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Abstract

Recent protectionist trends around the world have raised interest in newly enforced or increased tariffs and their effects on global supply chains. For firms sourcing globally, tariff introductions or increases significantly affect importing costs, which ultimately affect product costs. Such tariff changes may incentivize firms to adjust their supply base to mitigate these cost increases, thus altering the structure and complexity of firms' supply bases. In this paper, we first characterize the U.S. tariff landscape from 1997 to 2017. We then develop a conceptual model to explain how the severity and timing uncertainty of expected tariff increases influence a firm's speed of adapting to the changing tariff environment. Specifically, we explore firms' propensity to form or delete ties to suppliers, which influences supply base complexity. Moreover, we consider factors that moderate the relationship between severity, timing uncertainty, and supply base complexity, including a tariff's geographical scope, a firm's relative purchase spend, and supply risk. Our conceptual model offers both research and managerial implications.

Keywords

Tariffs, Trade barriers, Supply base complexity, Supply network, Total cost of ownership, Resource dependence theory

1. Introduction

Recent political and economic changes, such as Brexit (Hunt and Wheeler, 2018) and trade-protectionist policies in the U.S. (Lambert, 2018), have raised awareness in the supply management community of the potential impact that new trade-restrictive policies and tariffs may have on a firm's supply base. An example showing the higher awareness is that suggests that the introduction of tariffs on aluminum and steel imported into the U.S. has motivated firms to rethink their supply bases (Tausche and Dhue, 2018). While the long-term effects of such policies and tariffs are not yet observable on a macro-level, anecdotal evidence suggests that these impending and actual changes affect firms. Harley-Davidson, for example, forecasted a $2,200 increase per motorcycle sold in the European Union (EU) following the 31% tariff enacted by the EU against imports from the U.S.; the company has announced plans to move production facilities outside the U.S. to avoid those tariffs (Tita, 2018a). Likewise, in their 2018 s-quarter earnings reports, both General Motors and Whirlpool reported spending over $300 million more than expected on raw materials due to emerging tariffs (Colias, 2018; Tangel and Zumbrun, 2018). Even before the formal introduction of tariffs, firms are challenged by the uncertainty surrounding potential tariff increases. Nissan has recently cited tariff uncertainty associated with Brexit for reversing its decision to build the new X-Trail model in the U.K. (Mayes, 2019). Similarly, U.S. traders have stockpiled aluminum in warehouses in anticipation of aluminum tariffs (Tita, 2018b). Hence, it is plausible that firms facing threats of tariff changes adjust their supply bases to circumvent cost.

The tariff-related examples mentioned above indicate that stricter protectionist policies are a broad phenomenon. Indeed, the World Trade Organization's (WTO) Director-General's 2018 report reveals that WTO

members applied 137 new trade-restrictive measures from mid-October 2017 to mid-October 2018, equating to about 11 new measures per month on average, an increase from the average of nine measures per month in the preceding year's report (mid-October 2016 to mid-October 2017). Trade-restrictive measures "include new import or export tariffs, increases in existing import or export tariffs, the introduction of import bans or quantitative restrictions, the establishment of more complex or stricter customs regulations or procedures and local content requirements. The duration of these measures can be temporary or permanent" (World Trade Organization, 2018, p. 90). What is more, the trade coverage of trade-restrictive measures, which amounts to US$588.3 billion, is nearly double the trade coverage of trade-facilitating measures, which amounts to US$295.6 billion. The trade coverage is also seven times larger than the one recorded in the previous WTO annual overview (World Trade Organization, 2018), showing that countries around the world are enacting tariffs that cover a higher value of imported goods import value.

Countries enact trade-restrictive measures to boost local economies or punish other countries (Johnson, 1965). While this strategy might have financial benefits for a country, such measures increase sourcing costs and, consequently, the total cost of ownership (TCO) for firms sourcing globally. This outcome is significant because TCO encompasses *"(…) all costs associated with a product, service, or capital equipment that are incurred over its expected life"* (Monczka et al., 2015, p. 444), and includes such costs as product price, transportation, logistics, receiving, inspection, and storing costs among others (Ellram and Siferd, 1998). Despite the increasing prevalence of trade-restrictive measures around the world, the effects of trade-restrictive measures on the emergence and evolution of global supply networks have received little attention from supply chain management (SCM) researchers. It is important to examine these effects since such measures can lead to buyer-supplier relationship dissolution and supplier switching, thereby changing the structure and complexity of a firm's supply base. Supply base structure and complexity are relevant for a buying firm since they can influence a firm's cost structure (Choi and Krause, 2006), innovation output (Bellamy et al., 2014), performance (Kim, 2014), and experience with supply chain disruptions (Bode and Wagner, 2015; Craighead et al., 2007).

In this paper, we focus on expected tariff increases and their effects on firm adaptation speed and supply base complexity.[2] We propose that expected tariff increases are characterized by the three key attributes: (1) *severity*, or the extent of the expected tariff increase; (2) *timing uncertainty*, or the degree of perceived uncertainty about a tariff's duration for a specific rate; and (3) *geographical scope*, or the number of geographical markets subjected to the tariff. Using the TCO framework, we propose that severity and timing uncertainty result in high sourcing costs, inducing firms to respond (slowly or swiftly) and to change their supply bases, which affects their supply base complexity. At the same time, we suggest that the opportunity to source from non-tariff-affected markets (as is reflected in a tariff's geographical scope) moderates the relationship between severity, timing uncertainty, and potential supply base adjustments. We derive our propositions by making two assumptions: (1) a firm's supply base prior to the expected tariff increase was optimally developed considering relevant cost aspects; and (2) the decision-making agent within the firm is intentionally rational and pursues the strategy that maximizes utility by minimizing TCO (Brenner and Cochran, 1991; Monroe and Maher, 1995).

We consider a tariff's geographical scope as well as two firm-level factors, relative purchasing spend and supply risk, as key moderators. Relative purchasing spend refers to a firm's proportion of the annual amount spent on the purchasing items affected by tariffs. On average, U.S. firms spend 43% of their revenues on procurement (Bain and Company, 2016). When firms incur a high spend from global suppliers, they are more severely affected by tariffs and more likely to adjust their supply bases. Supply risk refers to the probability that an unplanned event may occur in relation to the purchasing items' "*acquisition, delivery, and use that can negatively affect a firm's ability to serve its own customers*" (Provan and Gassenheimer, 1994, p. 15). When firms source high-risk

products from global suppliers, they may be more restricted in their sourcing options and thus more constrained in the ways they adjust their supply bases.

Our research contributions are threefold. First, we discuss tariffs and their relevance in supply chains, an under-researched topic in the SCM literature. To do so, we analyze the U.S. tariff environment and propose three key attributes to characterize expected tariff increases. Second, we use arguments from resource dependence theory (RDT) (Pfeffer and Salancik, 1978) and transaction cost economics (TCE) (Williamson, 1985) to explain how tariff increases influence the speed of a firm's response, resulting in changes in supply base complexity. Finally, we discuss a tariff's geographical scope, a firm's relative spend of the tariff-affected goods, and supply risk as moderators that may affect the relationships in our framework. These dimensions are critical variables influencing a firm's strategy (Kraljic, 1983; Montgomery et al., 2018). We also propose other moderating factors at the product-, firm-, supply chain- and industry-levels that can be examined in future research. Our research also contributes to supply management practice. The insights deriving from our proposed framework may help buying firms evaluate the effects of different tariff environments on their supply bases. An improved understanding of such effects can inform decisions regarding supplier selection, contract design, and supplier relationship management.

