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Product line transformation, foreign sales, and firm value: Evidence from COVID-19 pandemic governance in urban China

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ABSTRACT

Using a sample of Chinese firms, we examine stock market reaction to firms that announce a change in their product lines to those related to COVID-19 management (medical masks and ventilators, among others). We find the market reacts positively to the announcements. In addition, when a firm ordinarily has a large share of export sales, the stock market reaction is more salient, indicating that export sales provide a certification effect that positively signals investors. Additional analysis on moderating effects suggest that, conditional on foreign sales, prior experience with medical product lines or less uncertainty about supply availability enhances the cumulative announcement returns (CARs), while the adverse impact of firm size on CAR magnifies.

1. Introduction

On March 11, 2020, the World Health Organization declared COVID-19 had reached pandemic status. Before the official pandemic announcement, the adverse impact was already widespread in China, especially in Wuhan, the capital of Hubei. Although the adverse impact on human health has been at the forefront of COVID-19, its economic impact cannot be underestimated. To manage the disease, many federal, state, and local governments across the globe, including those in Italy and the United States, issued orders that required residents to observe various levels of confinement, up to and including lockdowns (Ashraf, 2020a).

COVID-19 was an exogenous shock that posed operating challenges to firms. The resulting economic shutdown brings hardship upon firms. Firms with great leadership and strategies leverage opportunities to adapt to the challenges of the pandemic. Although there is a body of crisis management literature that focuses on financial crises (Jebabli et al., 2014), scandal-type firm-level crises (Racine et al., 2020), and several specifically on COVID-19 on stock market reactions (Ashraf, 2020b; Baek et al., 2020; Zhai et al., 2021) and cryptocurrencies (Conlon et al., 2020), among others, little research explores the impact of a public health crisis, such as COVID-19, on a firm’s product line strategy.

This paper examines stock market reaction to firms that changed their product lines to those related to the management of COVID-19. Some examples include firms that altered their production to pandemic-related supplies such as medical masks and ventilators. It is not clear how financial markets perceive such a product line transformation. Specifically, we research two questions. First, does the stock market react favorably to a firm’s announcement that it is changing its product lines from those unrelated to the pandemic to...
those related to the pandemic? Second, is that market reaction moderated by the extent of the firm’s foreign sales?

To examine the first research question, we conduct an event study on the announcements of product line transformation using a sample of Chinese firms during the COVID-19 pandemic. For the second, we examine the impact of foreign sales on the cumulative announcement returns (CARs) related to the product line transformation. Our findings suggest that the market reacts favorably to announcements of pandemic-related product line transformations. The results are consistent with the notion that investors believe a firm will be successful if it can adapt to the new demand for pandemic-related products. In addition, we document that when a firm ordinarily has a large share of export sales, the stock market reaction is more salient, indicating that export sales provide a certification effect to positively signal investors. In contrast, firm size has an adverse impact on CARs. Additional analysis on moderating effects suggest that, conditional on foreign sales, prior experience with medical product lines or less uncertainty about supply availability enhances the CARs.

We make two contributions. First, using the COVID-19 pandemic as a natural experiment, we advance the literature on the impact of product line transformation. We show that while the COVID-19 pandemic has drawn market attention, investors rationally react to firms that change their operating strategy to directly focus on a pandemic-related product line. Second, we complement the emerging literature on the economic consequences of COVID-19. While literature related to COVID-19 is evolving, our results suggest that the pandemic has affected firms that have made bold strategy moves to leverage the unique opportunity presented by the pandemic.

The rest of the paper is organized as follows. Section 2 reviews the literature and develops the testable hypotheses. Section 3 presents the research design. Section 4 presents the results and discussion, and Section 5 concludes the paper.

2. Literature review and hypotheses development

Given the limited literature on the impact of public health crises on firm strategy, we primarily review the literature on product line changes. Dobson and Yano (2002) model a firm’s product line expansion using the objectives of increasing market share and the possibility of raising product prices. The model focuses on which products to offer and the associated pricing strategies. Mendelson and Parlaktürk (2008) examine product line competition in a model to help firms set their market size, returns to expanding capacity, product variety, and performance. Zhang et al. (2017) study firms’ offering of green products and examine the strategies of offering one standard product for all customers versus adopting a segmented approach by offering different products to customers in different market segments. Kulkarni and Francas (2018) study product line expansion from the view of a tradeoff between complementarity and substitution effects of shared and dedicated resources. These studies emphasize production line expansion from operation management perspectives during “normal” times as opposed to a crisis period. Almost all the studies are theoretical. The short-term effect of the decisions on product line expansion is seldom explored. During the COVID-19 crisis, most firms stopped production or had production slowed down leading to adverse effect on stock returns (Ashraf, 2020a, b; Zhai et al., 2021). We argue that if a firm is able to adapt and switch or expand into pandemic-related product production, it exhibits flexibility, innovative, and demonstrates its ability to seize opportunity. Hence, we expect that investors respond positively to the announcements. Our first testable hypothesis is:

**H1.** During the COVID-19 crisis, the stock market reacts favorably to an announcement that a product line is being transformed to a pandemic-related product.

