Manufacturing background CEOs and corporate cost management: evidence from listed manufacturing firms

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ABSTRACT
Manufacturing is fundamental to the real economy. Given the central role of cost management in the manufacturing industry, we study the role of people in firms’ cost management. We find that manufacturing background CEOs significantly decrease cost stickiness. The results can be explained by a manufacturing background CEO’s focus on corporate cost management and his superior ability to choose flexible production to accelerate inventory flow and mitigate the bullwhip effect. We also show that the impact of manufacturing background CEOs on cost stickiness is more prominent in firms with high demand uncertainty, high economic policy uncertainty, high asset intensity, or low customer concentration. Finally, we report evidence that CEOs with manufacturing and finance backgrounds are associated with less cost stickiness, thus confirming the critical role of business-finance integration in cost management. In sum, these findings highlight the importance of talents in building a powerful manufacturing country.

KEYWORDS
Manufacturing background CEOs; cost stickiness; flexible production; bullwhip effect; business-finance integration

1. Introduction
Manufacturing is a top priority for economic development. China’s 14th Five-Year Plan in 2020 claims that it is critical to maintaining manufacturing and consolidating the economy. However, manufacturing enterprises have been suffering from high labour costs, raw material costs, energy costs, etc. Moreover, the costs are easy to increase but challenging to reduce, which threatens the survival of manufacturing enterprises. Against the backdrop of increased global trading uncertainty and the COVID-19 epidemic, effectively controlling costs has become the primary issue that needs to be addressed for the further development of China’s manufacturing enterprises.

Considering the critical role of cost management in the sustainable development of manufacturing firms, we study the cost management of manufacturing firms. Many studies have sought to identify factors affecting firms’ cost management. From a macro-economy perspective, infrastructure (B.L. Liu & Liu, 2011; G.C. Yang et al., 2021; G.N. Zhang...
et al., 2014; X. Zhang et al., 2018), labour protection (Banker et al., 2013; Y.Y. Liu & Liu, 2014), and exchange rate fluctuations (Z.Q. Liu & Sheng, 2017) may influence firms’ cost management. From a micro-economy perspective, corporate governance (Chen et al., 2012), equity incentives (Liang, 2016), financing constraints (Jiang et al., 2015), institutional investors (S.K. Liang, 2018), and agency problems (Chen et al., 2012) may influence firms’ cost management. As the most crucial input in manufacturing activities, people are the core driver of corporate cost management behaviour. But surprisingly, the existing literature has neglected the positive impact of people on corporate cost management. Considering that CEOs play a crucial role in business decisions (Bamber et al., 2010; Graham et al., 2015), this paper examines whether and how manufacturing background CEOs influence firms’ cost management decisions.

It is not unusual for executives from manufacturing backgrounds to become CEOs in practice. Apple’s current CEO, Tim Cook, is a case in point. Before joining Apple, Cook worked in the manufacturing departments of IBM and Compaq. He was heavily influenced by IBM’s just-in-time manufacturing methods and Compaq’s optimising distribution model. Since joining Apple, he has dramatically reduced the company’s inventory and production lead times, strengthened partnerships with supply chain partners, and made Apple the world’s first company with a market capitalisation of over US$1 trillion. As the upper echelon theory suggests, different attributes of executives influence management decisions (Hambrick, 2007; Hambrick & Mason, 1984). Manufacturing experience could be a unique and valuable work experience. CEOs with manufacturing backgrounds gain hands-on experience and expertise in enhancing production processes and supply chain management, enabling them to make more flexible cost management decisions.

Cost stickiness, proposed by Anderson et al. (2003), provides a good proxy for cost management. Costs are sticky in that they decrease less when revenues fall than they increase when revenues rise by an equivalent amount. The phenomenon of cost stickiness is worldwide (Banker & Byzano, 2014). The easy-to-increase and hard-to-reduce nature of cost increase firms’ burden when revenues fall, further deteriorating their performance and threatening survival. Cost stickiness also implies a less efficient allocation of resources. In view of this, this paper examines whether and how manufacturing background CEOs affect firms’ cost stickiness. At the micro level, this study is essential in understanding executives’ personal experiences in firms’ cost management decisions. At the macro level, this study, to some extent, reminds policymakers of the strategic importance of tens of millions of skilled industrial workers in the development of the country’s manufacturing sector.