The remainder of the paper is structured as follows. In the second section, we analyze the U.S. tariff environment, which has largely been unexplored in extant supply management literature. We propose that tariff increases or introductions are characterized by severity, timing uncertainty, and geographical scope. In the third section, we discuss supply base complexity. In the fourth section, we present our conceptual framework linking two of the attributes—severity and timing uncertainty—as primary drivers of firm response speed and supply base complexity in response to tariff introduction or increases. In the fifth section, we discuss geographical scope as well as two sourcing-related contingencies—relative spend and supply risk—that moderate the relationships proposed in our framework. In the final section, we present the main conclusions of our study, discuss our study's implications for research and practice, outline the limitations of this study, and identify future research directions that this study prompts.

2. Overview of the U.S. Tariff environment

Tariffs are customs duties levied on merchandise imports on a *specific basis* (i.e., a fixed charge per unit of import, such as a pound/kilogram, gallon, or case) or an *ad valorem basis* (i.e., a fixed percentage of the value of the good imported) (Suranovic, 2010).[3] The U.S. International Trade Commission (USITC) publishes a tariff announcement when a tariff for an imported good is introduced and when its rate or duration changes. These tariffs are documented according to the Harmonized Tariff Schedule (HTS) administered by the USITC. The schedule includes HTS Sections, which correspond to broad categories of imported goods. Each HTS Section includes multiple eight-digit HTS codes that correspond to narrower categories of goods on which tariffs can be imposed. HTS Section 1, for example, includes 699 distinct eight-digit HTS codes that were affected by tariffs in 2019 (U.S. International Trade Commission, 2017). Tariffs are imposed on single eight-digit HTS code or groups of eight-digit HTS codes, with a specific *ad valorem* rate, for a specific period (with the possibility of extension), and on specific countries. Table 1 summarizes our analysis of tariff announcements.

Table 1. U.S. Tariff Announcements (1997–2017, eight-digit HTS code-level).

HTS section	Description	Number of HTS codes affected	% of HTS codes affected	Severity (***Ad Valorem*** Rate*)			Timing (Years)**			
				Avg.	Min	Max	Avg.	Std. Dev.	One year	Perm[†]
1	Live Animals; Animal Products	243	28.2%	10.6%	0.5%	26.4%	5.7	8.0	64.3%	6.7%
2	Vegetable Products	221	30.0%	11.8%	0.5%	163.8%	7.6	8.4	67.4%	9.0%
3	Animal or Vegetable Fats, Prepared Edible Fats	28	33.7%	7.2%	2.0%	19.1%	6.6	7.6	63.9%	7.7%
4	Prepared Foodstuffs; Beverages, Tobacco	520	56.9%	16.5%	0.8%	350.0%	6.9	7.3	70.1%	8.3%
5	Mineral Products	34	13.4%	4.9%	1.0%	12.5%	10.6	8.6	51.1%	11.1%
6	Products of the Chemical Industries	1627	70.6%	5.2%	0.1%	9.2%	8.1	8.3	59.2%	9.8%
7	Plastics and Articles Thereof	347	78.3%	4.9%	1.9%	14.0%	9.7	9.2	58.4%	11.0%
8	Raw Hides and Skins, Leather, Handbags	240	77.2%	6.1%	1.5%	20.0%	10.6	8.8	53.7%	11.6%
9	Wood and Articles of Wood	204	45.8%	5.8%	0.2%	18.0%	8.2	5.1	58.4%	9.2%
10	Pulp of Wood, Paper and Paperboard	234	61.6%	0.5%	0.1%	3.4%	1.0	0.0	100.0%	0.0%
11	Textile and Textile Articles	1797	92.1%	10.3%	0.1%	32.5%	3.3	6.9	80.3%	4.9%
12	Footwear, Headgear, Umbrellas, Walking Sticks	209	82.9%	16.3%	1.4%	48.0%	4.6	8.0	72.8%	6.8%
13	Articles of Stone, Ceramic Products, Glassware	258	66.3%	8.6%	0.4%	38.0%	8.8	7.9	60.4%	10.5%
14	Precious or Semiprecious Stones, Precious Metals	57	52.8%	5.9%	2.1%	13.5%	12.0	10.9	48.2%	12.5%
15	Base Metals and Articles of Base Metal	864	77.0%	3.9%	0.1%	15.8%	11.3	6.0	51.0%	11.0%
16	Machines, Mechanical Appliances; Electrical Equipment	838	44.9%	3.6%	0.9%	15.0%	14.0	9.1	38.2%	12.7%
17	Vehicles, Aircraft, Vessels	164	48.8%	5.9%	0.4%	25.0%	10.9	8.2	46.9%	10.8%
18	Optical, Photographic, Cinematographic, Measuring	370	59.4%	4.0%	0.7%	16.0%	12.8	10.2	41.5%	13.2%
19	Arms and Ammunition	20	37.7%	3.6%	2.6%	5.7%	13.4	8.4	36.6%	12.0%
20	Miscellaneous Manufactured Articles	180	54.4%	6.0%	1.3%	32.0%	10.2	10.2	51.8%	12.1%

21	Works of Art, Collectors' Pieces and Antiques	–								
22	Special Classification Provisions	3200	62.6%	27.8%	0.1%	200.0%	24.1	4.5	12.3%	22.3%
	Average	*555*	*55.9%*	*8.1%*	*0.9%*	*51.3%*	*9.5*	*7.7*	*56.5%*	*10.2%*

Notes: Data analyses based on 1997–2017 tariff announcements retrieved from the USITC. * Only *ad valorem* rates >0 were analyzed; specific rates were not analyzed. ** Timing refers to the difference between a tariff's effective end year and effective start year as announced by USITC. † Perm. refers to a "permanent" tariff, namely when the end year is indicated as 2050 or 2100.

In total, the HTS schedule comprises 22 sections with 12,753 eight-digit codes (U.S. International Trade Commission, 2017); these 22 HTS Sections and their descriptions are displayed respectively in the first and second columns in Table 1. The number of eight-digit HTS codes and the percentage of eight-digit codes within a given HTS Section that were affected by at least one tariff announcement (introduction or increase) from 1997 to 2017 are displayed in the third and fourth columns. For example, within HTS Section 6, "Products of the Chemical Industries," 1,627 eight-digit codes, which corresponds to 70.5% of eight-digit HTS codes within that Section, were affected by at least one tariff introduction or increase from 1997 to 2017. The fifth column in Table 1 shows the *ad valorem* rates. It includes three sub-columns corresponding to the average, minimum, and maximum rate within a given HTS Section. The sixth column in Table 1 illustrates the timing of a tariff. It includes four sub-columns corresponding to the average number of years a tariff is in effect, the standard deviation of duration within a given HTS section, the percentage of tariffs that were announced to be in effect for one year, and the percentage of tariffs that were considered to be permanent (i.e., end year is 2050 or 2100).

