with other dyad-level predictors.

In terms of the existence of major inter-firm transactions, Hypothesis 1 is not supported. Contrary to this hypothesis, there is a U-shape relationship between inter-firm similarity and inter-firm transaction. Hypothesis 2 is fully supported by the empirical results. It is worth mentioning that the control variables “previous transaction” and “value buyer incoming links” are the strongest predictors, in comparison with all variables.

5.2 Determinants of the Magnitude of Inter-firm Transactions

The random-effect models are run by STATA 10.0 and the estimation results are presented in Table 5.2. The random-effect models generate a coefficient rho, which is an indicator of the absence or presence of heterogeneity. An estimate close to zero implies little heterogeneity, and at all times dependence in the occurrence of major transactions can be ascribed to the independent variables in the models (Gulati, 1995). In my regression, the parameter rho is close to zero, thus indicating the absence of the heterogeneity problem in my panel models. Model 1 reports the effects of firm- and dyad-level control variables on the magnitude of major transaction. Models 2-4 present the results of the sequential introduction of independent variables. Model 5 is the full model including all independent and control variables. Specifically, Model 3 tests the quadratic relationship between inter-firm similarity and the magnitude of major transaction.

Hypothesis 1 states that there will be an inverted-U relationship between inter-firm similarity and inter-firm transaction. In Model 3, the “NAICS proximity” is positive and significant and the squared term of NAICS proximity is negative and significant, thus indicating the presence of an inverted-U relationship between NAICS proximity and the magnitude of major transaction. In Model 2, inter-firm similarity, measured as NAICS proximity, is not significant, but it becomes important in the later models when more variables are included, thus suggesting a mediation effect as a result of the addition of new variables. In Model 5, the squared term of “NAICS proximity” is not significant when taking into account all the variables. There is a mixed result for Hypothesis 1 that firms will be more likely to have transactions of larger value with similar firms, rather than with unrelated firms or with equivalent peers from the same industry.

Hypothesis 2 is fully supported by the empirical results shown in Table 5.2. The

coefficient of the dependency degree variable is significant and positive at the 99% confidence level, thus indicating that inter-firm complementarity is positively associated with the magnitude of major inter-firm transaction. In addition, the introduction of the variable “dependency degree” increases the R^2 and the Wald χ^2 of the model. A comparison among models indicates that “dependency degree” behaves better than “NAICS proximity” in predicting the dependent variable.

There are also interesting results for the control variables. First, the “previous transaction” dummy (which is the indicator of whether there has been a prior transaction) is insignificant across all models. The result suggests that whether there has been a previous inter-firm transaction will not affect the magnitude of a subsequent transaction. Such a result would be inconsistent with the expectation that a previous transactional relationship would influence the current transaction because firms tend to sustain the relationship and to increase future transaction value with their old partners. The reason might be that such information may not be captured by the major inter-firm transaction. Furthermore, in order to measure the dummy “previous transaction,” I include all previous transactional links between firms regardless of when they took place. However, it may be that only transactional links established in certain prior years have an influence on the magnitude of the current transaction. “Previous transaction value” between two firms is positively associated with the magnitude of a major transaction. This is not surprising because firms that had large-value transactions in previous years will subsequently sustain or strengthen their relationship. It is worth noting that the “previous transaction value” variable becomes less significant in later models when more variables are introduced, thus indicating a suppresser effect by the addition of other variables. Second, the coefficient of “number seller outgoing links” is significant but negative. It is understandable that the size of a single transactional link will be reduced when the number of transactional links increases, especially in terms of major transactions. As expected, “seller revenue” is positively associated with the magnitude of major inter-firm transaction. However, the variables “buyer revenue” and “number buyer

incoming links” are both insignificant across models in my regression. The results may suggest that the buyer’s attributes are not important in explaining the magnitude of major transactions.

In terms of the magnitude of major inter-firm transaction, Hypothesis 1 and Hypothesis 2 are both supported. Both inter-firm similarity (as measured by NAICS proximity) and inter-firm complementarity (as measured by the degree of dependency) are significant in explaining major inter-firm relations. Table 5.2 suggests that the magnitude of inter-firm transactions seems to be independent of the buyer’s attributes. The seller’s attributes are more important than the buyer’s attributes in explaining the magnitude of major inter-firm transactions.

5.3 Comparison of Results

The empirical results of the two sets of regressions are inconsistent. Hypothesis 1 is supported when predicting the magnitude of inter-firm transactions, but is not supported when predicting the existence of inter-firm transactions. Surprisingly, when predicting the existence of transaction, the expected inverted-U shape relationship is replaced by a U-shape relationship between inter-firm similarity and inter-firm transaction.

The inconsistency with Hypothesis 1 can be ascribed to the limitation of the SIC-based measure to effectively capture the nature of inter-firm similarity. SIC-based measurement has been criticized because it fails to consistently reflect relationships among valuable resources in the ways that firms actually combine them to create value (Bryce & Winter, 2009). In my data, the preponderance of major transactions in apparel sector is from manufacturer to retailer. Firms from NAICS subsector 315 (Apparel Manufacturing) and firms from NAICS subsector 448 (Clothing and Clothing Accessories Stores) are closely related, but the degree of NAICS proximity

between firms from those two subsectors takes the value of 0. Therefore, for most of the observations that take the value of 1 (which indicates the existence of a transaction) for their binary dependent variable “existence of transaction,” their independent variable “NAICS proximity” takes the value of 0. When predicting the existence of a transaction, this problem will result in a negative coefficient of NAICS proximity because most transactions in the apparel sector take place between firms that are in fact related but whose connection is obscured by their positions in unrelated NAICS industries. This unavoidably weakens the sensitivity of my data in terms of reflecting the actual relation between inter-firm similarity and the existence of transaction. The same problem occurs again when predicting the “magnitude of transaction.” But this problem is mitigated because the “magnitude of transaction” is a continuous variable.

