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Operational safety: The hidden cost of supply-demand mismatch in fashion and textiles related manufacturers

Abstract

Inventory management is a focus for operation management scholars and operations managers. Previous literature mainly investigates the relations between firm's inventory and financial performance. However, the link between firm's inventory and non-financial performance (e.g., social outcome) is missing. This study takes a fresh perspective to examine the impacts of supply-demand mismatch on firm's safety performance. Based on a sample set from fashion and textiles related manufacturers, the analyses suggest that supply-demand mismatch (measured by inventory volatility) can lead to a higher likelihood of safety incidents. The impact is more salient when the firms are operating in complex (labour intensive) and tightly coupled (high production capacity utilization) environments. This study provides significant contributions to the inventory management literature, occupational health and safety management literature and operational managers.

Keywords: inventory management; occupational health and safety; empirical study; fashion and textiles

Introduction

Inventory management receives much attention from operations managers and operations management scholars. The previous studies in this area raise controversial arguments on the inventory performance. Some evidences indicate that low inventories level may improve profitability, such as earning per share (Huson and Nanda, 1995), stock return (Chen et al., 2007; Modi and Mishra, 2011), labour productivity (Lieberman and Demeester, 1999), return-on-assets (ROA) (Fullerton et al. 2003; Modi and Mishra, 2011), and gross margin (Gaur et al., 2005). While others find a low inventory level causes no improvement on perceived operational performances by managers (Vastag and Whybark, 2005), ROA (Balakrishnan et al. 1996; Cannon 2008) and exceptional stock price performance (Chen et al., 2007). Recent research started to focus on inventory dynamics and investigate the impacts of inventory deviating from the normal level (supply-demand mismatch). Hendricks and Singhal (2003; 2009) find that firm value is depreciated due to insufficient and exceed inventory. Abnormal inventory change also negatively associates with stock return (Steinker and Hoberg, 2013). Hoberg et al., (2016) find that firm may intentionally reduce inventory in the fourth quarter of a fiscal year for window dressing the earnings and cash flows in the annual report.

The above literature provides important insights of the relations between inventory management and financial performance. However, the impacts of inventory management on non-financial performances are overlooked, making the understanding of inventory and firm's holistic performance outcome unclear. Thus, this study aims to study inventory management from a fresh perspective by examining the role of supply-demand mismatch on the safety of operational workers.

We sampled the manufacturing firms in the fashion and textiles industry to conduct our research. Because fashion and textiles industry is a sector that demands fluctuate with seasons. It is particularly difficult to manage the inventory in seasonal sectors because the demands are difficult to predict (Hendricks and Singhal, 2009). On the other hand, corporate social responsibility (CSR) greatly associates with a fashion brand's image and consumer's buying intention (Werther & Chandler, 2005). The occupational health and safety (OHS) incidents exposed in recent years have raised public concern over CSR problems in the global fashion supply chain. Media claimed that fashion firms might be putting workers' lives at risk, especially the fast fashion firms (Dudley et al., 2013). The safety incidents have negatively affected both workers and firms. For example, a fire at an Inditex factory in Bangladesh on January 26, 2013, killed at least seven people (Dudley et al., 2013). Later, The Rana Plaza collapse in Bangladesh killed more than 1,100 people, mostly apparel factory workers (Donaldson, 2015), and brought public condemnation upon the fashion brands such as Benetton, JC Penney, and Wal-Mart (Forbes, 2014). Jacobs and Singhal (2017) capture a significant decline in stock prices of the retailers who were sourcing from Bangladesh on the day of the collapse. Such examples demonstrate the urgency and inevitability of scholars' investigation on OHS in the fashion and textiles related industries. Thus, building the link between inventory and safety is critical for fashion and textiles manufacturers. This study can also provide significant implication to other manufacturing industries, especially the ones with unsteady inventory demands.