We find that manufacturing background CEOs can significantly decrease cost stickiness using a sample of Chinese A-share listed manufacturing firms from 2008 to 2018. We use CEO turnovers to construct a difference-in-difference framework to address possible endogeneity issues. We further use plausibly exogenous CEO turnovers, such as illness and retirement, to build a more valid difference-in-difference framework (Chyz et al., 2019; Islam & Zein, 2020). In robust tests, we consider the effects of multiple CEO changes within a year, major asset restructuring, agency problems, and other CEO characteristics on the results. The results remain valid. When randomising the sample to whether the CEO had a manufacturing background or not, it was found that the effect of manufacturing background CEOs on cost stickiness was no longer present, thus mitigating the possible spurious regression problem.

2Steve Jobs: A Biography, Tim Cook: The Genius Who Took Apple to the Next Level.
We then examine how manufacturing background CEOs relate to cost stickiness. We find that manufacturing background CEOs pay more attention to cost management by using textual analysis of annual reports’ Management’s Discussion and Analysis (MD&A) part. Moreover, they are more likely to use flexible production methods to reduce inventory levels and better cope with the bullwhip effect in the supply chain. We also find that the association between manufacturing background CEOs and cost stickiness is only present in firms with high demand uncertainty, high economic policy uncertainty, high asset intensity, and low customer concentration.

Finally, further analysis suggests that CEOs with manufacturing and finance backgrounds inhibit the degree of cost stickiness more. These additional results thus confirm the critical role of business-finance integration in firms’ cost management.

Our paper contributes to several strands of the literature. First, to the best of our knowledge, our paper is the first to systematically document the impacts of CEOs’ manufacturing backgrounds on corporate performance. Prior studies examine the impact of CEOs’ demographic characteristics, personality traits, unique experiences, academic experiences, and professional background on corporate performance (Benmelech & Frydman, 2015; Bernile et al., 2017; Faccio et al., 2016; Phua et al., 2018; Sunder et al., 2017; Xu & Li, 2016; Zhou et al., 2017). For CEOs’ professional background, prior studies have mainly focused on inventor background (Islam & Zein, 2020; Yu et al., 2018) and finance background (Custódio & Metzger, 2014; Du et al., 2019; Kalelkar & Khan, 2016), and overlooked the manufacturing background. This study aims to fill this gap.

Second, our findings emphasise the positive role of managers in firms’ cost management from their attributes. Numerous studies suggest that firms incur cost stickiness because managers have empire-building incentives (Anderson et al., 2003; Chen et al., 2012; Liu et al., 2019), or when they are under less performance pressure and industry competition (Dierynck et al., 2012; Kama & Weiss, 2013; Xiao et al., 2016). However, much less is known about how managers lessen the degree of cost stickiness. A possible reason is that prior studies have treated managers as an undifferentiated group, but different managers have entirely different personal experiences in practice. Our paper contributes to this strand of the literature by documenting the positive role of CEOs’ manufacturing background in lessening the degree of cost stickiness.

Third, this study advances our understanding of factors underlying the observed cost stickiness. Prior studies suggest three factors may contribute to cost stickiness: adjustment costs, managerial positive expectation, and agency problem. Based on the adjustment costs perspective, we provide evidence that manufacturing background CEOs could reduce adjustment costs and decrease cost stickiness. Specifically, we create a cost management dictionary using the latest machine learning techniques – the word embedding model – and MD&A in firms’ annual reports. We show that manufacturing background CEOs pay more attention to cost management. Moreover, we find that manufacturing background CEOs can better deal with the bullwhip effect by building a two-layer supply chain to measure the bullwhip effect.