Another explanation for the unexpected U-shape relationship is the presence of partially integrated firms. Firms develop a permeable vertical architecture that is partly integrated and partly open to the markets along a firm’s value chain, thereby allowing their units to make and buy simultaneously, as well as to transfer downstream or sell (Jacobides & Billinger, 2006). Due to the benefits of vertical permeability, firms within the same industry will have transactions with their peers in order to effectively monitor competitors and competitively benchmark.

Hypothesis 2 is fully supported by the empirical results of both sets of regressions. Inter-firm complementarity is always statistically significant and is positively associated with both the existence and magnitude of major inter-firm transaction. Overall, the results imply that inter-firm complementarity is a strong predictor in explaining inter-firm relations and that it behaves better than inter-firm similarity in explaining major inter-firm transactions.

There are some notable inconsistencies between the two sets of regressions regarding the results of the control variables. First, “seller revenues” is negatively associated with the existence of transaction, but is positively associated with the magnitude of

transaction. This difference may be attributed to the nature of my data. The criterion of a major transaction is that the transaction value to a specific buyer must exceed 10% of the seller's total annual revenues. Therefore, the larger the seller's revenues, the less likely it is that a single transaction will be reported as a major transaction. Second, the results do not show a significant relationship between previous transaction and the magnitude of current transaction. While the existence of previous transactions will induce subsequent transactions, it does not have a significant impact on the magnitude of subsequent transactions. Third, while the buyer's attributes have a positive relationship with the existence of transaction, these attributes do not have a statistically significant impact on the magnitude of transaction. The results imply that the seller's and buyer's attributes are both important in explaining the likelihood of a transaction. Yet the magnitude of transaction seems to be related only with the seller's attributes while being independent of the buyer's attributes.

Given the joint consideration of inter-firm similarity and inter-firm complementarity, the empirical results show that the existence and magnitude of major transaction will be a reflection of inter-firm complementarity, rather than of inter-firm similarity. Major transactions are more likely to take place between vertically related pairs of industries to which firms belong than between horizontally equivalent peers in similar industries. In addition, my results imply that the theoretical sector role dependency concept will better predict inter-firm relations than the empirical relatedness measure based on NAICS.

Table 5.1 Logistic Regression of the Existence of Transaction on NAICS Proximity and Dependency (N=23586)

Independent variables	Model 1	Model 2	Model 3	Model 4	Model 5
Seller revenues	-0.0004*** (-5.14)	-0.0004*** (-6.10)	-0.0004*** (-6.11)	-0.0004*** (-4.24)	-0.0004*** (-4.95)
Buyer revenues	0.00001** (3.36)	0.000002 (0.78)	0.000001 (0.43)	0.00001** (3.08)	0.000001 (0.52)
Outgoing values	0.002*** (4.33)	0.002*** (5.92)	0.002*** (5.85)	0.002*** (3.98)	0.002*** (5.20)
Incoming values	0.002*** (13.52)	0.001*** (10.36)	0.001*** (9.98)	0.002*** (12.13)	0.001*** (9.16)
Previous transaction	5.354*** (31.20)	4.799*** (27.53)	4.767*** (27.31)	5.113*** (29.78)	4.675*** (26.95)
Previous transaction values	0.0005* (2.52)	0.0006** (3.10)	0.0006** (2.95)	0.0004* (1.93)	0.0005* (2.30)
NAICS proximity		-1.247*** (-9.42)	-2.111*** (-6.60)		-2.113*** (-6.24)
NAICS proximity ²			0.375** (3.13)		0.438** (3.43)
Dependency degree				1.697*** (8.35)	1.336*** (4.92)
Log likelihood	-1023.569	-954.492	-949.668	-986.459	-934.506
LR Chi ²	3362.38***	3500.53***	3510.18***	3436.60***	3540.50***

Note: t-value or chi-square value in parentheses; *: p<0.05; **: p<0.01; ***: p<0.001.

Table 5.2 GLS Regression of the Magnitude of Transaction on NAICS Proximity and Dependency (N=599)

Independent variables	Model 1	Model 2	Model 3	Model 4	Model 5
Seller revenues	0.091*** (41.79)	0.091*** (41.67)	0.091*** (41.85)	0.093*** (43.63)	0.094*** (43.84)
Buyer revenues	-0.000003 (-0.03)	0.00001 (0.07)	0.00001 (0.10)	0.00005 (0.46)	0.00006 (0.59)
Outgoing links	-12.395*** (-4.58)	-12.602*** (-4.67)	-12.283*** (-4.56)	-8.992** (-3.38)	-8.713*** (-3.28)
Incoming links	0.696 (1.47)	0.738 (1.64)	0.826 (1.83)	0.576 (1.34)	0.769 (1.77)
Previous transaction	7.584 (1.25)	7.328 (1.21)	7.234 (1.20)	8.446 (1.45)	9.294 (1.59)
Previous transaction values	0.022*** (3.55)	0.023*** (3.67)	0.022*** (3.59)	0.016** (2.60)	0.015* (2.47)
Same firm	854.842*** (31.18)	844.744*** (25.70)	876.655*** (24.35)	905.264*** (32.65)	890.186*** (25.57)
NAICS proximity		2.735 (0.43)	33.932* (2.13)		32.510* (2.21)
NAICS proximity^2			-13.673* (-2.14)		-8.408 (-1.35)
Dependency degree				83.681*** (6.51)	88.421*** (6.63)
Constant	28.021** (3.38)	27.737** (3.41)	25.459** (3.11)	-18.979 (-1.79)	-26.672* (-2.39)
rho	0.021	0.00	0.00	0.00	0.00
R^2	0.927	0.927	0.928	0.932	0.933
Wald Chi^2	7331.32***	7541.31***	7591.74***	8122.89***	8189.97***

Note: t-value or chi-square value in parentheses; *: p<0.05; **: p<0.01; ***: p<0.001.