This study aims to answer two research questions: 1) Does supply-demand mismatch affects fashion and textiles manufacturers' safety performance? 2) In what circumstances, this effect is more salient? We draw on Normal Accident Theory (NAT) to develop our theoretical framework to answer these two questions. We argue that supply-demand mismatch (indicated by high inventory volatility) could generate productivity pressure to the firm, leading to more safety incidents (Brown et al., 2000). In addition, the fashion and textiles firms operating with tightly coupled (e.g., fast fashion indicated by short inventory days) and highly complex (indicated by high labor intensity) operations could suffer more from the supply-demand mismatch. We test our hypotheses using a panel data set of 1850 firm-year observation from 203 United States listed manufacturers in fashion and textiles related sectors. This study can contribute to inventory management literature and occupational health and safety management literature by investigating the relations between inventory management and operational safety. In addition, we also explore the potential moderating role of operating environments between inventory dynamics and safety.

Theoretical background and hypotheses development

In the founding NAT literature, Perrow (1984) analyzed the Three Mile Island nuclear disaster and argued that accidents are inevitable, regardless of control mechanisms. The key premise of NAT is that safety failures can easily occur in complex and tightly coupled contexts (Perrow 1984; Rijpima, 1997). It is because workers have insufficient time and understanding to react correctly in dangerous situations, thereby causing accidents. In addition, scholars further develop the coupling component and propose that the trade-off between productivity and workplace safety may exist (e.g., Brenner et al., 2004; Ford & Tetrick, 2008; Godard, 2004; Landsbergis et al., 1999; Parker 2003; Pate-Cornell & Murphy, 1996; Zohar, 2002; Zohar & Luria, 2005).

Recent studies develop NAT by synthesizing with high-reliability organization theory and suggests that mindfulness of safety is key to preventing accidents (Shrivastava et al., 2009; Lo et al., 2014; Pagell et al., 2014; 2015; Weick et al., 2008). Worker's mindfulness often drifts from reliable behavior to unsafe behavior, leading to safety incidents (Shrivastava et al., 2009; Snook, 2000). The drift is more likely to occur when workers are under productivity pressure (Brown et al., 2000; Lo et al., 2014). The productivity pressure of workers is the perception that the organization encourages them to meet production quotas and important deadlines (Brown et al., 2000). Under such circumstance, workers have limited time to accomplish tasks so that they may take safety shortcuts (an example of drift) to meet operational objectives (Pagell et al., 2014). Such phenomena can be observed in experiment (Ray et al., 1993) and many industrial settings such as spaceship launch (Vaughan, 1996) and coal mining (Brown et al., 2001).

Supply-demand mismatch and safety incidents

Supply-demand mismatch reflects the poor demand prediction of the firms (Lo et al., 2014). It can come from unexpected sales opportunities which may signal the shareholder of unexpected earnings (Steinker and Hoberg, 2013). However, the mismatch could cause the firm's inventory temporary deviate from a normal level. Therefore, it creates a pressure for firms to recover their inventory level back to the normal level by urgent production tasks, more frequent set up, etc. For example, if stock-out occur, the firm needs extra production effort to meet the unexpected demand. The production pressure for inventory recovery can transfer from the firm to the production workers (Nickell and Nicolitas, 1999). The pressure can cause role overload of workers and lead to the drift (Brown, 1996, Brown et al., 2000). Workers may abandon the mindfulness and take shortcuts to catch up with production quota, leading to more safety incidents (Brown and Starkey, 2000; Brown, 1996; De Koster et al., 2011). In addition, the overstocking could occur when the current demand is insufficient. Wiengarten et al., (2017) find that a high level of overstocks may lead to more safety incidents. It may because that the stocks increase opaque and complexity of the firm and thus generate safety risks (Rijima, 1997). In addition, if the overstocking is caused by holding the wrong inventory, the firm have the pressure to not only dump the wrong inventory, but also reproduce the right inventory. The sales and production pressures may also transfer to the workers (Nickell and Nicolitas, 1999), causing the drift of mindfulness, and leading to more safety incidents.

H1. Supply-demand mismatch associates with a higher likelihood of having safety incidents of fashion and textiles manufacturers.