Lastly, this study documents the positive impact of business-finance integration on cost management. Existing discussions on the integration of business and finance are mainly focused on theoretical aspects (Xu et al., 2017) and are not yet supported by empirical evidence. This study provides empirical evidence to support the business-finance integration theory.
This paper is organised as follows. In section 2, we review the literature and develop our hypothesis. Section 3 describes the methodology. In section 4, we provide the empirical results, and we conclude in section 5.

2. Literature review and hypothesis development

2.1. Literature review

Cost stickiness is the phenomenon of asymmetric changes in costs when revenues rise or fall (Anderson et al., 2003). The phenomenon of cost stickiness is worldwide, and prior studies propose three factors underlying the observed cost stickiness: adjustment costs, management’s optimistic expectations, and agency problems (Banker et al., 2018).

First, firms incur adjustment costs when making resource capacity adjustments, which lead to cost stickiness. For example, adjustment costs include the severance payments and loss of employee morale for dismissing workers, and the selecting and training costs for hiring new workers. From a micro perspective, Anderson et al. (2003) show that the degree of adjustment costs increases with the asset and employee intensity, which leads to cost stickiness. Liu et al. (2019) find that customer-oriented and employee-oriented firms incur higher adjustment costs; therefore, these firms have greater cost stickiness. From a macro perspective, Banker et al. (2013) show that countries with stricter employment protection legislation have more significant adjustment costs for labour. Firms in these countries are reluctant to dismiss workers and have greater cost stickiness. Similarly, Y.Y. Liu and Liu (2014) show that adopting the ‘Labor Protection Law’ in 2008 in China increases the degree of cost stickiness at the firm level. Jin and Wu (2021) argue that higher economic policy uncertainty decreases inventory and wage levels, leading to lower adjustment costs and thus lower cost stickiness for firms.

Second, managers’ optimistic expectations for future revenue may lead to cost stickiness. In an economic upturn, managers are more likely to believe that the fall in demand is temporary and are reluctant to reduce resources immediately, leading to increased cost stickiness. If a firm’s revenue falls for two consecutive years, managers may believe that the fall in revenue is persistent and will reduce resources immediately, inhibiting cost stickiness (Anderson et al., 2003). W. Lee et al. (2020) point out that the financing environment may be more relaxed in election years, and politicians may suppress negative news and make promises of a significant economic improvement, leading managers to have more optimistic expectations for the future. Therefore, managers are reluctant to reduce resources immediately even in falling revenues, leading to cost stickiness.

Third, agency costs can also contribute to cost stickiness. Managers have empire-building incentives, such that they refrain from cutting slack resources when sales decline (Chen et al., 2012). When external corporate governance is strengthened, opportunistic behaviour of managers is curbed, and firms’ cost stickiness will be reduced (Cui & Xu, 2013; Liang, 2017; Liang et al., 2015). When firms are headquartered in places with high social capital, managers are restrained from opportunistic behaviour, leading to less cost asymmetry (Hartlieb et al., 2020).
Whatever the motivation for cost stickiness, keeping slack resources when revenues fall leads to accelerated decline in profits. Therefore, a rational CEO would have a strong incentive to decrease cost stickiness. However, prior studies paid less attention to managers’ positive role in reducing adjustment costs and curbing cost stickiness. Because of this, we study the impact of manufacturing background CEOs on cost stickiness.

2.2. Hypothesis development

Upper echelons theory suggests that managers’ experience influence their decisions (Hambrick & Mason, 1984). Dearborn and Simon (1958) find that managers tend to identify the main issues in business cases based on their professional experience; for example, managers from the operations department tend to raise production issues, while managers from the sales department tend to raise sales issues. The phenomenon of imprinting is common in business. For example, Du et al. (2019) show that firms with financial expert CEOs hold more financial assets; Islam and Zein (2020) find that firms with inventor CEOs are associated with higher-quality innovation. These results indicate that professional experience is imprinted on managers, which influences their decisions. Manufacturing experience is also a valuable and unique professional experience. The spectrum of manufacturing experience includes experience in operations, supply chain, procurement, logistics, and distribution (Hendricks et al., 2014). Therefore, we predict that manufacturing background CEOs place greater emphasis on the manufacturing aspects of the business, which are all relevant to firms’ cost management.