Based on our analyses of the U.S. tariff schedule, we propose that tariff increases should be characterized by three key attributes: severity, timing uncertainty, and geographical scope.

2.1. Severity of expected tariff increase

The severity of an expected tariff introduction or increase is defined as the extent of the increase in a tariff's specific or *ad valorem* rate. As such, a higher rate reflects a more severe tariff. When a severe tariff is imposed on goods sourced from countries that are in a firm's supply base, the firm incurs a higher total cost of ownership and lower competitiveness (Ossa, 2014). Hence, more severe tariff increases likely induce buying firms to change their sourcing strategies to mitigate the cost increases. More severe tariffs result in adjustments in their supply bases to a greater extent than less severe tariffs.

The "severity" columns in Table 1 illustrate the average, minimum, and maximum *ad valorem* rate across all tariff announcements made in 1997–2017 for eight-digit HTS codes within a specific HTS section. For example, in HTS section 2, "Vegetable Products," the average *ad valorem* rate across all tariff announcements was 11.8%, while the *ad valorem* rates ranged from 0.5% to 163.8% depending on the eight-digit HTS code within that section. Across all HTS sections, the average *ad valorem rate* in 1997–2017 was 8.1% (Table 1, last row). This analysis thus suggests that *ad valorem* rates range on a continuum from low (less severe) to high (more severe).

2.2. Timing uncertainty of expected tariff increase

Uncertainty refers to the unpredictability of conditions in a firm's environment (Miles et al., 1978). We define a tariff's timing uncertainty as the degree of unpredictability about a new tariff's period of validity, from its introduction to its termination. Some tariffs are announced for specific periods with the possibility of renewal or renegotiation, while others may be permanent (Schott et al., 2017). Additionally, timing uncertainty also encompasses expected tariff increases that were discussed by policymakers but never implemented. According to RDT (Pfeffer and Salancik, 1978) and TCE (Williamson, 1985), uncertainty plays a critical role in firms' sourcing strategy decisions. We build on these theories and suggest that firms are motivated to mitigate uncertain tariff environments since uncertainty affects firm competitiveness (Walker and Weber, 1987).

In Table 1, the columns related to "timing" illustrate the duration of newly announced tariffs, which range from a minimum length of one year up to permanent for the foreseeable future. Across the 22 HTS sections, the average duration of announced tariffs in 1997–2017 was 9.54 years (Table 1, last row). For example, the duration for all tariff announcements in HTS section 2, "Vegetable Products," between 1997 and 2017 was on average 7.6 years with a standard deviation of 8.4. The high standard deviation shows the variability of tariff duration. Additionally, 67.4% of all announced tariffs in section 2 were valid for one year, suggesting that these

tariffs either would end or be renegotiated yearly and demonstrating the timing uncertainty. Conversely, 9% of all tariffs were characterized to be in effect permanently with the end year indicated to be 2050 or 2100, suggesting that these tariffs may be in effect indefinitely. Moreover, the announced timing of a specific tariff change resulted in a high standard deviation of 8.42 for HTS section 2. In comparison to the average standard deviation of 7.58, this high standard deviation indicates that uncertainty stems from not knowing how long a tariff will be in effect. These results demonstrate that firms may find it difficult to plan their supply base for the long-term, given that the majority of tariffs is potentially subject to renegotiation.

The statistics presented in Table 1 refer to tariffs that were implemented. Frequently, however, potential tariffs are discussed and negotiated, but they are never implemented. We argue that this latter situation also contributes to tariff uncertainty because upon hearing about a tariff, firms may evaluate the impact of potential tariff increases on their business, assess potential actions of other firms, develop plans to mitigate the tariff's impact, and even begin executing these plans before the potential tariff is implemented. The U.S. automobile manufacturer Ford, for example, abandoned its plan to build a new plant in Mexico and decided to build its Focus compact car at an existing U.S. facility after the U.S. President called for a 35% tariff on cars produced outside the country (Welch and Merrill, 2017). Ford took these actions when the potential tariff was merely mentioned and not yet implemented by the U.S. government.

2.3. Geographical scope of tariff

We define a tariff's geographical scope as the number of exporting countries subjected to a tariff increase. For example, a tariff's geographical scope can apply to imports from a single country (e.g., the 25% tariff on pneumatic rubber tires from China) (U.S. International Trade Commission, 2017); from a specific number of countries, such as those without a free-trade agreement (FTA) with the focal country (e.g., the 163.8% tariff on in-shell, unroasted, uncooked, ground peanuts imported to the U.S. from all countries except for Jordan or Mexico) (U.S. International Trade Commission, 2017); and from all countries (e.g., the 5.5% tariff on polyhydric alcohols) (U.S. International Trade Commission, 2017). There are, however, tariff exemptions – special situations where a tariff does not apply to all countries due to alternative trade agreements. A tariff exemption, therefore, narrows the tariff's geographical scope and enables a firm to source from a broader set of countries without incurring additional duties.

Table 2 presents the percentage of HTS codes affected by tariff exemptions. Based on our analysis of the U.S. tariff landscape, approximately 46% of all U.S. tariff announcements in 1997–2017 affected all countries (i.e., approx. 56% of tariffs announcements included exemptions). Exemptions usually exist because of FTAs. In 2016, for example, the U.S. had 14 FTAs covering 20 countries, and 34.2% of its imports came from FTA countries (U.S. International Trade Commission, 2016). Referring again to the example of HTS Section 2, “Vegetable Products,” there were 517 country exemptions between 1997 and 2017 in Section 2, and 70.1% of the eight-digit HTS codes within this section had at least one exemption, meaning that the regular tariff did not apply to the countries included in that exemption.

Table 2. U.S. Tariff exemptions (1997–2017).

% of HTS codes with exemptions	HTS Section	Description of HTS Section	Abs. Number of Exemptions	% of all Tariff Announcements
>90%	11	Textile and Textile Articles	1824	93.40%
80–90%	12	Footwear, Headgear, Umbrellas, Walking Sticks	209	82.90%
	4	Prepared Foodstuffs; Beverages, Tobacco	742	80.70%
70–80%	7	Plastics and Articles Thereof	347	78.30%
	8	Raw Hides and Skins, Leather, Handbags	240	77.20%
	15	Base Metals and Articles of Base Metal	866	77.20%
	3	Animal or Vegetable Fats, Prepared Edible Fats	62	74.70%
	6	Products of the Chemical Industries	1634	70.90%
	2	Vegetable Products	517	70.10%
60–70%	13	Articles of Stone, Ceramic Products, Glassware	262	67.40%
	10	Pulp of Wood, Paper, and Paperboard	239	62.90%
	18	Optical, Photographic, Cinematographic, Measuring	392	62.90%
50–60%	20	Miscellaneous Manufactured Articles	183	55.30%
	1	Live Animals; Animal Products	463	53.80%
	14	Precious or Semiprecious Stones, Precious Metals	57	52.80%
<50%	17	Vehicles, Aircraft, Vessels	164	48.80%
	9	Wood and Articles of Wood	206	46.30%
	16	Machines, Mechanical Appliances; Electrical Equipment	846	45.30%
	19	Arms and Ammunition	20	37.70%
	5	Mineral Products	80	31.60%
	22	Special Classification Provisions	803	15.70%

Note: Exemptions regard special situations, such as when a tariff does not apply to all countries (e.g., due to free-trade agreements (FTA) or other bilateral agreements with the U.S.).