5.4 Evolution of Apparel Sector

Figure 5.1 presents the proportion of service-provider firms versus manufacturing firms involved in major transactions in the apparel sector. According to Hypothesis 3, over time there will be a shrinking proportion of manufacturer firms relative to service providers involved in major transactions in the U.S. apparel sector. In the apparel sector, value chains are dominated by retailers and marketers (Gereffi et al., 2002; Gereffi & Frederick, 2010) that exert considerable power over wholesalers, manufacturers, and textile providers. The competitive advantage of U.S. apparel firms may lie in their ability to capitalize on high quality and maintain strong brand identities (Mittelhauser, 1997), to exert substantial control over their resources and profit distribution (Gereffi & Frederick, 2010), and to control high value-added activities such as branding and retailing (Gereffi, 2002). Therefore, I expect to see an increasing proportion of service activities versus manufacturing activities in the U.S. apparel sector. This expectation is consistent with the view that the U.S. outsources and offshores its manufacturing activities to less-developed areas in order to achieve economic superiority by capturing the most downstream value-added (Tassely, 2010). In Figure 5.4, from 1976 to 1990, the proportion of service firms versus manufacturing firms has increased in every five-year period. On the other hand, during the decade from 1991 to 2000, this proportion has decreased by 10% in each of the component five-year periods. The decade from 2000 to 2010 witnessed a substantial increase in service activities. Therefore, Hypothesis 3 is not fully supported due to the mixed results. But, interestingly, my results indicate a wave pattern in the trend associated with the proportion of service activities versus manufacturing services over time.

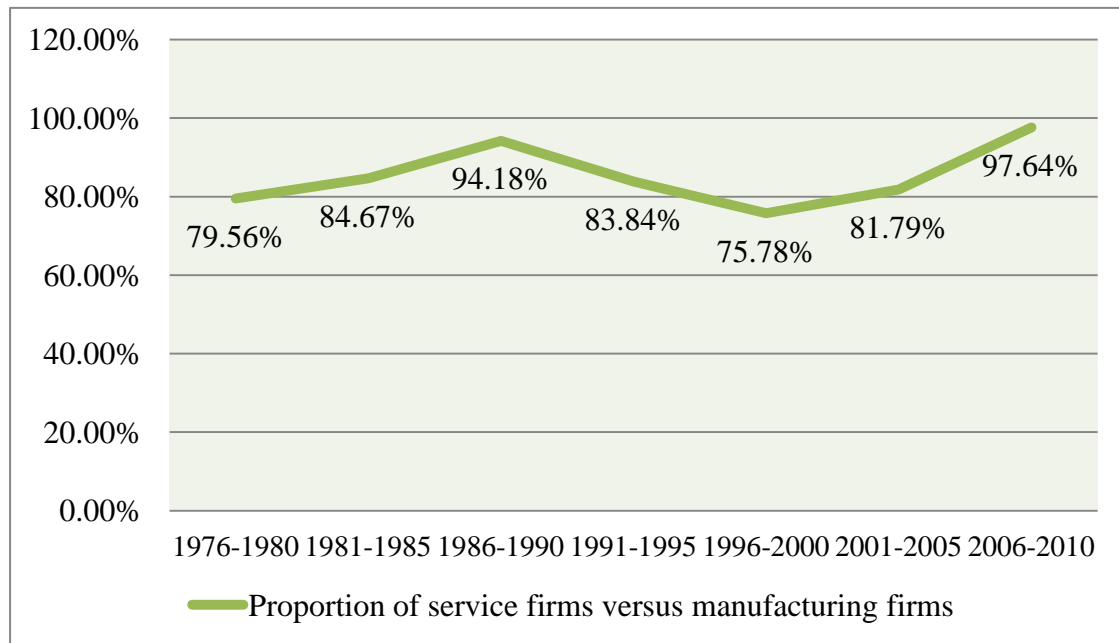


Figure 5.1 Proportion of Service Firms versus Manufacturing Firms

Figure 5.2 presents the proportion of external firms involved in transactions with apparel firms versus all firms. Besides some low fluctuations, the percentage of external firms versus all firms is between 11% and 12% from 1976 to 1995. In the subsequent period from 1996 to 2010, the proportion of external firms versus all firms has increased steadily and it peaked during the 2006-2010 period. Hypothesis 4 is supported by the fact that over time the proportion of major transactions that involve firms outside the apparel sector tends to increase. This is not surprising in that there is a continuous increase in the diversification of multiple players from non-apparel industries because products and services currently are provided by networks of firms. Empirical results have demonstrated that apparel suppliers increasingly invest in new information technologies, distribution systems, and other associated services in order to respond rapidly to consumer demand while minimizing exposure to inventory risk (Abernathy et al., 1995).