Moreover, manufacturing background CEOs accumulate a great deal of explicit and tacit knowledge from their manufacturing experience, all of which help them to control costs better. Explicit knowledge is essential for manufacturing. For example, operations research is about the efficient allocation of scarce resources, including scheduling, graph theory, inventory theory and queuing theory. Demirel et al. (2015) state that operations research can help firms to achieve greater output with fewer resources. Tacit knowledge is also essential due to the complexity of manufacturing. Certain tacit knowledge can only be acquired through hands-on experiences, such as handling emergencies, resolving employee conflicts, and coordinating production with supply chain partners. Therefore, manufacturing background CEOs’ learning-by-doing advantage equips them with explicit and tacit knowledge, which help them to make a better decision in cost management.

Specifically, manufacturing background CEOs could play an essential role in reducing adjustment costs in production and supply chain management. First, manufacturing background CEOs may decrease adjustment costs from production. They may adopt flexible production methods. For example, just-in-time (JIT) is characterised as suppliers sending materials to the required places in the required time, and vendor-managed inventory (VMI) is featured by coordination and information sharing with suppliers. These more advanced production methods have greatly improved the efficiency of inventory management and shifted the production process from crude to refined one. Therefore, the adjustment costs are reduced, and cost stickiness is inhibited.

Second, manufacturing background CEOs may decrease adjustment costs from supply chain management. One problem that often paralyzes the supply chain is the bullwhip effect (Shan et al., 2014; Z.Q. Yang et al., 2020). The bullwhip effect means that the
information about product demand becomes distorted when it moves upstream in the supply chain. The bullwhip effect may lead to excessive inventory, lost revenues, and missed production schedules (Lee et al., 1997). When demand becomes more volatile, firms need to maintain more safety stock and safety capacity in times of revenues fall to cope with future sales surges, leading to cost stickiness (Banker et al., 2018). The bullwhip effect is a consequence of inadequate supply chain infrastructure and production processes (Lee et al., 1997, 2004). Manufacturing background CEOs could inhibit the bullwhip effect by adopting flexible production processes and coordinating with supply chain partners (Bray & Mendelson, 2012; Lee et al., 2004; Lu et al., 2017), which lessens the degree of cost stickiness.

In summary, manufacturing background CEOs pay more attention to cost management and have more ability to decrease adjustment costs. We thus propose that manufacturing background CEOs will reduce cost stickiness.

Hypothesis 1. Manufacturing background CEOs are associated with lower degree of cost stickiness.

3. Methodology

3.1. Sample and the sources of data

Our sample covers manufacturing firms listed on China’s A-share stock market from 2008 to 2018. The sample is chosen for two reasons. First, manufacturing background CEOs play a more critical role in manufacturing firms than non-manufacturing firms. Second, China has adopted new accounting standards for listed firms since 2007 (X.Y. Wang & Gao, 2017), leading to inconsistencies between old and new standards in terms of costs and revenues. Since key variables require lagged data, the sample interval is selected from 2008 onwards.

The initial sample consists of 14,158 observations. Following Chen et al. (2012) and Gu et al. (2020), our sample selection procedures are as follows: First, we drop 296 observations for which operating costs exceed sales for the current year; Second, we drop 979 observations with missing data; Third, we drop the top and bottom 1% of the observations with extreme values in the log change of operating costs ($Δ\ln\text{COST}$) and the log change of sales revenue ($Δ\ln\text{SALE}$), where are 450 observations. Other continuous firm-level explanatory variables are winsorised at the top and bottom one percentile. The final sample consists of 12,433 firm-year observations.