Based on the analysis of severity, timing uncertainty, and geographical scope of tariff increases, we develop in the fourth section a conceptual model using severity and timing uncertainty to predict how firms will respond to the increase or introduction of tariffs by adjusting their supply base and altering its complexity. The effect of severity and timing uncertainty is augmented by the geographical scope of the tariff increase or introduction. Therefore, geographical scope is discussed as a moderator, along with other firm-level variables in Section 5.

3. Supply base complexity

A firm's supply base refers to the *"suppliers that are actively managed contracts and the purchase of parts, materials and services"* (Choi and Krause, 2006, p. 639). Complexity, however, is notoriously difficult to define (Handley and Benton, 2013; Bode and Wagner, 2015), and various conceptualizations in the context of supply networks are offered in the literature. Choi and Krause (2006) build on Kauffman, 1993 NK model of complexity and conceptualize supply base complexity using three dimensions: number of suppliers, differentiation among suppliers, and inter-relationships among suppliers. In another study, Handley and Benton (2013) investigate the link between service outsourcing complexity and control and coordination costs. They conceptualize complexity using two dimensions: task-specific complexity (referring to the system's scale, breadth, and customization) and location-specific complexity (referring to geographic distance, cultural distance, and geographic dispersion). Choi and Hong (2002) and Bode and Wagner (2015) conceptualize upstream supply chain complexity using three dimensions: horizontal complexity, which regards the number of a focal firm's direct suppliers; vertical complexity, which describes the number of supply tiers; and spatial complexity, which regards the geographical spread of a firm's supply base. In this paper, we adapt these conceptualizations to the context of supply base complexity in international trade relationships. We propose three dimensions of supply base complexity: number of suppliers (Bode and Wagner, 2015; Choi and Krause, 2006), relationships among suppliers (Choi and Krause, 2006), and geographical complexity (Bode and Wagner, 2015; Handley and Benton, 2013).

Environmental changes, such as new tariff introductions, can induce firms to adapt their approaches to managing suppliers, influencing the overall complexity of their supply bases. This adaptation phenomenon is widely discussed in the early systems theory literature (e.g., Ashby, 1958; Simon, 1957; Von Bertalanffy, 1968). Ashby (1958) proposed the Law of Requisite Variety, which states that a system is stable when its internal variety matches the environment's variety. A revised version of Ashby's law, known as the Law of Requisite Complexity, concerns system adaptation, rather than stability, and the link between system adaptation and complexity. Specifically, it proposes that a system is adaptive when its internal complexity (i.e., of the supply base) matches external complexity (i.e., of the environment) it intends to control (Boisot and McKelvey, 2011). More recently, the Complex Adaptive Systems (CAS) perspective has emerged and links adaptation and complexity. It describes supply networks as complex systems of firms that exhibit adaptive responses to environmental and systemic changes (Choi et al., 2001; Pathak et al., 2007). Based on these insights, we suggest that firms seek to adapt to environmental changes that arise from expected tariff increases and thus make changes to their supply bases. These changes are likely to alter supply base complexity.

3.1. Number of suppliers

In Kauffman, 1993 NK model, the variable "N" represents the number of sites or nodes in a complex system, which corresponds to Choi and Hong (2002) definition of horizontal complexity. From a buying firm's perspective, the number of suppliers with recurring business transactions is directly related to the difficulty of managing the supply base (Bode and Wagner, 2015; Choi and Krause, 2006).

3.2. Relationships among suppliers

The K variable of the NK model represents the number of functional couplings among the sites in a complex system (Kauffman, 1993). Extending this "K," Choi and Krause (2006) suggest that supplier-supplier relationships

are an essential element of supply base complexity. When suppliers are closely connected via exchange relationships, the buying firm's actions (e.g., relationship termination) against certain suppliers are more likely to influence other suppliers that are related to the former. Therefore, the higher the number of relationships among suppliers, the higher the difficulty for a focal firm to manage its supply base, and, thus, the higher the complexity.

3.3. Geographical complexity

In this paper, we consider geographical distance and geographic dispersion to be aspects of geographical complexity (Handley and Benton, 2013; Bode and Wagner, 2015). First, geographical distance refers to the distance between a focal firm and its suppliers. Bode and Wagner (2015) describe this geographic distance as being weighted by purchasing volume and describe this concept as spatial complexity, while Handley and Benton (2013) introduce geographical distance as one dimension of location-specific outsourcing complexity. More extended spatial separation between a buying firm and its suppliers increases lead times and lead time variability (Bode and Wagner, 2015) and, consequently, transportation and inventory carrying costs (Christopher et al., 2011). Ultimately, a firm's overall control and coordination costs rise with increased geographical distance and increased complexity (Handley and Benton, 2013). Second, geographic dispersion refers to the number of countries from which a firm sources (Handley and Benton, 2013). Various studies discuss the increasing complexity that arises from managing suppliers from a wide variety of geographical locations (Handley and Benton, 2013; O'Leary and Cummings, 2007). In this paper, we build on these prior studies and consider geographical distance and geographic dispersion to be aspects of geographical complexity (Bode and Wagner, 2015; Handley and Benton, 2013).

4. Effects of tariff increases on firm adaptation speed and supply base complexity through tie formation/deletion

We propose that the severity and timing uncertainty of expected tariff increases influence the number of suppliers a firm has, the relationships among a firm's suppliers, and the geographical complexity of a firm's supply base, all of which result in changes in supply base complexity. Further, we investigate two adaptation mechanisms with effects on supply base complexity: firm adaptation speed and the formation or deletion of ties (i.e., buyer-supplier relationships) in the supply base. *Firm adaptation speed* refers to how quickly a firm changes its supply base after an expected tariff increase, ranging from slow to fast. Firm adaptation speed is important because firms need to respond appropriately to cope with dynamic environments (e.g., Bernardes and Zsidisin, 2008; Lee, 2003; Swafford et al., 2006). Firms that respond swiftly to rapidly changing market conditions—both in terms of direct investment and, crucially to this study, in terms of adjusted relationships with suppliers (Motta, 1992)—have a first-mover advantage. First-movers may also reap benefits when trade agreements are introduced between established and developing nations because these agreements allow first-mover firms to tap into new sources of low-cost labor (Nakata and Sivakumar, 1997). Firms that act slowly risk losing ground to more agile competitors. Conversely, less severe environmental changes require slower responses, allowing firms to assess the potential implications of the environmental changes before adapting their supply base (Swafford et al., 2006). The second adaptation mechanism, *tie formation or deletion*, explains the formation of relationships with new suppliers (i.e., tie formation), the termination of relationships with existing suppliers (i.e., tie deletion), or the substitution of suppliers (i.e., simultaneous tie formation and deletion).