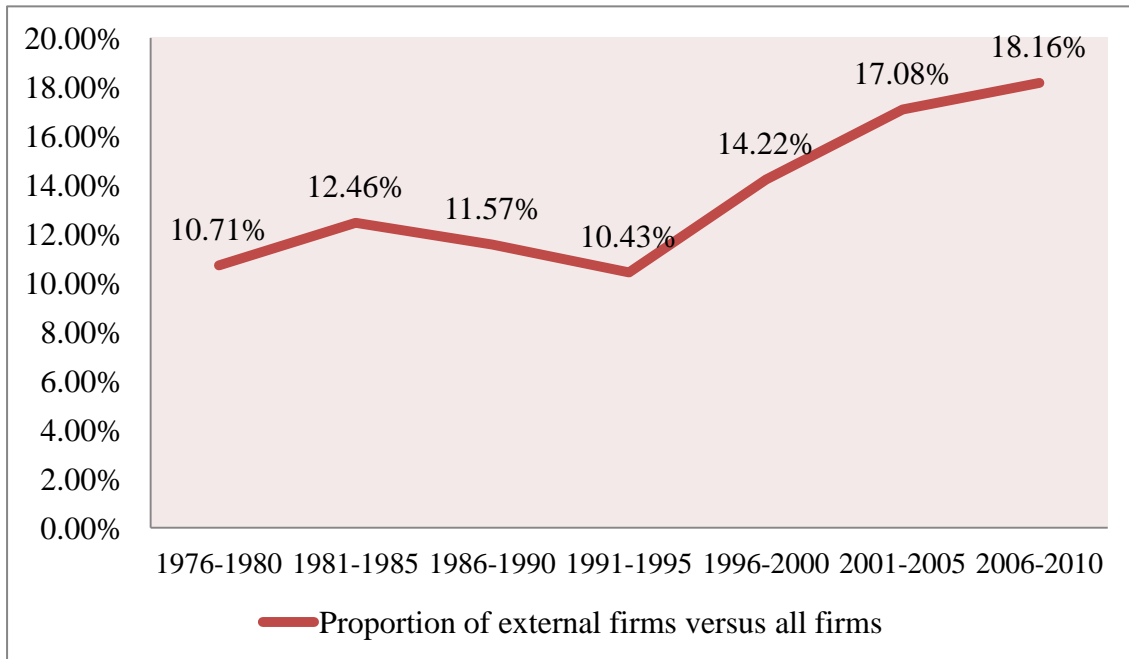


Figure 5.2 Proportion of External Firms versus All Firms

Figure 5.3 shows the proportion of non-regular transactions versus regular transactions. Regarding regular transactions, I include one-level up transactions and transactions between apparel manufacturers and retailers.³ In terms of non-regular transactions, I include level-skipping, same-level, and backward transactions. My result shows that the period from 1986 to 1990 witnessed the largest percentage of non-regular transactions relative to regular transactions. Hypothesis 5 is not fully supported because the trend appears to be random. But my result indicates the existence of vertically integrated or tapered integrated firms, and the fact that firms develop permeable boundaries. This finding is consistent with previous studies that investigate “taper integration” (Harrigan, 1984), “partially integrated firms” (Rothaermel et al., 2006), “permeable boundaries” (Jacobides & Billinger, 2006), and “concurrent sourcing” (Parmigiani, 2007; Parmigiani & Mitchell, 2009).

³ According to apparel sector roles’ dependency, transactions between apparel manufacturers and retailers are one-level skipping transactions. However, in the apparel sector, such transactions should be considered regular.

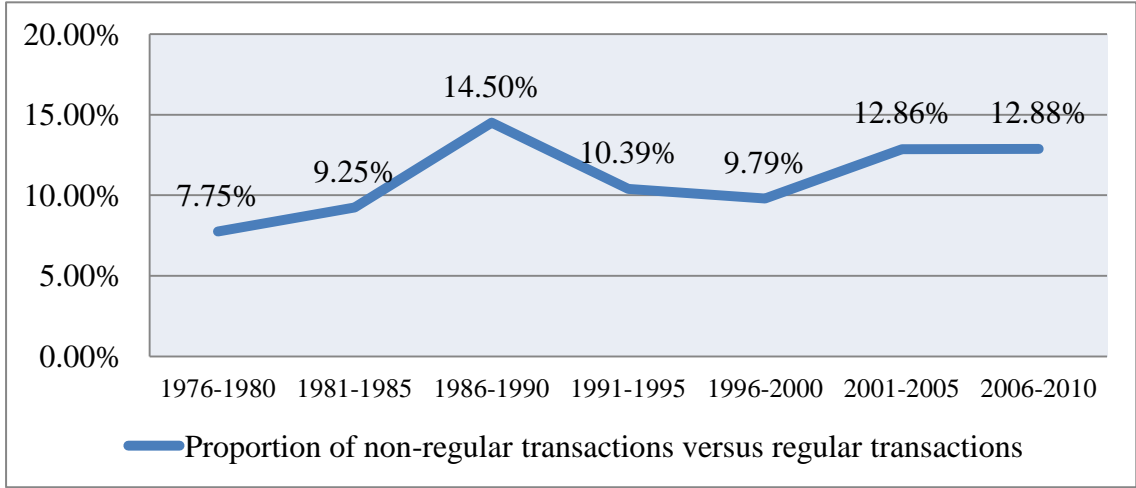


Figure 5.3 Proportion of Non-regular Transactions versus Regular Transactions

6. Conclusion

This study investigates the nature of major transactions in the U.S. apparel sector, using a general theory that is applicable across sectors. The firm-level analysis provides knowledge regarding the relationship between a firm's value chain position and the nature of its transactions with other firms. The industry-level analysis examines the evolution, over the course of 30 years, of the apparel sector by focusing on the relative importance of manufacturing activities versus service activities, and on the involvement of firms from external sectors (non-apparel sectors). Business practitioners and journalists have provided descriptive statistics and general knowledge regarding the nature of inter-firm relations, but these are not theory-based and so there is little possibility of generalization to other contexts. My study is able to predict the existence and magnitude of major transactions between firms based on theory.

Using a unique sample of over 2,000 observations of major inter-firm transactions, I test the theory of inter-firm similarity and of inter-firm complementarity to explain inter-firm relations. My results suggest that inter-firm relations are a consequence of inter-firm complementarity, rather than of inter-firm similarities. Major transactions are more likely to take place between the vertically related pairs of industries to which firms belong, rather than between horizontally equivalent peers in similar industries. In the discussion below, I present the contributions and implications of this study. The last subsection discusses limitations and future research directions.

6.1 Contributions

This study provides a systematic description of the nature of major transactions in the U.S. apparel sector, using a theory that has the potential to apply across different sectors. This is one of the few studies to use an important dataset to examine the

nature and determinants of the overall network structure and the first to consider network relations in addition to bilateral relations. This exceptional dataset has been used by financial researchers to support their award-winning research, but it has never been used by strategy researchers. The dataset holds great promise for examining the structure and evolution of transactional networks across sectors over time.