The most important explanatory variable in our study is a dummy variable, OPE, indicating whether the CEO has a manufacturing background or not. We download CEO biography data from the China Securities Market and Accounting Research (CSMAR) database. The CEO is considered to have a manufacturing background if he or she has manufacturing-related career experience, such as manufacturing manager, production manager, workshop manager, purchasing manager, supply chain manager, etc. For other data, marketisation indices come from Wang et al. (2019), China’s economic policy uncertainty data come from Baker et al. (2016), and the other data come from CSMAR.
3.2. Empirical models and variable description

Following the cost stickiness literature (Banker et al., 2013; Chen et al., 2012; Gu et al., 2020; Liu et al., 2019), we build the empirical model (1) below:

\[
\Delta \ln\text{COST} = \beta_0 + (\beta_1 + \beta_2 OPE + \beta_3 AINT + \beta_4 EINT + \beta_5 GDPG) \times \Delta \ln\text{SALE}
+ (\beta_6 + \beta_7 OPE + \beta_8 AINT + \beta_9 EINT + \beta_{10} GDPG + \beta_{11} SD) \times \text{DEC} \times \Delta \ln\text{SALE}
+ \beta_{12} OPE + \beta_{13} AINT + \beta_{14} EINT + \beta_{15} GDPG + \beta_{16} SD + \tau + \mu + \epsilon
\]  

(1)

The dependent variable \(\Delta \ln\text{COST}\) is the natural logarithm change of operating costs between year \(t\) and \(t-1\). We expect manufacturing background CEOs to decrease the adjustment costs from manufacturing. Therefore, following Banker et al. (2013), Jiang et al. (2017), and L. Zhang et al. (2019), we study the impact of manufacturing background CEOs on the stickiness of operating costs. The independent variable \(\Delta \ln\text{SALE}\) is the natural logarithm change of sales between year \(t\) and \(t-1\). \(\text{DEC}\) is a dummy variable, which takes the value of one if sales decreased in year \(t\) and zero otherwise. \(OPE\) is the critical independent variable in our study, it takes the value of one when CEO has a manufacturing background and zero otherwise. We also include four known economic determinants of cost stickiness in the control variables: asset intensity (\(AINT\)), measured as the log ratio of assets to sales; employee intensity (\(EINT\)), measured as the ratio of the number of employees to sales and multiply by 10,000, GDP growth rate (\(GDPG\)), and a dummy variable for whether sales are successive decreasing (\(SD\)). \(\tau\) represents the time fixed effects, which captures economic shocks that affected all firms in a year. \(\mu\) represents the firm fixed effects, which captures all time-invariant firm characteristics. \(\epsilon\) is the error term. The parameter of interest is \(\beta_7\). According to hypothesis 1, we expect \(\beta_7\) to be positive. The definition of specific variables is detailed in Table 1.

3.3. Descriptive statistics

Table 2 reports observations for each year and the proportion of manufacturing background CEOs. The proportion of manufacturing background CEOs was relatively stable over the sample period, and the proportion of manufacturing background CEOs in the sample was 17.74%.

| Table 1. Variables definition. |
|--------------------------------|
| Variables | Definition |
| \(\Delta \ln\text{COST}\) | Log change of operating costs between year \(t\) and \(t-1\). |
| \(OPE\) | Manufacturing background CEO: equal to one if the CEO has manufacturing background and zero otherwise. |
| \(\Delta \ln\text{SALE}\) | Log change of sales between year \(t\) and \(t-1\). |
| \(\text{DEC}\) | Sales decreasing: equal to one if sales decreased in year \(t\) and zero otherwise. |
| \(AINT\) | Asset intensity: log ratio of assets to sales. |
| \(EINT\) | Employee intensity: the ratio of number of employees to sales and multiply by 10,000. |
| \(SD\) | Sales successive decreasing: equal to one if sales are decreasing for two consecutive years. |
| \(GDPG\) | GDP growth rate: \((GDP_t - GDP_{t-1})/GDP_{t-1}\). |
4.1. Manufacturing background CEOs and cost stickiness

We investigate the impact of manufacturing background CEOs on cost stickiness by using model (1). The main regression results are presented in Table 4. The regression in column (1) follows Anderson et al. (2003). The significant and negative coefficient on $DEC \times \Delta \ln \text{SALE}$ suggests that operating costs for listed manufacturing firms in China are sticky. Column (2) controls for the impact of manufacturing background CEOs on cost stickiness. The coefficient on $DEC \times \Delta \ln \text{SALE}$ is $-0.054$, which is significant at the 1% level, implying that operating costs for firms without manufacturing background CEOs are sticky. Column (3) further controls for the impact of asset intensity ($AINT$), employee intensity ($EINT$), GDP growth rate ($GDPG$), and successive decreasing of sales ($SD$). Column (4) further controls the industry and year fixed effects, and column (5) controls for firm and year fixed effects.