As a corollary of H1, the new pandemic-related products enjoy a favorable competitive environment if the products can be sold worldwide. The demand for pandemic-related products is expected to remain high after the COVID-19 crisis has ebbed. Thus, if a firm had international sales channel prior to the onset of the crisis, the impact of the product line transformation on the stock price reaction will be more salient. Thus, the second testable hypothesis is:

**H2.** During the COVID-19 crisis, stock market reaction to a product line transformation announcement is stronger if the firm’s proportion of foreign sales is already high.

3. Research design

3.1. Data

We used the key word “COVID-19” to search all the news on www.cninfocom.cn to screen for firms that engaged in product line transformation. For purposes of our study, we read the full news to identify firms with pandemic-related product line transformations. We confine our sample to those firms that switched to or added new product lines of pandemic-related products such as medical masks, ventilators, protective gowns, disinfectant, or other medical equipment. After the initial screening, we searched for the official announcement dates and identified 125 firms that announced between February 1 and March 31, 2020, that they were newly producing pandemic-related products. Of the 125 firms, three of them were recent public firms and two had missing financial data. We deleted these five firms. Hence, we have a final sample of 120 firms with announcements. We primarily use an event window of (−3, +3) to calculate the CAR. The accounting and stock return data are from the China Stock Market and Accounting Research database.

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1 Please refer Goodell (2020) for a review of COVID-19 related research opportunities.
3.2. Abnormal returns (AR) through event study methodology

We follow MacKinlay (1997) to calculate abnormal returns (AR) around the announcement date on pandemic-related product transformation, i.e., the event day, \( t_0 \). AR is calculated as the residual from a market model:

\[
AR_{t,i} = R_{t,i} - (\bar{g}_i + \bar{\beta}_i R_{mt})
\]

where \( R_{t,i} \) is the return of \( i^{th} \) firm at \( t \); \( R_{mt} \) is the market return at \( t \); \( \bar{g}_i \) is the time-invariant idiosyncratic effect of \( i^{th} \) firm on its own return; and \( \bar{\beta}_i \) is the effect of the entire market on the return of \( i^{th} \) firm. Both \( \bar{g}_i \) and \( \bar{\beta}_i \) are estimated from a market model using 120 days\(^2\) of return data over the estimation window \((-140, -21)\).

We use an event window of \((-3, +3)\) to incorporate the possibility that a firm’s product line transformation news come out before its official announcement date. Previous event studies in China use a similar approach (Wang et al., 2011). To expand a much long event window may not distinguish investor reaction from other events. Nonetheless, for robustness, we also use \((-5, +5)\) as alternative event windows. The cumulative abnormal return (CAR) for \((-3, +3)\) is the sum of abnormal returns in \( t-3 \) to \( t+3 \) as follows:

\[
CAR_{t,(-3,+3)} = \sum_{t-3}^{t+3} AR_{t,i}
\]

If H1 is valid, then \( CAR(-3, +3) \) is positive and significant.

3.3. Multiple regression model

To examine H2, we follow Wang et al. (2011) and use the following multiple regression model:

\[
CAR_{t} = \beta_0 + \beta_1 FSR_{t,i} + \beta_2 SIZE_{t,i} + \beta_3 MB_{t,i} + \varepsilon_{t,i}
\]

where \( CAR \) is the cumulative abnormal return, \( FSR \) is a firm’s foreign sales as a percent of total sales, \( SIZE \) is the natural logarithm of a firm’s market capitalization at the end of 2019, and \( MTB \) is a firm’s market-to-book ratio in 2018 (the most recently available data). To mitigate the influence of outliers, all continuous variables are winsorized at the 1\(^{st}\) and 99\(^{th}\) percentiles. Eq. (3) follows Dimson and Marsh (1986) and Fama and French (1992). If H2 is valid, \( \beta_1 \) is positive.

4. Results and discussion

4.1. Descriptive statistics

Table 1 presents the summary statistics of the sample. The mean of the \( CAR(-3, +3) \) is 0.056, with a standard deviation of 0.127, suggesting that firms making the product line transformation enjoy a positive market reaction, but the variation in reactions is high. The mean and standard deviation of \( FSR \) are 0.177 and 0.237, respectively, suggesting an average firm has approximately 17.7 %, of export sales, with considerable variation.

4.2. Cumulative abnormal returns

We present the stock market reaction of the pandemic-related product line transformation announcements from \( t-10 \) to \( t+10 \) in Fig. 1. AR begins to rise a few days before the event date and continues to rise one day after the event date.