Moderating effects of operational coupling and complexity

Besides productivity pressures, NAT suggests that operational complexity and coupling are two factors leading to safety incidents. This premise is operationalized and supported in the studies of petroleum (Wolf, 2001) and manufacturing industries (Lo et al., 2014). However, the indirect effects of operational complexity and coupling on safety are not explored in the literature. This study takes a step further to investigate their moderating effects on the productivity-safety trade-off relation. We argue that the effects of supply-demand mismatch on safety incidents may be more salient when the firms' operations are highly complex and tightly coupled.

With productivity pressure, the works in highly complex operations have higher exposure to unsafe circumstances. A complex operation could go beyond manager's ability to understand, thus, it is difficult to thoroughly plan, anticipate and protect from safety risk (Perrow, 1984). The design errors are difficult to be detected and fixed by managers and workers because of the incomplete planning and testing before production (Leveson et al., 2009). For example, the production process of clothing manufacturers is more complex than textiles mills because garment sewing is difficult to be automated (Swink and Jacobs, 2012). The labor-intensive nature also makes clothing manufacturers harder to anticipate the safety risks in the operations (Lo et al., 2014). The sewing workers are more likely under pressure caused by supply-demand mismatch, comparing to the automated production process where machinery are free from production pressure. Thus, a complex operational environment additionally increases the risk of workers engaging into a dangerous circumstance. Therefore, we hypothesize

H2. More complex operations strengthen the positive relation between supply-demand mismatch and the likelihood of having safety incidents of fashion and textile manufacturers.

In addition, when the operation elements are tightly coupled, the operational slack between elements is minimal (Perrow, 1984; Pagell et al., 2014). Slack can create buffers for stochastic demand, stochastic processes, and unexpected failure in a firm's operations, preventing workers from role overload (Lo et al., 2014; Wiengarten et al., 2017). Slack can also keep supply chains running by compensating any disruption. When demand spike or supply chain glitch occurs, the slack in production capacity may fulfill the supply gap with ease. If the current production capacity is fully utilized, the firm may require workers to work overtime. Therefore, tightly coupled operations, with minimal slack, could further limit workers' time to accomplish production goal when they are already with production pressure to meet unexpected production tasks. The additional production pressure may increase the chance of drift, leading to safety incidents. Therefore, we hypothesize

H3. Tighter coupled operations strengthen the positive relation between supply-demand mismatch and the likelihood of having safety incidents of fashion and textile manufacturers.

Figure 1 illustrates our theoretical framework.

[Figure 1 about here]

Methodology

Samples

This study samples U.S.-listed fashion and textile firms. Following Fan & Lo (2012), fashion and textile industry firms were identified according to their four-digit Standard Industry Classification (SIC) codes. We reviewed all the four-digit SIC codes and selected fashion and textiles related industries. The dependent variable of this study was the likelihood of a safety incident. OSHA regulation violation has been used as a standard measurement of safety incidents and safety performance (e.g., Pagell and Gobeli, 2008; Lo et al., 2014). Violation data is locatable by firm name in the OSHA violation database (OSHA, 2015). The database contains the inspected violation record by OSHA. The information includes the violating firm's name, industry, location, the violation date and types. The types of violation include serious violation, willful violation, repeat violation and other violation. According to OSHA's (2015) definition, a serious violation is that the exist of workplace hazard that would result in employee's death or serious physical harm; a willful violation is that employer purposefully disregards to comply with a legal requirement; a repeat violation would be cited by OSHA if the firm has been cited for the same violation previously; a other violation is the violation which is not serious in nature. A violation can span different types, for example, a violation can be serious and repeat at the same time. We followed the previous literature and treated all types as equal (Pagell and Gobeli, 2009). We identified 655 violation records from 1990 to 2013 for the fashion and textiles manufacturing sectors.