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Table 2. Sample distribution from 2008 to 2018.

| Year | Obs. | Obs. with manufacturing background CEOs | Proportion |
|------|------|-----------------------------------------|------------|
| 2008 | 629  | 114                                     | 18.12%     |
| 2009 | 694  | 128                                     | 18.44%     |
| 2010 | 744  | 138                                     | 18.55%     |
| 2011 | 839  | 148                                     | 17.64%     |
| 2012 | 1125 | 205                                     | 18.22%     |
| 2013 | 1276 | 239                                     | 18.73%     |
| 2014 | 1301 | 228                                     | 17.52%     |
| 2015 | 1254 | 233                                     | 18.58%     |
| 2016 | 1376 | 235                                     | 17.08%     |
| 2017 | 1497 | 252                                     | 16.83%     |
| 2018 | 1698 | 286                                     | 16.84%     |
| Total| 12,433| 2206                                   | 17.74%     |

Table 3. Descriptive statistics.

| Variables | N    | Mean  | Std dev | Min  | 25th | Median  | 75th | Max     |
|-----------|------|-------|---------|------|------|---------|------|---------|
| $\Delta \ln \text{COST}$ | 12433 | 0.117 | 0.224   | $-0.506$ | $-0.016$ | 0.105   | 0.236 | 0.935   |
| $OPE$     | 12433 | 0.177 | 0.382   | 0.000 | 0.000 | 0.000   | 0.000 | 1.000   |
| $\Delta \ln \text{SALE}$ | 12433 | 0.117 | 0.222   | $-0.677$ | $-0.011$ | 0.098   | 0.233 | 1.310   |
| $DEC$     | 12433 | 0.267 | 0.443   | 0.000 | 0.000 | 0.000   | 0.000 | 1.000   |
| $AINT$    | 12433 | 0.557 | 0.551   | $-0.884$ | 0.207   | 0.546   | 0.906 | 2.027   |
| $EINT$    | 12433 | 0.016 | 0.012   | 0.001 | 0.008 | 0.013   | 0.020 | 0.071   |
| $SD$      | 12433 | 0.098 | 0.298   | 0.000 | 0.000 | 0.000   | 0.000 | 1.000   |
| $GDPG$    | 12433 | 0.108 | 0.037   | 0.070 | 0.082 | 0.093   | 0.112 | 0.185   |

Table 3 reports descriptive statistics for our sample period. The average (median) of $\Delta \ln \text{COST}$ is 0.117 (0.105). The average (median) of $\Delta \ln \text{SALE}$ is 0.117 (0.109). Approximately 26.72% of sample firms experience a decline in sales. The mean values for $AINT$, $EINT$, $SD$, $GDPG$ are 0.557, 0.016, 0.098, and 0.108, respectively. These descriptive statistics are similar to those reported in prior literature (e.g. L. Zhang et al., 2019).

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3It is worth to note that the coefficients on $DEC \times \Delta \ln \text{SALE}$ for column (3) to column (5) are not statistically significant. The coefficients on $DEC \times \Delta \ln \text{SALE}$ for column (3) to column (5) represent cost stickiness for firms with low asset intensity, low employee intensity, low GDP growth rate, and firms that have not experienced two consecutive years of declining sales, where the cost stickiness may be weak.
For all of these regressions, the coefficient on $DEC \times \Delta \ln \text{SALE} \times \text{OPE}$ is positive and statistically significant at the 1% level. The results suggest that manufacturing background CEOs are associated with lower cost stickiness, which supports hypothesis 1.