For \( CAR(-3, +3) \), the results in Table 2 show that the mean value is approximately 5.6 %, which is significant at the 1 % level. Hence, the market responds favorably to firms making the pandemic-related product line transformation. We interpret the results in Table 2 as that the market perceives firms favorably when firms quickly adapt by changing their production focus to pandemic-related products.

4.3. The impact of foreign sales on CAR

4.3.1. Univariate analysis

We conduct a univariate analysis on \( CAR(-3, +3) \) to compare high versus low foreign sales subsamples using the median of \( FSR \). The results in Table 3 show that the mean and median of \( CAR(-3, +3) \) are significantly larger in the high foreign sales subsample than those in the low foreign sales subsample. Specifically, the mean of \( CAR(-3, +3) \) in the high foreign sales subsample is approximately three times that of the low foreign sales subsample. We plot the profiles of \( CAR(-3, +3) \) in the two subsamples in Fig. 2, and the results show economically difference between the two subsamples. The findings in Table 3 and Fig. 2 preliminarily support H2.

4.3.2. Regression results

We present the results for Eq. (3) in Table 4. We include the full equation as well as a simplified equation. In both columns, the

\[^{2}\] In the robustness tests, we also use a 90-day window of return data to calculate abnormal returns. The results are qualitatively similar.
coefficients of \( FSR \) are positive and significant at the 10 % level. Hence, when a firm has a larger share of foreign sales, its CAR is higher. The result is economically significant. The coefficient of \( FSR \) in column (2) is 0.058. Hence, for every 10 % increase in foreign sales, the market responds positively by 0.58 % in stock returns over the \((-3, +3)\) window. The coefficient of \( SIZE \) is negative and significant, suggesting that the market perceives smaller firms more favorably market when those firms transform their product lines.

We interpret the results in Table 4 to be consistent with a certification effect of foreign sales. When a firm had a large proportion of foreign sales prior to the COVID-19 crisis, it indicates that the firm can meet the quality demanded by foreign customers. Therefore, firms’ previous foreign sales signal that they are more likely to be successful after a product line transformation. In terms of firm size, we conjecture that smaller firms enjoy better stock returns because they are more flexible and thus have a better chance of success after the transformation. Product line transformations help a firm to refocus, and the market rewards these firms.

### 4.4. The moderating effect of industry experience, supply certainty, and firm size

Transforming a product line is a major change to corporate strategy. We specifically consider the moderating effects of the firm’s prior industry experience, supply certainty, and firm size. Specifically, we augment Eq. (3) with the appropriate interaction variable as
follows:

$$ CAR_i = \gamma_0 + \gamma_1 FSR_{i,t} + \gamma_2 X_i + \gamma_3 (X \times FSR)_{i,t} + \gamma_4 SIZE_i + \gamma_5 MTB_i + \mu_i $$

(4)

Where \( X \) is the specific moderating factor. When \( X \) is firm size, we drop \( \gamma_2 \). For prior industry experience, we define \( PMI \) as a dummy variable with a value of one if the firm has a prior production line in medical products, and zero otherwise. For supply certainty, we denote \( MER \) as a dummy variable with a value of one if the supplies needed to manufacture the pandemic-related products are internally available, and zero otherwise.

We present the findings of Eq. (3) in columns (1)–(3) of Table 5. Several interesting findings appear. First, the coefficients of \( FSR \) and \( SIZE \), if significant, are consistent with those in Table 4. Hence, augmenting Eq. (2) with moderating variables does not largely change the baseline findings in Table 4. Second, the coefficients of \( PMI \times FSR \) and \( MER \times FSR \) are positive and significant at the 1 % or 5 % level. That is, conditional on a firm’s foreign sales, the CARs are higher if a firm has prior experience in manufacturing medical products or it has internal supplies to support the new products. Hence, investors believe that prior experience in the pandemic-related products or less uncertainty about a firm’s supply availability further enhances the future of the newly transformed company. In contrast, the coefficient of \( SIZE \times FSR \) is negative and significant at the 5 % level, suggesting the market perceives firm size negatively. Conditional on a firm’s foreign sales, a large firm is less likely to successfully transition in the investors’ view.