The data collected from OSHA are for the dependent variable. We then collected financial data for the firms in these industries from the Compustat database for independent variables. Because we lagged the independent variable for one-year to the dependent variable (safety violation, from 1990 to 2013), the period of collected financial data is from 1989 to 2012. Finally, we consolidated the financial data with the OSHA data to construct a panel dataset. 1850 firm-year observations with 203 firms and 578 violations were analyzed. These 578 violations were conducted by 75 firms, thus, 128 control firms were free from any violation. We presented the distribution of violation by industry (grouped to three-digit SIC for simplicity) in Figure 2. The violations spanned several fashion and textile manufacturing sectors, including cotton, manmade fiber, and silk fabric mills (SICs 221 and 222); carpet and rug manufacturers (SIC 227); paper mills[1] (SICs 262 and 267); synthetic fiber manufacturers (SIC 282);

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[1] Paper is a kind of non-woven fabric. The end product includes apparel components, surgical drape, filters of protective clothing and wipes. Thus the paper industry is a textile industry.

textile machinery firms (SIC 355); doll and toy makers (SIC 394); and miscellaneous fashion and textile producers (SIC 308 and SIC 274). Retailers were not included in our sample. Figure 3 presented the distribution of the violations by year. Generally, the violation number was reduced in the 2000s compared to 1990s, which indicating the safety had raised the attention of operational managers in the recent years.

[Figure 2 about here]

[Figure 3 about here]

Measures

Followed previous studies of corporate malfeasance, we focus on the first violations conducted by the firms (e.g., Harris and Bromiley, 2007; Yiu et al., 2014). Thus, the multiple violations in a year only appear once in each firm-year observation. Because firms may act differently when they have a recent violation experience (Harris and Bromiley, 2007). The firms may learn from the most recent violation experience and avoid repeat violation, while the learning effect is most prominent within one year (Yiu et al., 2014). The potential learning effects from the recent experience may affect our results. Therefore, we used whether a firm violated an OSHA regulation in a focal year *t* ("1" = yes and "0" = no) as the dependent variable (*Safety violations*). Given the binary fashion of measuring violation, we performed probit regression to examine the likelihood of firms having safety violations from 1990 to 2013. We also conducted robustness check to use logistic regression for analysis. The results are largely similar. And we also conducted additional tests by replacing the dependent variable by number of violations. The details were provided in the robustness check section.

The *supply-demand mismatch* is the independent variable for testing our baseline hypothesis (H1). Because supply-demand mismatch could be either supply shortage or excess inventory, early stage studies measure the two circumstances separately. Hendricks and Singhal (2003, 2005) use supply chain glitch and delay announcements to measure supply shortage. They then use excess inventory announcements to measure excess supply (Hendricks and Singhal, 2009). Recently, scholars use a unified indicator, inventory volatility, to measure the two circumstances of supply-demand mismatch (Steinker and Hoberg, 2013; Lo et al., 2014). Because unexpected high and low demand affect the fluctuations of quarterly inventory (Steinker and Hoberg, 2013), and it is indicating the poor forecasting to demand of firm which leading to the mismatch (Lo et al., 2014). Thus, we use yearly inventory volatility to measure yearly *supply-demand mismatch*. It was calculated by the standard deviation of the quarterly inventory divided by the mean of quarterly inventory in a year (Steinker and Hoberg, 2013; Lo et al., 2014).

H2 examined the moderating effect of *operational complexity* to the relation between *supply-demand mismatch* and *safety violation*. We followed previous studies to use labor intensity to measure operational complexity because the production processes are often complicated and not automated (Swink and Jacobs, 2012; Lo et al., 2014). Labour intensity was calculated by the number of employees divided by total assets (million dollars) (Dewenter and Malatesta, 2001).

H3 examined the moderating effect of *operational coupling* to the relationship between *supply-demand mismatch* and *safety violation*. Production capacity is an essential buffer between production and demand, which could reduce the operational coupling (Kovach et al., 2015). Tightly coupled operations have significant fewer production capacity remained for buffer than loosely coupled operations (Modi and Mishra, 2011). Thus, we used sales to property, plant and equipment ratio (SOP) to measure *operational coupling* high SOP indicates a low level of operational slack (Modi and Mishra, 2011).