### 4.2. Robustness discussion

#### 4.2.1. Difference-in-difference analysis

To mitigate possible endogeneity issues, we examine whether firms experience a change in cost stickiness from CEO turnover. We identify a set of treated turnovers, defined as a manufacturing background CEO is replaced with a non-manufacturing background CEO. For treated turnovers, we set $Treat$ equals to one. To obtain a sample of non-treated turnovers, we identify turnovers involving a change from a non-manufacturing background CEO to another non-manufacturing background CEO. For non-treated turnovers,

| Table 4. Manufacturing background CEOs and cost stickiness. |
|---------------------------------|
|                                | 1     | 2     | 3     | 4     | 5     |
|                                | $\Delta \ln \text{COST}$ | $\Delta \ln \text{COST}$ | $\Delta \ln \text{COST}$ | $\Delta \ln \text{COST}$ | $\Delta \ln \text{COST}$ |
| $\Delta \ln \text{SALE}$       | 0.946*** | 0.957*** | 0.982*** | 0.980*** | 0.969*** |
|                                | (207.60) | (192.06) | (60.88) | (60.40) | (52.54) |
| $\Delta \ln \text{SALE} \times \text{OPE}$ | $-0.068***$ | $-0.066***$ | $-0.066***$ | $-0.082***$ | $-0.082***$ |
|                                | ($-5.59$) | ($-5.41$) | ($-5.49$) | ($-5.96$) | ($-5.96$) |
| $\Delta \ln \text{SALE} \times \text{AINT}$ | $-0.072***$ | $-0.072***$ | $-0.073***$ | $-0.073***$ | $-0.073***$ |
|                                | ($-8.29$) | ($-8.22$) | ($-7.23$) | ($-7.23$) | ($-7.23$) |
| $\Delta \ln \text{SALE} \times \text{EINT}$ | 1.992*** | 1.894*** | 1.179**  | 1.179**  | 1.179**  |
|                                | (4.52) | (4.29) | (2.29) | (2.29) | (2.29) |
| $\Delta \ln \text{SALE} \times \text{GDPG}$ | $-0.189$ | $-0.169$ | $-0.033$ | $-0.033$ | $-0.033$ |
|                                | ($-1.54$) | ($-1.36$) | ($-0.24$) | ($-0.24$) | ($-0.24$) |
| $DEC \times \Delta \ln \text{SALE}$ | $-0.035***$ | $-0.054***$ | $0.018$ | $0.018$ | $0.037$ |
|                                | ($-2.99$) | ($-4.26$) | (0.42) | (0.42) | (0.80) |
| $DEC \times \Delta \ln \text{SALE} \times \text{OPE}$ | 0.120*** | 0.096*** | 0.097*** | 0.124*** | 0.124*** |
|                                | (3.81) | (3.05) | (3.09) | (3.49) | (3.49) |
| $DEC \times \Delta \ln \text{SALE} \times \text{AINT}$ | 0.017 | 0.019 | 0.014 | 0.014 | 0.014 |
|                                | (0.81) | (0.86) | (0.57) | (0.57) | (0.57) |
| $DEC \times \Delta \ln \text{SALE} \times \text{EINT}$ | $-3.945***$ | $-4.003***$ | $-3.194***$ | $-3.194***$ | $-3.194***$ |
|                                | ($-4.21$) | ($-4.26$) | ($-2.99$) | ($-2.99$) | ($-2.99$) |
| $DEC \times \Delta \ln \text{SALE} \times \text{GDPG}$ | 0.090 | 0.210 | $-0.122$ | $-0.122$ | $-0.122$ |
|                                | (0.27) | (0.62) | ($-0.33$) | ($-0.33$) | ($-0.33$) |
| $DEC \times \Delta \ln \text{SALE} \times \text{SD}$ | $-0.030$ | $-0.030$ | $-0.041*$ | $-0.041*$ | $-0.041*$ |
|                                | ($-1.32$) | ($-1.34$) | ($-1.67$) | ($-1.67$) | ($-1.67$) |
| $OPE$                          | 0.009*** | 0.008**  | 0.009*** | 0.011*** | 0.011*** |
|                                | (2.85) | (2.54) | (2.99) | (2.60) | (2.60) |
| $AINT$                         | 0.013*** | 0.014*** | 0.014*** | 0.014*** | 0.014*** |
|                                | (5.96) | (5.88) | (2.64) | (2.64) | (2.64) |
| $EINT$                         | $-0.435***$ | $-0.391***$ | $-0.382**$ | $-0.382**$ | $-0.382**$ |
|                                | ($-4.16$) | ($-3.57$) | ($-2.11$) | ($-2.11$) | ($-2.11$) |
| $GDPG$                         | 0.145*** | 0.078 | 0.155**  | 0.155**  | 0.155**  |
|                                | (4.45) | (1.64) | (2.90) | (2.90) | (2.90) |
| $SD$                           | $-0.017***$ | $-0.015***$ | $-0.013***$ | $-0.013***$ | $-0.013***$ |
|                                | ($-4.27$) | ($-3.97$) | ($-2.95$) | ($-2.95$) | ($-2.95$) |
| $Constant$                     | 0.004*** | 0.003**  | $-0.011***$ | $-0.002$ | $-0.007$ |
|                                | (3.77) | (2.30) | ($-2.67$) | ($-2.4$) | ($-1.04$) |
| $Firm \ FE$                    | No | No | No | No | Yes |
| $Industry \ FE$                | No | No | No | Yes | No |
| $Year \ FE$                    | No | No | No | Yes | Yes |
| $N$                            | 12433 | 12433 | 12433 | 12433 | 12433 |
| $Within R^2$                   | 0.866 | 0.866 | 0.869 | 0.870 | 0.858 |