We argue that expected tariff increases prompt firms to adapt their supply bases slowly or swiftly (i.e., firm adaptation speed) and form or delete ties, resulting in changes to supply base complexity. Supply base complexity is described by the number of suppliers, relationships among suppliers, and geographical complexity. We also suggest that these relationships are moderated by the tariff's geographical scope, the firm's relative

purchase spend on the tariff-affected good, and supply risk. Fig. 1 depicts our conceptual framework and these proposed moderators.

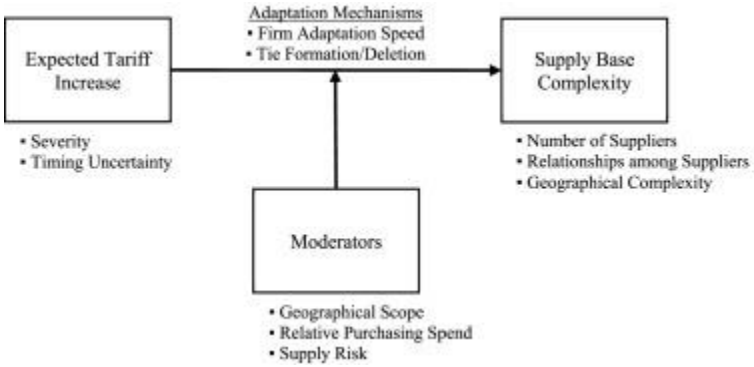

Fig. 1. Conceptual framework.

For our predictions, we divided severity and timing uncertainty of the expected tariff increase into two levels (low and high), which generated four primary scenarios regarding firm adaptation speed, tie formation/deletion, and changes in supply base complexity. The four scenarios are labeled *swift response*, *securing alternatives*, *wait-and-see*, and *deliberate response*. Fig. 2 depicts these scenarios.

		TIMING UNCERTAINTY (of the expected tariff increase)	
		LOW	HIGH
SEVERITY (of the expected tariff increase)	HIGH	**"Swift Response" Scenario** **Adaptation mechanisms:** **a) Adaptation speed:** high **b) Tie deletion/formation:** old ties deleted; new ties formed **Supply base complexity:** increases	**"Securing Alternatives" Scenario** **Adaptation mechanisms:** **a) Adaptation speed:** moderate **b) Tie deletion/formation:** old ties maintained; some new ties formed (new domestic ties possible) **Supply base complexity:** increases
	LOW	**"Deliberate Response" Scenario** **Adaptation mechanisms:** **a) Adaptation speed:** moderate **b) Tie deletion/formation:** some old ties deleted; some new ties formed with domestic suppliers and suppliers in unaffected countries **Supply base complexity:** decreases	**"Wait-and-See" Scenario** **Adaptation mechanisms:** **a) Adaptation speed:** low **b) Tie deletion/formation:** few old ties deleted; few new ties formed **Supply base complexity:** constant

Fig. 2. Effects of tariff severity and timing uncertainty on supply base complexity.

4.1. "Swift response" scenario (high severity and low timing uncertainty)

Firms are most likely to change the composition of their supply base in the swift response scenario. In the high severity, low timing uncertainty scenario, firms face higher sourcing costs because importing costs increase significantly. When a tariff has high severity, firms become alert and increasingly prone to act swiftly. At the same time, the low timing uncertainty of this scenario allows firms to estimate their TCO over time, giving them confidence in making long-term decisions. Through swift efforts to devise new sourcing strategies and develop new relationships, firms not only reduce sourcing costs quickly but also realize first-mover advantages, such as protecting access to scarce resources or securing access to limited alternative suppliers, thereby gaining ground relative to competitors.

As tariffs are introduced, firms incur higher sourcing costs if they continue sourcing from suppliers located in tariff-affected countries. Per RDT arguments, firms seek to mitigate the expected sourcing-cost increases by reducing their dependence on their current tariff-affected suppliers and terminating existing ties (Pfeffer and Salancik, 1978). At the same time, firms seek to secure access to limited resources, forming relationships with suppliers not affected by the tariff increase (Pfeffer, 1981; Ulrich and Barney, 1984), namely by creating new ties. Due to this creation of new ties and subsequent deletion of old ties, the size of a firm's supply base is likely to remain constant in the long term.

New suppliers in non-tariff affected countries, however, are likely to be less efficient than existing suppliers, particularly if they had not been in a firm's supply base before the tariff increase (assuming optimally-selected suppliers). If these alternative suppliers are located in more distant and potentially less-developed markets, more intermediaries may need to be involved in the sourcing process to ensure firms' access to the less developed suppliers. In this way, firms need to increase their coordination efforts to manage the longer distance and increased interconnectedness between suppliers, resulting in higher supply base complexity. Firms, however, will be willing to accept this higher complexity given that the new supply-base configuration results in a lower TCO than the TCO of the tariff-affected supply base. For example, when a tariff was imposed on solar panels imported from China to the U.S., importers of solar panels stopped sourcing from China and turned to Taiwan to develop manufacturing cells, thus securing the continuity of sales to the U.S. (Cardwell, 2014). As such, the manufacturing process started in China but was completed in Taiwan before the final product was shipped to the U.S. Importers of solar panels essentially accepted an additional link in their supply base to avoid increased sourcing costs. As the geographical dispersion and interconnectedness between suppliers in a firm's supply base increases, supply base complexity increases.

Alternatively, firms may consider working with domestic suppliers who were previously unattractive due to reasons such as higher labor costs. When domestic suppliers are available and cost-effective, firms may re-shore their sourcing operations and thus create new ties with domestic suppliers (Ellram et al., 2013). In many cases, however, alternative local suppliers are not readily available. For example, in the mineral commodity markets (e.g., arsenic, asbestos, natural graphite, or rare earth minerals), there are no available U.S. suppliers with satisfactory cost and quality (U.S. Geological Survey, 2017). Considering the limited supply capacity in many industries (Abraham et al., 2018), re-shoring becomes a complementary strategy to global sourcing that helps mitigate cost increases (Foerstl et al., 2016), including cost increases associated with tariffs. With additional suppliers, a firm's supply base complexity would further increase.

Proposition 1: Under the conditions of high severity and low timing uncertainty, firms act swiftly to mitigate the expected tariff increase. Moreover, firms form new ties with suppliers from non-tariff affected countries, including domestic suppliers, and delete ties with suppliers from tariff-affected countries. Therefore, supply base complexity increases.

4.2. “Securing alternatives” scenario (high severity and high timing uncertainty)

It is difficult for firms to select an effective adaptation response to a scenario in which they face severe tariff increases and high timing uncertainty. On the one hand, high timing uncertainty calls for caution, as the costs associated with changing the supply base structure may be high (Monteverde and Teece, 1982) and are only justified if a severe tariff increase occurs. Thus, firms likely take time to assess a tariff's impact and identify appropriate solutions. On the other hand, firms may be pressured to modify supply arrangements in the absence of specific details concerning the timing of a tariff increase. We argue that in times of high severity and high timing uncertainty, firms carefully weigh the benefits of swiftly switching suppliers to avoid increased sourcing costs and the risks of the tariff increase not being enacted as expected. Before acting, firms must be

confident enough that a tariff increase will occur as expected. Thus, we predict that firm responses will occur at a moderate speed.