In addition, this study examines the importance of the theory of inter-firm complementarity, rather than the theory of inter-firm similarity, in explaining sector architecture; therefore, it contributes to the literature by illuminating the positive and statistically significant relationship between inter-firm complementarity and the existence and magnitude of inter-firm transactions. Inter-industry similarity is important for explaining the performance differences among firms in terms of profitability (Rumelt, 1982), for determining the direction of firm growth and the degree of diversification (Rumelt, 1974; Teece et al., 1994; Bryce & Winter, 2008), and for predicting firms' decisions to enter new markets (Lien & Klein, 2009). Nevertheless, inter-firm similarity is not useful for predicting firms' decisions to establish transactional relations with other firms. My theory of inter-firm complementarity is based on the theory presented in Dalziel's (2007) paper, which leads to the identification of complementary firm roles and which better predicts the transactional relationships between firms that are critical to illuminating sector architecture. Dalziel (2007) proposes a system-based approach to industry classification and introduces the sector-role concept which distinguishes between service and manufacturing subsectors, and between central and complementary firms. My thesis is the first empirical test of the proposed theory that sectors are hierarchically structured according to dependency relations.

Finally, my study elucidates the importance of complementarity and the limitation of similarity in predicting inter-firm relations and hence transactional networks' structure; it therefore contributes to the future improvement of industry classification systems. The current industry classification systems are built on the use of similarity in

activities as the criterion for aggregating lower-order groups into higher-order groups. Such systems depict sector structures as homogeneous clusters of industries but, in practical terms, firms from complementary industries are hierarchically ordered according to dependency relations. My findings are consistent with previous studies that have observed the failure of current industry classification systems to reflect the structure of the economy (Bryce & Winter, 2009; Hicks, 2011) and the failure to capture the broad patterns in the nature of inter-firm relations that have been indicated by researchers investigating supply chains, ecosystems, and modular clusters (Baldwin & Clark, 2000).

6.2 Implications

Transactions are the most basic economic activities of firms and have extensive implications on firms' social activities and public actions in terms of international norms, ethical standards, sustainable development, and so forth. For instance, a buy-sell transaction between a Western retailer and manufacturing factories in less-developed countries has implications for employee welfare, the enforcement of building standards, and labour safety issues in poverty-stricken areas. In 2010, Foxconn, a Taiwanese company, was plagued by a series of suicides that resulted in 14 deaths. Such out-of-the-ordinary fatalities threw an awkward spotlight on the labour practices of Foxconn, which is a unit of Taiwan's Hon Hai Precision Industry Co. Ltd., whose clients include Apple Inc., Hewlett-Packard Co., and Sony Ericsson (Reuters, 2010). In addition to the series of tragedies that occurred at Foxconn's plants, a series of tragedies took place in the buyer firms' supply chains. As Foxconn's overseas partners, Apple, Dell, and HP were indirectly involved in the fatalities and made statements that they would further investigate and audit the working conditions of their Asian suppliers (Dean, 2010). Fatalities of this nature are not restricted to the high-technology sector. Recently, public media has reported the collapse of garment-manufacturing buildings in Bangladesh and the deaths of at least 1,100

workers (Nolen, 2013). Western retailers and consumers who bought shirts made in Bangladesh cannot isolate themselves from this tragedy since they are aware that their purchasing activities and their pursuit of fast fashion and low cost to some extent contributed to the fatalities in that country. However, this awareness is not based on any official data pertaining to inter-firm transactions, but is instead based on reports disseminated by the public media. Regrettably, it is only when tragedies and fatalities take place that most people are informed of the fact that their purchasing of cheap clothes exacts a heavy human cost.

In addition to the implications for human welfare, inter-firm transactions may also provide information on environmental welfare and sustainable development. In order to fully account for the environmental effects of the products and services that we consume, we require readily accessible data on the relationships between firms in global supply chains (Henrickson et al., 2006). In global value chains, most developing countries concentrate their activities in lower value-added sectors such as manufacturing and raw material industries. Developing countries have long been blamed for their contributions to industrial pollution, especially to the rise of carbon dioxide emissions. However, studies have suggested that the stabilization of emissions in developed countries was partially due to the growth of imports from developing countries (Peters et al., 2011) and have revealed the full extent of the West's responsibility for expanding the world's emissions of greenhouse gases (Clark, 2009). According to a report from Oslo's Centre for International Climate and Environmental Research, around 9% of total Chinese emissions are now the result of manufacturing goods for the U.S., and around 6% are the result of producing goods for Europe. Academics and campaigners increasingly say that responsibility for this pollution lies with the consumer countries (Clark, 2009). Peters et al. (2011) have examined the growth in emissions transfer via international trade from developing to developed countries and their results indicate that international trade is a significant factor in explaining the shift in emissions from both a production and a consumption

perspective (Peters et al., 2011). The failure of the Copenhagen summit may partially be explained by the fact that the developing world is reluctant to take the West's share of the responsibility for causing emissions by means of off-shored manufacturing facilities aimed at producing goods for foreign markets (Clark, 2009). To solve the issue of off-shored emissions, a new challenge is introduced because of the measurement of domestic, exported, and imported emissions from both the production and consumption perspectives. Relevant international-trade data of each country is required for such meticulous measurements. Data regarding inter-firm transactions are of benefit to the calculation of emissions from both the production and consumption perspectives and may provide empirical evidence that can be used for the further improvement of environmental and climate-change policies. My study calls for efforts to improve the current industry classification systems. If industry classification systems were designed in ways that reflect actual industry structures, as manifested by transactions, then such systems would be an effective means of providing a superior knowledge of industry and international-trade policies, of human-welfare issues in manufacturing industries, and of environmental issues in raw-material industries.