This study used control variables to increase the robustness of the analysis. First, we controlled *firm performance* according to return on assets (ROA) because the profitable firm may have more resources to avoid safety violations. Second, we controlled *firm size* according to the number of employees because larger firms may have a higher chance to be inspected. Third, we controlled a firm's *risk propensity* according to research and development (R&D) intensity because risk-seeking managers more likely involve illegality (Tsai, 2001; Mishina et al., 2010). Fourth, we controlled a firm's *financial slack resources* according to quick ratio because firms with sufficient liquidity have less financial pressure. Financial pressure may transfer to productivity pressure to the workers, leading to the worker's unsafe behavior (Love and Nohria, 2005; Brown et al., 2000). Quick ratio was calculated by current assets (excluding inventory) divided by current debt. Fifth, we controlled *firm age* because the older firm may have more experience to avoid violations. Sixth, we controlled *geographical diversification* of firm because resources may be more difficult to deploy if the firm is operating in more geographical regions. *Geographical diversification* is the Herfindahl-Hirschman index (HHI) calculated by the assets deployed in different geographical segments of a firm. In addition, we controlled for *inventory days*. Because the firm with longer inventory days may have more inventory to buffer for demand spikes. Finally, we included the dummy variables of *year, industry* and *state* of the firm located to control for the yearly, industrial and geographical fix effects such as the seasonality in industries and regions. We performed natural logarithm transformation to *supply-demand mismatch* (inventory volatility), *operational coupling* (SOP), *firm size* (number of employees) and *firm age* to correct for the skewed distributions.

Results

Table 1 contains the descriptive statistics and correlations of the variables. We examined the variance inflation factors (VIFs) for our independent variables, the average VIF is 1.711 and the largest VIF is 4.583 (*geographical diversification)*. The largest VIF is smaller than the tenfold threshold and our sample size is large, thus the muti-collinearity is not a serious concern in our analysis (Cohen et al., 2013). Table 2 shows the probit regression results. We conducted omnibus tests to examine the goodness-of-fit of each probit regression model. Model 1 includes all the control variables. The omnibus test ($Chi^2 = 371.917$, $p < .01$) indicates that the control variables significantly improve the fit of Model 1 compared to the intercept-only model.

[Table 1 about here]

[Table 2 about here]

Model 2 tests H1 by including all the control variables and the main effects of *supply-demand mismatch*. The coefficient of *supply-demand mismatch* is significantly positive (0.083, $p < .05$). A one-unit increase in inventory volatility (approximately equals to one standard deviation) increases 8.3% chance of having safety violations in one year. Adding the variable significantly improve the model fit compared to Model 1(incremental $Chi^2 = 4.825$, $p < .05$). Thus, H1 is supported.

Model 3 tests H2 and H3. The coefficient of interaction term *supply-demand mismatch x operational complexity* is significantly positive (0.838, $p < .01$). Moving from the mean to one standard deviation above the mean of labor intensity, the effects of *supply-demand mismatch* on the *safety violations* increase by 17.85% (0.213*0.838). In addition, the coefficient of interaction term *supply-demand mismatch x operational coupling* is significantly positive (0.207, $p < .05$). Moving from the mean to one standard deviation above the mean of naturally logged SOP, the effects of *supply-demand mismatch* on the *safety violations* increase by 12.81% (0.619*0.207). The model fit of Model 3 is significantly improved compared to Model 2 (incremental Chi^2 = 17.276, $p < .01$). Thus, H3 is supported. Figure 4 and 5 illustrate the moderating effects of *operational complexity* and *operational coupling* on the relation between *supply-demand mismatch* and *safety violation.* The high and low levels of moderators are based on one standard deviation above or below the mean. The X-axis is the level of supply-demand mismatch range from the minimum to maximum value. The Y-axis is the probability of a safety violation. The figures show that the slopes are more positive when the moderators are at high levels than at low levels.