In the securing alternatives scenario, firms have several choices for mitigating tariff increases and supply base complexity. First, firms can seek to protect themselves against a potentially severe tariff increase by establishing new ties with a variety of suppliers in regions not affected by the tariff in order to secure supplier capacity (Pfeffer and Salancik, 1978) or by replacing foreign suppliers with domestic sources (i.e., re-shoring) (Ellram et al., 2013; Foerstl et al., 2016; Gray et al., 2013). Alternatively, firms may decide to near-shore their suppliers – an increasingly prominent strategy of sourcing from countries with greater proximity to their own (Hartman et al., 2017). Near-shoring allows firms to offset severe tariff increases with lower transportation and logistics costs. While proximity does not prevent the tariff, firms may benefit overall due to lower logistics costs and more effective coordination. Considering the high uncertainty in this scenario, firms could avoid investing exclusively in one strategy (Klein et al., 1990) and seek to balance strategic options by offshoring, near-shoring, or re-shoring, which create additional sourcing options (McGrath, 1997) and increase the flexibility to adapt to highly uncertain environmental changes (Vitasek, 2017).

At the same time, because of the high uncertainty within this scenario, firms likely do not rush to terminate ties with existing suppliers in tariff-affected countries. Instead, firms may increase communication and negotiation with existing suppliers to evaluate ways to mitigate uncertain and severe tariff increases (Rindfleisch and Heide, 1997), such as by negotiating price decreases or production-location changes. For example, Apple and its key supplier, Foxconn, considered creating manufacturing capacity in the U.S. as a way to circumvent the high tariffs on Apple products imported from China to the U.S. (Webb, 2017). Considering the swift addition of new ties and the slow termination of old ties (i.e., moderate adaptation speed), firms aim to be flexible by having more sourcing options ("Securing Alternatives" scenario). Therefore, we argue that a combination of international and domestic suppliers is likely to be the preferred strategic option in a high-uncertainty, high-severity tariff environment. This option increases the number of suppliers and geographical complexity, providing the requisite variety to adapt to trade changes (Boisot and McKelvey, 2011) but at the same time, increasing governance costs and the complexity of the supply base.

Proposition 2: Under the conditions of high severity and high timing uncertainty, firms act at a moderate speed to mitigate the expected tariff increase, tie formation is higher than tie deletion, and supply base complexity increases.

4.3. "Wait-and-see" scenario (low severity and high timing uncertainty)

In this scenario, firms are likely to be hesitant to change their supply bases without knowing the actual consequences of an expected tariff increase. The impact of low tariff increases may not be considered significant enough to justify immediate changes to the supply base; thus, firms likely wait and thoroughly evaluate the effects of tariff changes on the market and the actions of competitor firms before making a decision (Anderson and van Wincoop, 2004; MacPhee and Rosenbaum, 1989). At the same time, the low severity of potential tariffs alleviates any time pressure for firms to create or eliminate existing relationships. Consequently, a firm's response to low severity, high timing-uncertain tariff increases is likely to be slow, if at all.

In this scenario, firms incur slightly higher sourcing costs if they continue sourcing from suppliers located in tariff-affected countries. Firms must evaluate whether a low tariff increase justifies the search, onboarding, and development costs for new suppliers. For example, in December 2016, the incoming Trump administration announced a potential 5% tariff increase on all U.S. imports. Firms, however, did not have precise information as to when this tariff increase would be implemented (Bryan, 2016). As a result, very few firms took substantive action; most waited until more specific information became available before making supplier changes.

Only when alternative sources in non-tariff affected countries are available would firms decide to switch (substitute) suppliers, given that the TCO of this sourcing option is lower. Considering switching costs, most firms would evaluate potential relationships with suppliers in non-tariff affected markets without necessarily substituting existing suppliers with them. In the low severity, high timing uncertainty scenario, we expect a minimal replacement of existing suppliers and a careful assessment of alternative sources. To reduce uncertainty, firms target a reliable and stable pattern of resource flows (Oliver, 1991). To do so, firms strengthen their relationships with existing suppliers and ask suppliers to communicate and coordinate with each other (Rindfleisch and Heide, 1997) to improve information exchange and joint-problem solving (Granovetter, 1985; Koka and Prescott, 2002; Uzzi, 1997). This practice results in high firm preparedness for the time when more information about the tariff increase becomes available, and it is particularly important when supplier switching is not a cost-effective option (Koka et al., 2006).

With a wait-and-see response, firms assess and weigh the cost of changing suppliers or shifting the supply base to domestic suppliers against the cost of absorbing the expense of increased tariffs. While this scenario allows for the potential of re-shoring or changing to suppliers in unaffected countries, the low tariff severity enacted in this scenario likely prevents the majority of firms from pursuing either option. In countries where domestic sourcing is generally more expensive than global sourcing, firms are more inclined to maintain the status quo and absorb the cost of a minimal tariff increase than to change to domestic sources as long as timing uncertainty remains at a high level. For these reasons, the assessment of alternative sourcing options is likely to occur without building ties to new suppliers. Finally, as no ties are formed or deleted, the interconnectedness between suppliers and geographical complexity is expected to remain constant. Hence, in the low-severity and high-uncertainty case, supply base complexity remains constant.

Proposition 3: Under the conditions of low severity and high timing uncertainty, firms act slowly to mitigate the expected tariff increase, tie formation remains the same as tie deletion, and supply base complexity remains constant.

4.4. “Deliberate response” scenario (low severity and low timing uncertainty)

In this final scenario, firms are confident they will incur small sourcing-cost increases for some time if they do not change their supply base. Nevertheless, because of the low severity of the expected tariff increase, firms will thoroughly assess any change and thus respond at moderate speed. Firms take this approach to evaluate any consequences of the tariff increase on their supply base, their competitors’ actions, and the cost of potential alternative supply sources before making any changes to their sourcing strategies (Smart and Vertinsky, 1984). In this scenario, any change would be deliberate.

Firms are likely to act carefully, substituting old ties in tariff-affected countries with new ones in unaffected countries in a balanced manner. Assuming the supply base existing before the tariff increase was optimally developed, firms are unlikely to develop new relationships with suppliers in markets not affected by the tariff increase: if supplier-switching costs outweigh the costs associated with new tariffs, firms will maintain the status quo, or at least wait until current contracts are due to expire before exploring alternatives. Firms switch to more expensive (previously not preferred) suppliers only if the transaction (safeguarding and monitoring) and logistics costs are lower than those of the previous sourcing strategy (Ellram et al., 2008; Rindfleisch and Heide, 1997). This case would only be possible if the alternative suppliers are domestic or geographically close to the domestic market, resulting in reduced geographical distances and dispersion and, thus, lower supply base complexity. Therefore, we propose the following:

Proposition 4: Under the conditions of low severity and low timing uncertainty, firms act at a moderate speed to mitigate the expected tariff increase, tie formation and tie deletion remain stable, and supply base complexity decreases.