Second, the findings of this study also have several important implications regarding the evolution of U.S. apparel sector and its future governance. Some analysts have suggested a bleak future for the U.S. apparel sector based on the erosion of domestic employment and the increase in import penetration (Mittelhauser, 1997). It has often been reported that the availability of high-quality jobs has been compromised by the outsourcing of manufacturing activities (Tassey, 2010). In order to better understand the relationship between outsourcing and employment opportunities, we also need to consider the growth of related professional service activities. The results of my study indicate an increasing proportion of service activities versus manufacturing activities in the apparel sector and an increasing proportion of external firms involved in transactions with firms in the apparel sector. The methodology employed in my study raises the possibility that the loss of manufacturing jobs has been compensated by a gain in service jobs. In the apparel sector, value chains are dominated by retailers and

marketers that exert more power over wholesalers, manufacturers, and textile providers. The competitive advantage of U.S. apparel firms may lie in their ability to capitalize on high quality and maintain strong brand names (Mittelhauser, 1997), to develop information integrated supply chains (Abernathy et al., 1995, 2000), to exert substantial control over their resources and profit distribution (Gereffi & Frederick, 2010), and to control high value-added activities such as branding and retailing (Bair & Gereffi, 2003). My study indicates a more encouraging picture of the U.S. apparel sector than the pessimistic prognosis suggested by previous studies.

Finally, the durability of major transactions may have implications for firm competition policies. The enduring linkages between certain large firms may indicate the potential risk of dominance and monopoly in the market and may predict future merger and acquisition activities.

6.3 Limitations and Future Research Directions

Despite this study's attempt to be as thorough and rigorous as possible, there are limitations that need to be acknowledged. First, due to the time limitation, this study only investigates one sector. Therefore, the generalization of the findings in terms of sector architecture and evolution in the apparel sector may not apply to other sectors. My study is at the starting point of investigation into sector and value chain architectures in the economy; future studies are expected to test the theory in more complex sectors than the apparel sector. Studies on other sectors may display more complex sector architecture, different transactional relationships, or tremendous changes over time.

Second, the data sample of this study only contains "major transactions" rather than the "total transactions" in the U.S. apparel sector. I believe that major transactions are sufficient to capture the general picture of sector architecture and that large firms in

most cases lead the trend while small firms are more likely to follow. For example, Luo et al. (2012) investigate the transaction networks of two large sectors in Japan and demonstrate that there are no backward linkages or cycles once the 10 largest firms are removed from the dataset in the Japanese electronics sector. However, a further exploration with additional data on “total transactions” will yield a more holistic view of the structure of transaction networks. Future studies are expected to compare the differences or similarities between the network structure of major transactions and the network structure of minor transactions.

Moreover, this study only considers one highly developed country in North America. Inter-firm transaction networks in the apparel sector can be very different in Asia and South America where most firms are positioned in low value-added industries and are engaged in manufacturing activities. Future studies are expected to explore the apparel sector’s architecture and transactional networks in the developing world.

Finally, in terms of the theory employed in my study, I believe that it will hold for other sectors as well. Notwithstanding the strategic behaviour of firms, differences in business environments across regions and nations, and relentless change in technology, there are broad and stable patterns in the nature of inter-firm relations that can be described succinctly. Future studies are therefore expected to empirically test the same theory in other sectors and in other countries.

References

- Abernathy, F. H., Volpe, A., & Weil, D. (2006). The future of the apparel and textile industries: Prospects and choices for public and private actors. *Environment and Planning A*, 38(12), 2207-2232.
- Abernathy, F. H., Dunlop, J. T., Hammond, J. H., & Weil, D. (2000). Retailing and supply chains in the information age. *Technology in Society*, 22(1), 5-31.
- Abernathy, F. H., Dunlop, J. T., Hammond, J. H., Weil, D., Bresnahan, T. F., & Pashigian, B. P. (1995). The information-integrated channel: A study of the U.S. apparel industry in transition. Brookings Papers on Economic Activity. *Microeconomics*, 1995, 175-246.
- Arora, A., & Gambardella, A. (1990). Complementarity and external linkages: The strategies of the large firms in biotechnology. *The Journal of Industrial Economics*, 38(4), 361-379.
- Bain, J. S. (1968). *Industrial organization*. New York: Wiley.
- Bair, J., & Gereffi, G. (2003). Upgrading, uneven development, and jobs in the North American apparel industry. *Global Networks*, 3(2), 143-169
- Baldwin, C. Y. (2000). In Clark K. B. (Ed.), *Design rules: The power of modularity*. Cambridge, Mass.: MIT Press.
- Baldwin, C. Y. (2008). Where do transactions come from? Modularity, transactions, and the boundaries of firms. *Industrial and Corporate Change*, 17(1), 155-195.
- Baltagi, B. H. (2001). *Econometric Analysis of Panel Data*. 2d Ed. New York: John

Wiley & Sons.

Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of Management*, 17(1), 99-120.

Bonaccorsi, A., & Giuri, P. (2001). The long-term evolution of vertically-related industries. *International Journal of Industrial Organization*, 19(7), 1053-1083.

Bonaccorsi, A., & Giuri, P. (2001). Network structure and industrial dynamics. The long term evolution of the aircraft-engine industry. *Structural Change and Economic Dynamics*, 12(2), 201-233.

Borgatti, S.P., Everett, M.G. & Freeman, L.C. (2002). Ucinet for Windows: Software for Social Network Analysis. Harvard, MA: Analytic Technologies

Brusoni, S., Prencipe, A., & Pavitt, K. (2001). Knowledge specialization, organizational coupling, and the boundaries of the firm: Why do firms know more than they make? *Administrative Science Quarterly*, 46(4), 597-621.

Bryce, D. J., & Winter, S. G. (2009). A general interindustry relatedness index. *Management Science*, 55(9), 1570-1585.

Cacciatori, E., & Jacobides, M. G. (2005). The dynamic limits of specialization: Vertical integration reconsidered. *Organization Studies*, 26(12), 1851-1883.

Clark, D. (2009). West blamed for rapid increase in China's CO2. The Guardian.

Available at:

<http://www.guardian.co.uk/environment/2009/feb/23/china-co2-emissions-climate>

Cohen, L., & Frazzini, A. (2008). Economic links and predictable returns. *Journal of*

Finance, 63(4), 1977-2011.