For better understanding of the interaction effect among industry experience, supply certainty, and firm size, we present several graphical analyses in Figs. 3–5. In Fig. 3, we present the effect of \( FSR \) on CAR after controlling for \( PMI \). The graphs suggest that, compared to firms without medical product industry experience (\( PMI = 0 \)), firms with such experience (\( PMI = 1 \)) exhibits an increase in CAR when it has high foreign sales (High FSR). In Fig. 4, we plot the effect of \( FSR \) on CAR after controlling for \( MER \). The graphs suggest that, compared to firms without supply certainty (\( MER = 0 \)), firms with supply certainty (\( MER = 1 \)) exhibits an increase in CAR when it has high foreign sales (High FSR). For Fig. 5, we depict the effect of firms size for the effect of \( FSR \) on CAR. When compared to larger firms (\( SIZE \) is one standard deviation above mean, i.e., \( SIZE > 23.37 \)), small firms (\( SIZE \) is one standard deviation below mean, i.e., \( SIZE < 21.37 \)) exhibit a positive relation between CAR and FSR.
Research in International Business and Finance 58 (2021) 101487

4.5. Robustness tests

The COVID-19 crisis is a unique natural experiment. Essentially, the world economy shut down. While we follow the asset pricing literature (Acharya and Pedersen, 2005; Fama and French, 1992) to include firm size and market-to-book ratio as control variables, we add control variables of state-ownership (SOE) and Hubei province location (Hubei) to augment Eq. (4). Both SOE and Hubei are dummy variables with values of one if a firm is state-owned or located in the Hubei province. We use them to mitigate state-ownership and the sensitivity of the COVID-19 origin. The findings in Table 6 are qualitatively similar to those in Table 5.

In addition, we conduct several other robustness checks, such as using (−110, −21) in Eq. (1), using geometric mean in Eq. (2), and using CAR(−5, +5). The unreported results are qualitatively similar to all the findings.

4.6. Additional analyses

Baek et al. (2020) document that, during the COVID-19, Pharmaceutical firms experienced substantial gains. While our study is

Table 5
Impact of foreign sales on CAR: Heterogeneous impact.

| Variable | CAR(−3, +3) |
|----------|-------------|
|          | (1)        | (2) | (3)     |
| FSR      | −0.029     | −0.082 | 1.733** |
|          | (−0.79) | (−1.27) | (2.10) |
| PMI      | −0.091*** | (−3.24) |       |
| PMI*FSR  | 0.351***  | (3.54) |       |
| MER      | −0.040     | −0.040 | 0.179** |
|          | (−1.54) | (1.54) | (2.33) |
| MER*FSR  | 0.179**   | (2.33) |       |
| SIZE     | −0.025*** | −0.023** | −0.015* |
|          | (−2.79) | (−2.47) | (−1.77) |
| MTB      | −0.002     | −0.005 | −0.011 |
|          | (−0.11) | (−0.24) | (−0.47) |
| Intercept| 0.637***  | 0.596*** | 0.378* |
|          | (3.01) | (2.74) | (1.94) |
| N        | 120        | 120   | 120    |
| R-square | 0.139      | 0.068 | 0.067  |

The dependent variable is CAR(−3, +3). FSR is the ratio of a firm’s export value to total sales. SIZE is the logarithm of market capitalization. MTB is the market-to-book ratio. PMI is a dummy variable with a value of one if the firm has a prior production line for medical products, and zero otherwise. MER is a dummy variable with a value of one if the supplies for the pandemic-related products are internally available, and zero otherwise. t-values reported in parentheses are based on heteroscedasticity robust standard errors (White, 1980). *, **, *** indicate statistical significance at the 10 %, 5 %, and 1 % levels, respectively.

Fig. 3. The effect of having related medical product line (PMI = 1) and non-PMI on CAR with high and low foreign sales (FSR).

4.5. Robustness tests

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4.6. Additional analyses

Baek et al. (2020) document that, during the COVID-19, Pharmaceutical firms experienced substantial gains. While our study is
related to Baek et al. (2020), it differs that our product line transformation announcements include firms in all industries, not just those in pharmaceutical firms. Hence, we have a broader consideration than Baek et al. (2020). Most important, our study focuses on a firm’s change of business strategy when facing COVID-19. Pharmaceutical firms, however, experienced gains during COVID-19 by staying on their own course. To gain insights into the possibility that the positive findings of the study might just be due to overall positive market reaction to pharmaceutical firms, we compare the CAR (−3, +3) of the announcement returns by firms in firms in the pharmaceutical industries (PHARM) vs. those in non-PHARM industries. The results are presented in Table 7. In terms of means and medians, non-PHARM firms experience higher mean and median (while not significant) than those of PHARM firms. Therefore, it is unlikely that the positive findings of our paper is due to overall positive market reaction to pharmaceutical firms.

5. Summary

We study stock price reaction to firms that announced during the COVID-19 pandemic that they would transform their product line to pandemic-related products. Our findings suggest that the market reacts favorably. The average cumulative abnormal return (CAR) on a (−3, +3) window is 5.6 %. In addition, we document that when a firm had significant foreign sales prior to the pandemic, the positive market reaction magnifies. Both results are consistent with our testable hypotheses. Overall, our findings show that the stock market positively views able corporate leaders who can leverage a public health crisis.

Author statement

We have made substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; and we have drafted the work or revised it critically for important intellectual content; and we have approved the final version to be published.

All persons who have made substantial contributions to the work reported in the manuscript, including those who provided editing
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