5. Moderating factors

Although there are many potential factors that might moderate the effect of tariff introductions or increases on supply bases, we suggest that three key factors moderate the relationships between tariff attributes and supply base complexity: (a) geographical scope of tariffs (i.e., the countries affected by tariffs); (b) relative purchasing spend (i.e., the proportion of spend on the product/service subject to the tariff in relation to total spend); and (c) supply risk (i.e., the factors that increase the probability of a firm not being able to receive materials/products, such as availability, number of suppliers, competitive demand, or substitution possibility (Kraljic, 1983)). We selected these factors because they are generalizable to global supply bases and they have previously been identified in the literature as critical factors in supplier selection (Elliott-Shircore and Steele, 1985; Novak and Eppinger, 2001). Moreover, the purchasing portfolio models (Kraljic, 1983; Olsen and Ellram, 1997) consider these factors to be key criteria for categorizing and managing suppliers.

5.1. Geographical scope of tariff increase

The geographical scope dimension suggests that sourcing from suppliers located in countries subjected to tariffs results in higher sourcing costs than sourcing from suppliers in FTA countries. Thus, we argue that geographical scope influences a firm's sourcing strategy and, consequently, its supply base. Before firms decide to switch suppliers, they are likely to conduct a TCO evaluation of sourcing options from alternative markets, including domestic markets.

If a tariff increase is targeted at only one or a few countries, firms are likely able to identify alternative suppliers in tariff-unaffected countries. In contrast, when many countries are affected, firms are less likely to have the ability to switch to other international suppliers. Domestic suppliers, which previously may have been less attractive due to higher cost, may become viable sourcing options for avoiding a tariff increase. When domestic resources are available and cost-effective, firms may re-shore their sourcing operations and give up more complex sourcing relationships (Ellram et al., 2013). Consequently, a tariff's geographical scope augments the impact of a tariff's severity or timing uncertainty. Tariffs with a wide geographical scope limit a firm's international sourcing options and constrain the level of complexity that can be added to a firm's supply base. This result may drive firms towards the domestic supply base and may thus reduce complexity.

5.2. Relative purchasing spend

As supply managers are incentivized to improve firm profitability, they generally devote much of their focus and managerial resources to high-spend items with greater bottom-line impacts (Riordan and Williamson, 1985). Therefore, when tariffs are applied to items with high relative spend, decision-makers are more likely to react swiftly to adjust the supply base to minimize the impact of tariffs. Moreover, an intrinsic cost is associated with any supplier change (Collins and Hitt, 2006; Zsidisin, 2003). The larger the relative spend a firm commits to an item, the greater the associated costs with that item become. However, these costs may be offset by the potential for significant savings/cost avoidance in the sourcing process. Essentially, if the savings generated by deselecting suppliers and adding new suppliers outweigh the associated switching costs, firms are more likely to turn over suppliers and change the structure of their supply bases. Therefore, it is more likely that firms act swiftly, and on a large scale, when the potential for savings is high.

Relative spend also moderates the relationship between tariff increases and supply base complexity. Firms are highly vulnerable to price changes in high-spend suppliers and will be more willing to shrink, expand, or replace existing suppliers with the same number of new suppliers to avoid increased costs. A break-even point exists between the costs avoided and the costs incurred by altering the supply base structure. The higher the relative spend, the more likely it is that avoided costs outweigh incurred costs, making supply base adaptation under the conditions of new tariffs more likely when relative spend is high.

5.3. Supply risk

We contend that even when the buying firm is willing to adjust its supply base to account for an expected tariff increase, the actual adjustment depends on the level of supply risk. Supply risk encompasses different factors, such as the number of potential suppliers, supplier reliability, product complexity, munificence, product substitution possibility, and industry- and product-level effects (Christopher et al., 2011; Manuj and Mentzer, 2008; Zsidisin, 2003). We also note that the relative power of the buying firm over its suppliers could be included as an element of supply risk. According to power dependence theory (Emerson, 1962) and RDT (Pfeffer and Salancik, 1978), limited options in the supply side (i.e., high supply risk for a buying firm) give more power to suppliers. In contrast, abundant options in the supply side (i.e., low supply risk for the buying firm) provide power to buyers. Therefore, a powerful buyer with many dependent suppliers not only has a lower supply risk in the case of severe tariff increases but also offers increased freedom to change the design of its supply base in this situation. Low supply risk products are highly substitutable across the globe as their products are commodified (Olsen and Ellram, 1997). Thus, in the case of low supply risk, supply bases are more adaptable, and complexity can change significantly soon after a tariff introduction when firms are quickly adjusting both the number of suppliers in and the geographical scope of their supply bases.

In contrast to sourcing decisions regarding low-supply-risk items, sourcing decisions of high-supply-risk items are based primarily on ensuring a constant flow of supply (Riordan and Williamson, 1985, p. 57). High levels of supply risk are likely to alter some of the firm strategies discussed in Section 4, particularly strategies related to high levels of existing supplier replacement with new suppliers. Suppliers of high-supply-risk items are more difficult to replace than suppliers of low-supply-risk items due to the lack of alternative sources (Olsen and Ellram, 1997); this situation potentially leads to a high level of firm dependence on suppliers and results in a power imbalance in the buyer-supplier relationship (Kogut and Zander, 1992; Monteverde and Teece, 1982). Hence, when firms have fewer sourcing options, they are limited in their potential response to the implementation of new tariffs. For instance, China controls approximately 70% of the global rare earth metal production (Yang, 2019). If tariffs were imposed on Chinese companies, U.S. firms would be unable to immediately shift to suppliers in other countries and, subsequently, be forced to bear the additional cost imposed by the tariffs. Even if items might be procured from other sources, it can be difficult to replace both relational capital and the tacit knowledge of how best to work with the buying firm that is built up over time (Cousins et al., 2006; Craighead et al., 2007).

If goods and services are highly substitutable, firms will be more reactive to tariffs and more likely to shift their supply bases; in fact, firms may even consider insourcing or re-shoring. However, insourcing and re-shoring become much less tenable when supply risk is high. The digital random access memory (DRAM) cluster in South Korea, for example, supplies over 70% of the global DRAM market (Sheffi, 2012). Since sources for these items are not highly substitutable and are very concentrated, firms cannot delete ties to the providers of important resources for what amounts to minimal financial gain. Only when available sources in non-tariff affected countries are easily available would firms decide to switch suppliers and employ near-shoring or re-shoring strategies. In this case, the changes in supply base complexity are limited. Firms are less likely to deselect the suppliers for items that carry higher levels of supply risk. Conversely, low supply-risk suppliers are easily substituted, which leads to more adaptable supply bases.

6. Implications, limitations, and future research

6.1. Research implications

In this paper, we consider the growing protectionist trends that manifest into increased trade-restrictive measures being adopted globally. We focus on tariffs, a specific trade-restrictive measure, and propose that expected tariffs induce firms to act and adapt their supply bases to mitigate potentially increasing sourcing

costs. This adaptation of supply bases also influences the complexity of the supply bases, potentially increasing the costs to manage or govern the supply base. We also propose that these relationships are moderated by a tariff's geographic scope, relative purchasing spend, and supply risk.

Given these proposals, several research and practical implications derive from this paper. First, this paper is among the few studies in the SCM literature to focus on tariff increases and introductions and their effects on supply base complexity. In this paper, we emphasize the importance of examining the effects of environmental factors, specifically policy and economic changes, on global supply chains. Specifically, we identify severity, timing uncertainty, and geographical scope as key attributes of expected tariff increase or introductions. By doing so, we provide a comprehensive description of a tariff introduction or increase.