[Figure 4 and 5 about here]

Robustness check

Despite inventory volatility was widely used as an indicator of supply-demand mismatch (e.g., Steinker and Hoberg, 2013; Lo et al., 2014). However, the standard deviation nature of the measure (always a positive number) cannot clearly indicate the directions of supply-demand mismatch. In recent studies, abnormal inventory change was used to indicate the two circumstances of supply-demand mismatch (Chen et al., 2007; Kesavan and Mani, 2013). Abnormal inventory was calculated by the difference between firm inventory and industry average inventory level then scaled by the standard deviation of industry inventory (Chen et al., 2007; Kesavan and Mani, 2013). A positive number of abnormal inventory change indicates the excess supply, while a negative number indicates the excess demand. Thus, we used the yearly abnormal inventory change as an alternative measure of supply-demand mismatch to examine the robustness of the results examining H1 (Chen et al., 2007; Kesavan and Mani, 2013). Table 3 presents the results. The squared term of abnormal inventory change is significantly positive (coefficient = 0.2, $p < .05$), which indicating a parabolic relation between abnormal inventory change and the likelihood of safety incidents. Figure 6 illustrates the parabolic relation considering other control variables are constants. The figure shows that the likelihood of safety incidents increases with the abnormal inventory change deviates to the negative and positive tails, which supports H1. When the abnormal inventory change is about one standard deviation above zero, the firm has the lowest likelihood of having safety incidents. The optimal level of abnormal inventory change is not zero may because a certain level of safety stock is effective to buffer for the additional production pressures caused by demand spike. The results are consistent with the recent findings of the buffering value of inventory on safety (Wiengarten et al., 2017).

In addition, the dependent variable of our primary models is a binary measure of safety incidents. Thus, the effects of multiple violations in one year are not counted in. The firms may learn from the recent violation experience and reduce the subsequent violation, the learning effect is most prominent for the experience within one year (Yiu et al., 2014). We conducted an additional test by replacing the dependent variable by an ordinal measure, number of violations at year *t*. The test examines whether the learning effect could falsify our results in Table 2. Table 4 presents the robustness check results. In the Model 1, the coefficient of supply-demand mismatch remains significantly positive (coefficient = 0.017, p < .05), which does not falsify H1. However, the marginal effect is smaller than the coefficient of supply-demand mismatch in the Model 2 of Table 2 (difference = 0.066, Z = 1.64, p = 0.05). The results imply that learning effect may diminish the harm of supply-demand mismatch to safety. In the Model 2, the coefficient of Supply-demand Mismatch x Operational Complexity remains significantly negative (coefficient = 0.113, p < .05), which provide additional supports to H2. However, the coefficient of Supply-demand Mismatch x Operational Coupling is not significant (p > .1), which provide a boundary condition to our H3.

Contrary to the results of our primary models (Table 2), Table 4 suggests that the amplifying effect of operational coupling on the impacts of supply-demand mismatch is not significant for the repeat offender in the same year. It might because although tightly coupled operations have little operational slack buffers for the mismatch, the leanness of fixed production assets can facilitate the firm to learn from the most recent violation experience to reduce the subsequent violations (Voss et al., 2008; Yiu et al., 2014). For example, additional operational slack may increase the complexity of firm's operations because of the increased works for machine setting, manipulations and maintenance (Perrow, 1984). The increased complexity makes firms more difficult to understand the root cause of safety hazards and take corrective actions (Fiol and Lyles, 1985). Therefore, the firm with lean production assets (tightly coupled operations) facilitates firm to learn from the recent violation experience, which diminishes its harm to safety from little buffer.

Discussion

In contrary to the studies on the relation between inventory management and financial performance, this study investigates the effect of inventory management on safety performance, a non-financial operating performance. We draw on NAT to conceptually establish the link between inventory management and safety performance. The trade-off argument of NAT suggests that the supply-demand mismatch can generate production pressure to workers, leading to the unsafe behavior to meet the productivity goal (Brown et al., 2000). In addition, the premise of NAT also suggests that the trade-off effect can be more salient when the firms' operation is tightly coupled and highly complex.

We tested our hypotheses on 1850 firm-year observations in fashion and textiles industries involving 203 firms and 578 safety violations from 1990 to 2013. Our results reveal that supply-demand mismatch, indicated by inventory volatility, associates with a higher likelihood of subsequent safety violations. In addition, we find that operational complexity (indicated by labor intensity) and operational coupling (indicated by production capacity utilization) strengthen the effects of supply-demand mismatch on the likelihood of safety violations.