Dalziel, M. (2007). A systems-based approach to industry classification. *Research Policy*, 36(10), 1559-1574.

Dalziel, M., & Zhang, S. C. (2008). The main and contingent effects of the systems integrator and component supplier roles. Proceedings of the 4th IEEE International Conference on Management of Innovation and Technology, ICMIT, 854-859.

Dean, J. (2010). Suicides Spark Inquiries: Apple, H-P to examine Asian supplier after string of deaths at factory. The Wall Street Journal. Available at:
<http://online.wsj.com/article/SB10001424052748704026204575267603576594936.html>

DFAIT(Foreign Affairs and International Trade Canada) . (2011). See Sydor 2011

Dickerson, K. G. (1995). *Textiles and apparel in the global economy*, 2nd edition. Englewood Cliffs, NJ: Prentice Hall.

Fixson, S. K., & Park, J. (2008). The power of integrality: Linkages between product architecture, innovation, and industry structure. *Research Policy*, 37(8), 1296-1316

Frederick, S., & Gereffi, G. (2011). Upgrading and restructuring in the global apparel value chain: Why China and Asia are outperforming Mexico and Central America. *International Journal of Technological Learning, Innovation and Development*, 4(1-3), 67-95.

Gereffi, G. (1999). International trade and industrial upgrading in the apparel commodity chain. *Journal of International Economics*, 48(1), 37-70.

Gereffi, G., Humphrey, J., & Sturgeon, T. (2005). The governance of global value chains. *Review of International Political Economy*, 12(1), 78-104.

Gereffi, G., & Tam, T. (1998). Industrial upgrading through organizational chains: dynamics of rent, learning-by-doing, and mobility in the global economy. 93rd Annual Meeting of the American Sociological Association, San Francisco, California

Gulati, R. (1995). Social structure and alliance formation patterns: A longitudinal analysis. *Administrative Science Quarterly*, 40(4), 619-652.

Gulbrandsen, B., Sandvik, K., & Haugland, S. A. (2009). Antecedents of vertical integration: Transaction cost economics and resource-based explanations. *Journal of Purchasing and Supply Management*, 15(2), 89-102.

Hausman, J. A. (1978). Specification tests in econometrics. *Econometrica*, 46(6), 1251-1271.

Hendrickson, C. T., Lave, L. B., & Matthews, H. S. (2006). Environmental Life Cycle Assessment of Goods and Services: An Input-Output Approach. Resources for the Future Press.

Hertzel, M. G., Li, Z., Officer, M. S., & Rodgers, K. J. (2008). Inter-firm linkages and the wealth effects of financial distress along the supply chain. *Journal of Financial Economics*, 87(2), 374-387.

Hicks, D. (2011). Structural change and industrial classification. *Structural Change and Economic Dynamics*, 22(2), 93-105.

Hsiao, C. (2007). Panel data analysis—Advantages and challenges. *Test*, 16(1), 1-22.

Van Assche, A. with commentary by Todd Evans. (2012). Global value chains and Canada's trade policy: Business as usual or paradigm shift? IRPP study 32. Montreal: Institute for Research on Public Policy

Jacobides, M. G. (2005). Industry change through vertical disintegration: How and why markets emerged in mortgage banking. *Academy of Management Journal*, 48(3), 465-498.

Jacobides, M. G., & Billinger, S. (2006). Designing the boundaries of the firm: From "make, buy, or ally" to the dynamic benefits of vertical architecture. *Organization Science*, 17(2), 249-261.

Jacobides, M. G., Knudsen, T., & Augier, M. (2006). Benefiting from innovation: Value creation, value appropriation and the role of industry architectures. *Research Policy*, 35(8 SPEC. ISS.), 1200-1221.

Jacobides, M. G., & Winter, S. G. (2005). The co-evolution of capabilities and transaction costs: Explaining the institutional structure of production. *Strategic Management Journal*, 26(5), 395-413.

Lamprinopoulou, C., & Tregear, A. (2011). Inter-firm relations in SME clusters and the link to marketing performance. *Journal of Business & Industrial Marketing*, 26(6), 421-429.

Langlois, R. N., & Robertson, P. L. (1992). Networks and innovation in a modular system: Lessons from the microcomputer and stereo component industries. *Research Policy*, 21(4), 297-313.

Lien, L., & Klein, P. (2009). Using competition to measure relatedness. *Journal of Management*, 35(4), 1078-1107.

- Lin, Z. (., Yang, H., & Arya, B. (2009). Alliance partners and firm performance: Resource complementarity and status association. *Strategic Management Journal*, 30(9), 921-940.
- Luo, J.L., Baldwin, C.Y., Whitney, D.E., & Magee, C.L. (2012). The architecture of transaction Networks: a comparative analysis of hierarchy in two sectors. *Industrial and Corporate Change*, 21(6), 1307–1335.
- Luo, J.L., & Magee, C. L. (2011). Detecting evolving patterns of self-organizing networks by flow hierarchy measurement. *Complexity*, 16(6), 53-61.
- MacCormack, A., Rusnak, J., & Baldwin, C. Y. (2006). Exploring the structure of complex software designs: An empirical study of open source and proprietary code. *Management Science*, 52(7), 1015-1030.
- Mittelhauser, M. (1997) Employment Trends in Textiles and Apparel, 1973-2005. *Monthly Labor Review*, August 1997, 24-35.
- Neffke, F., & Henning, S. M. (2008). Revealed Relatedness: Mapping Industry Space. Working Paper Series 08.19, Papers in Evolutionary Economic Geography, Utrecht University, Utrecht, the Netherlands
- Nelson, R. R. (1982). In Winter S. G. (Ed.), *An evolutionary theory of economic change*. Cambridge, Mass: Belknap Press of Harvard University Press.
- Nolen, S. (2013). Cheap clothes have helped fuel social revolution in Bangladesh. *The Globe and Mail*. Available at:
<http://www.theglobeandmail.com/news/world/cheap-clothes-have-helped-fuel-social-r-evolution-in-bangladesh/article11589450/>
- Parmigiani, A. (2007). Why do firms both make and buy? An investigation of

concurrent sourcing. *Strategic Management Journal*, 28(3), 285-311.