Second, we emphasize that tariffs are an important factor affecting supply management decisions. At the tactical level, tariffs increase firms' sourcing costs and overall supply governance costs (e.g., all costs related to supplier identification, switching, development, and management), while at the strategic level, they affect the structure and complexity of firms' supply bases. Specifically, our framework predicts how and why severity and timing uncertainty of expected tariff increases influence firm adaptation speed and tie formation/deletion, affecting supply base complexity. We argue that in specific tariff environments, higher complexity may be necessary for firms to respond to severe or uncertain tariff environments. While we consider severity and timing uncertainty essential determinants of firm decisions to change the supply base, we propose that geographical scope is a moderator that influences how the supply base is eventually adjusted.

Third, we suggest geographical scope, relative spend, and supply risk are factors that may moderate the relationships proposed in our framework. It is important to identify these contingencies since they can restrict the repertoire of a firm's possible actions and, thus, can hinder a firm from mitigating increased sourcing costs or supply base complexity. By acknowledging such contingencies, SCM researchers can improve their predictions regarding when and how the relationships proposed will be in effect (Edwards and Berry, 2010). SCM researchers can utilize these attributes to investigate the effects of tariffs on outcomes of interest, such as supply chain design decisions, outsourcing or offshoring decisions, as well as contracting decisions, in future research.

6.2. Managerial implications

This research has important practical implications. First, we offer three tariff attributes that sourcing managers can use to evaluate tariff changes and their potential effects on sourcing costs. Through our discussion regarding the effects of expected tariff increases on adaptation speed and supply base complexity, sourcing managers can also gain insights about how to adapt their supply bases to remedy tariff-related potential cost increases. Moreover, our framework suggests that supply managers facing actual or potential tariff increases must conduct a cost-benefit analysis, weighing the adaptability of a complex supply base against the lower governance costs of a simpler supply base. The tariff situation in which a firm finds itself weighs heavily on the calculus of this decision. We argue that increased awareness of the effects of tariff increases helps to identify more effective adaptation strategies. In this study, we provide firms a framework to diagnose tariffs by their dominant tariff characteristics (i.e., severity and timing uncertainty) and employ a prescriptive solution for four situations. For example, our framework suggests that when sourcing managers face a low-uncertainty/high-severity tariff environment, they search for alternative suppliers, domestically and globally, to mitigate the increased sourcing costs, even if this search is likely to increase supply base complexity, *ceteris paribus*. At the same time, our framework shows managers they need to be cognizant of the potential dangers of increased complexity, such as higher risk or potential for severe supply disruptions (Bode and Wagner, 2015; Choi and Krause, 2006; Craighead et al., 2007).

In a similar vein, managers responsible for exports can gain insights regarding the potential decisions made by their customers located in countries that impose tariff increases. Assuming firm decisions are driven by a TCO-based schema, we argue that, *ceteris paribus*, firms are likely to stop sourcing from tariff-affected suppliers if such decisions mitigate potential cost increases. We also provide insights about how certain supply characteristics about a firm (e.g., relative spend), the sourced product (e.g., supply availability), or the tariff itself (e.g., geographical scope) are likely to moderate firm decisions. Hence, exporting managers can try to mitigate tariff-related reactions by finding alternative customers, investing in relational mechanisms, or redesigning their products to utilize alternative materials.

Finally, our study is relevant to policy-makers responsible for tariff negotiation and implementation. While tariffs are often intended as trade barriers, there may be unintended consequences to these barriers, such as increased supply base complexity, for domestic firms with global sources. Firms with higher supply base complexity can incur high coordination and transaction costs (Choi and Krause, 2006; Handley and Benton, 2013). Moreover, they can experience more frequent (Bode and Wagner, 2015) and more severe (Craighead et al., 2007) supply chain disruptions. Ultimately, these concerns can jeopardize firm success and survival. Therefore, we encourage policy-makers to weigh the potential benefits of tariff implementation with their potential, often indirect, costs for local firms that source globally.

6.3. Limitations and future research

Conceptual framework building is an important step in the development of any field of research (Bordage, 2009). Nevertheless, many conceptual frameworks, including this one, are limited in that they tend to take a high-level perspective and cannot address every potentially important factor in understanding a given phenomenon. We thus propose four categories of additional factors that may influence the relationship between expected tariff increases and supply base changes (see Table 3). The first category captures factors that are relevant to a product's characteristics. The second category describes factors pertaining to a firm's role in the supply chain, its competencies, and its purchasing strategy. The third category describes moderators that originate from a firm's supply chain. The final category explains how factors outside a firm's immediate supply chain may influence the effect of tariff increases on a firm's response. Future research could empirically examine the moderating effects of these four factors.

Table 3. Factors influencing sourcing decisions in tariff-affected environments.

Level	**Additional Factors (examples)**
Product	Demand elasticity
	Price elasticity
	Product complexity
	Complexity of specifications
Firm	Purchase spend
	Importance of good for firm's business
	Buying firm's relative power over supplier (size, reputation)
	Internal competency to respond and develop alternative plans
Supply chain	Availability of suppliers
	Uniqueness of supplier's product
	Number of suitable suppliers
	Geographical concentration of suitable suppliers
Industry & Environment	Political climate (e.g., attitude towards global sourcing)
	Political stability in suitable supply markets
	Oil prices
	Technological innovation (e.g., 3D-printing, automation)

International trade relations among the largest economies around the world are currently facing levels of uncertainty not experienced since the Second World War. Newly-introduced, higher, or potential new tariffs on steel, aluminum, automobiles, and agricultural products are examples of this uncertainty. Many of the long-held assumptions of global free-trade trade have been called into question. The large, global supply networks that many firms employ have to adapt to changes in the rules of international trade that might emerge from this uncertainty. Thus, the effects of tariffs and trade policy on supply network structure are relevant, interesting topics that call for more research and analysis. Studies focusing on the impact of more granular factors on the relationship between changing trade policy and supply network design should be conducted. These topics might include the relative power of firms relative to their suppliers, the number of markets firms are operating in, or the cultural distance between buyers and suppliers. Our research also offers opportunities for examining decision-making processes at the individual level, such as managerial perceptions of and responses to news announcements of potential tariffs. Empirically investigating how firms interpret and act upon tariff uncertainty and understanding the thresholds for triggering responses from supply management practitioners are all worthy areas for further research, which have significant implications for policy and practice. Finally, our research is a starting point to future research that demonstrates to policy-makers that tariff introductions or increases are not merely a barrier to global trade but can also affect the design of supply bases with implications on firms and their customers.

Disclaimer

The list of the names is in alphabetical order. All authors contributed equally.

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[2]While tariffs may also be decreased or eliminated, we contend that firm responses to reduced tariffs likely differ from responses to increased tariffs, as decision-makers perceive potential gains and losses differently and respond to them in different ways (Kahneman and Tversky, 1979). Hence, in this paper, we consider tariff increases or introductions.

[3]Our analysis focuses on tariffs that are levied on an *ad valorem basis* because the basis of analysis is the product's value. The tariffs levied on a *specific basis* do not have a consistent basis for analysis (e.g., pound/kilogram, gallon, case).