Theoretical contributions

This study provides contributions to the inventory management literature. Previous studies explore inventory level and dynamics from the perspective of financial performance. However, since operational priority has been extended to safety apart from cost, flexibility, delivery and quality, the conceptualization of performance has expanded to include safety outcome (Brown, 1996). Therefore, this study expands the inventory management literature to link inventory to safety performance. We elicit the understanding that supply-demand mismatch causes not only financial consequence (e.g., stock price changes found by Hendrick and Singhal, 2003; 2005; 2009 and Steinker and Hoberg, 2013) but also potential safety problems.

This study also answers the call for the investigation to operational safety literature (e.g., Brown, 1996; Pagell et al., 2013). First, we provide implications to the debate to productivity-safety trade-off view from NAT. Although previous survey studies find that productivity pressure may associate with worker's unsafe behaviors (e.g., Brown et al., 2000). However, the cross-sectional analysis cannot rule out the reverse causality explanation to the productivity-safety relation (i.e. worker's unsafe behaviors may cause productivity pressure). Our analysis uses panel data with the lag of independent variables to the dependent variables to mitigate the alternative explanation concern that productivity pressure may come from poor safety performance. We provide solid evidence that productivity pressure can lead to poor safety performance of firms.

In addition, previous literature draws on NAT and investigate the direct effects of operational complexity and coupling on safety performance (e.g., Wolf, 2001). This study investigates the indirect effects of operational complexity and coupling by examining their moderating effects in the productivity-safety trade-off relations. We find that operational complexity and coupling can amplify the effect of productivity pressure on safety incidents (poor safety performance).

Managerial implications

Our results suggest that on the supply-demand mismatch can put the workers at risk of occupational incidents. This finding encourages the operational manager to improve the accuracy of demand prediction and inventory management to reduce the volatility of inventory and sales. It helps to prevent the unexpected productivity pressure putting on the workers and consequently reduce the unsafe behavior of the workers. The finding is critical because safety accidents could disrupt a firm’s operations, diminish employee morale, and lower the overall firm profitability in the long run. They could also hurt firms’ sustainable competitiveness by damaging brand reputations (Fernandez-Muniz et al., 2009).

Our results also suggest the safety of fashion and textiles firms with few inventory days are undermined by supply-demand mismatch more seriously. The prevailing fashion business models, such as fast fashion, zero inventory, and just-in-time, emphasize operational efficiency by removing slack from between processes (Cachon & Swinney, 2011; Grunwald & Fortuin, 1992), with minimal lead time from product design to retail

(Cachon & Swinney, 2011). Our results address the recent concern regarding the sustainability issues of fast fashion (Shephard & Pookulangara, 2013). Operational managers should be aware that workers' safety mindfulness may easily drift away because of the tightly coupled nature of fast fashion increasing the risk of safety incidents.

Last, we find that the safety of labor intensive fashion and textiles firms also suffered more from the supply-demand mismatch. It is because labor intensive firms' operations are complex and not automated. The results suggest that the firms should linearize the operations by increase the extent of automation and reduce the labor safety risk brought by the supply-demand mismatch.

6.3 Limitation and future research direction

This study suffers from several limitations that can be addressed in the future research. First, this study, in line with other previous literatures (e.g., Lo et al., 2014; Wiengarten et al., 2017), investigated OHS issues in the context of developed countries, while we encourage the future research to investigate OHS issues in developing countries where lack of sound regulation and enforcement to protect worker's safety (Fan et al., 2014; Mani et al., 2018). Second, this study explored the antecedence of safety violations, while the impacts of safety violation on firm's operational and financial performances received limited attention in the current literature. For example, follow the literature exploring the impacts of environmental events of the firm (e.g., Lam et al., 2016; Lo et al., 2017), scholars may explore whether safety violation can trigger a negative stock market reaction. Last, this study examined the moderating role of operational complexity in the relation between supply-demand mismatch and safety. However, complexity is a multi-dimensional construct and can be induced by the environment. For example, an increased number of suppliers can increase a firm's horizontal complexity, and an increased length of a supply chain can increase a firm's vertical complexity (Lu and Shang, 2017). Future research may explore the role of complexity induced by the supply chain.

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