Parmigiani, A., & Mitchell, W. (2009). Complementarity, capabilities, and the boundaries of the firm: The impact of within-firm and interfirm expertise on concurrent sourcing of complementary components. *Strategic Management Journal*, 30(10), 1065-1091.

Penrose, E.T. (1959). *The Theory of the Growth of the Firm*. Blackwell: Oxford

Peters, G., Minx, J., Weber, C.L., & Edenhofer, O. (2011). Growth in emission transfers via international trade from 1990 to 2008. *Proceedings of the National Academy of Sciences (PNAS)* 108(21): 8903-8908

Podolny, J. M. (1994). Market uncertainty and the social character of economic exchange. *Administrative Science Quarterly*, 39(3), 458-483.

Porter, M. E. (1985). *Competitive advantage: Creating and sustaining superior performance*. London; New York: Collier Macmillan; Free Press.

Reuters. (2010). Foxconn worker plunges to death at China plant: report. Available at: <http://www.reuters.com/article/2010/11/05/us-china-foxconn-death-idUSTRE6A41M920101105>

Robins, J. A., & Wiersema, M. F. (2003). The measurement of corporate portfolio strategy: Analysis of the content validity of related diversification indexes. *Strategic Management Journal*, 24(1), 39-59

Rosenkopf, L., & Schilling, M. A. (2007). Comparing alliance network structure across industries: Observations and explanations. *Strategic Entrepreneurship Journal*, 1(3-4), 191-209.

Rothaermel, F. T., Hitt, M. A., & Jobe, L. A. (2006). Balancing vertical integration and strategic outsourcing: Effects on product portfolio, product success, and firm performance. *Strategic Management Journal*, 27(11), 1033-1056.

Rothaermel, F. T. (2001). Complementary assets, strategic alliances, and the incumbent's advantage: An empirical study of industry and firm effects in the biopharmaceutical industry. *Research Policy*, 30(8), 1235-1251.

Rumelt, R.P. (1974). *Strategy, Structure and Economic Performance*. Cambridge, MA: Division of Research, Graduate School of Business Administration, Harvard University.

Rumelt, R. P. (1982). Diversification strategy and profitability. *Strategic Management Journal*, 3(4), 359-369.

Schilling, M. A., & Steensma, H. K. (2001). The use of modular organizational forms: An industry-level analysis. *The Academy of Management Journal*, 44(6), 1149-1168.

Smith, A. (1817). In Garnier (Ed.), *An inquiry into the nature and causes of the wealth of nations* [electronic resource] with a life of the author : Also, a view of the doctrine of smith, compared with that of the French economists, with a method of facilitating the study of his works, from the French of M garnier. Edinburgh: Printed for S. Doig and A. Stirling.

Sorenson, O., & Stuart, T. E. (2001). Syndication networks and the spatial distribution of venture capital investments. *The American Journal of Sociology*, 106(6), 1546-1588.

Strauss, M. (2013). Lower tariffs, fewer quotas make Bangladesh the go-to apparel producer. *The Globe and Mail*. Available at:

<http://www.theglobeandmail.com/news/world/lower-tariffs-fewer-quotas-make-bangladesh-the-go-to-apparel-producer/article11589221/>

Stuart, T. E. (1998). Network positions and propensities to collaborate: An investigation of strategic alliance formation in a high-technology industry. *Administrative Science Quarterly*, 43(3), 668-698.

Sturgeon, T., Van Biesebroeck, J., & Gereffi, G. (2008). Value chains, networks and clusters: Reframing the global automotive industry. *Journal of Economic Geography*, 8(3), 297-321.

Sturgeon, T. J., & Gereffi, G. (2009). Measuring success in the global economy: International trade, industrial upgrading, and business function outsourcing in global value chains. *Transnational Corporations*, 18(2), 1-35.

Sturgeon, T. J. (2002). Modular production networks: A new american model of industrial organization. *Industrial and Corporate Change*, 11(3), 451-496.

Tanriverdi, H., & Venkatraman, N. (2005). Knowledge relatedness and the performance of multibusiness firms. *Strategic Management Journal*, 26(2), 97-119.

Tassey, G. (2010). Rationales and mechanisms for revitalizing US manufacturing R&D strategies. *Journal of Technology Transfer*, 35(3), 283-333.

Teece, D. J. (2010). Forward integration and innovation: Transaction costs and beyond. *Journal of Retailing*, 86(3), 277-283.

Teece, D. J., Rumelt, R., Dosi, G., & Winter, S. (1994). Understanding corporate coherence. Theory and evidence. *Journal of Economic Behavior and Organization*, 23(1), 1-30.

Tomlinson, P. R. (2010). Co-operative ties and innovation: Some new evidence for UK manufacturing. *Research Policy*, 39(6), 762-775.

Williamson, O. E. (1975). *Markets and hierarchies, analysis and antitrust implications: A study in the economics of internal organization*. New York: Free Press.

Williamson, O. E. (1985). *The economic institutions of capitalism: Firms, markets, relational contracting*. London; New York: Collier Macmillan; Free Press.

Winter, S. G. (1988). On coase, competence, and the corporation. *Journal of Law, Economics, and Organization*, 4(1), 163-180.

Wooldridge, J. M. (2002). *Econometric Analysis of Cross Section and Panel Data*. Cambridge, MA: MIT Press.

Yamakawa, Y., Yang, H., & Lin, Z. (. (2011). Exploration versus exploitation in alliance portfolio: Performance implications of organizational, strategic, and environmental fit. *Research Policy*, 40(2), 287-296.