Note: The t-statistics are reported in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. The same as below.

For all of these regressions, the coefficient on $DEC \times \Delta \ln \text{SALE} \times \text{OPE}$ is positive and statistically significant at the 1% level. The results suggest that manufacturing background CEOs are associated with lower cost stickiness, which supports hypothesis 1.
we set Treat equals to zero. For each CEO turnover event, we select three years before and three years after the CEO turnover as the sample. For observations after CEO turnover, we set Post equals to one and zero otherwise. Column (1) of Table 5 reports the results of the difference-in-difference analysis. The coefficient for Treat×Post×ΔlnSALE×DEC is significantly negative, which support our hypothesis.

To further mitigate endogeneity concerns, we study situations when a CEO is replaced for plausibly exogenous reasons following Islam and Zein (2020). As suggested by Fee et al. (2013), the CEO departs for the cause of illness or retirement could be treated as exogenous turnover, and it is less likely that the firm selects the post-turnover changes. Therefore, we examine whether firms experience a shift in cost stickiness from exogenous CEO turnover. First, we choose a sample of CEO turnover for the reason of illness or retirement. Second, we identify treated turnovers as manufacturing background CEO replaced by non-manufacturing background CEO, and non-treated turnovers as non-manufacturing background CEO replaced by non-manufacturing background CEO. If manufacturing background CEOs have a causal impact on cost stickiness, the treated turnovers should be followed by a more significant increase in cost stickiness than non-treated turnovers. Column (2) of Table 5 reports the results, supporting our hypothesis.

4.2.2. Excluding observations that may affect the empirical findings
The cost management decision may not be clear for a year with CEO turnover. Our sample has 161 observations with more than one CEO turnover in a year and 2123 observations with one CEO turnover in a year. In the main results, we consider the CEO who has been in office longer in a year as the incumbent CEO if turnover happens in the year. In the robustness tests, we exclude the effect of CEO turnovers on the results. Since the calculation of the dependent variable ΔlnCOST needs two consecutive years of observations, we drop observations for the year of the CEO turnover and the following year. In column (1) of Table 6, we report results after removing the sample with more than one CEO turnover in a year. In column (2) of Table 6, we report results after removing the sample with one or more than one CEO turnover in a year. The coefficient on DEC×ΔlnSALE×OPE is significantly positive, consistent with the main results.

Major asset restructuring can significantly change in firms’ costs and revenues that do not come exclusively from a manufacturing background CEO. We exclude the influence of major asset restructuring in the robustness test. The results are reported in column (3) of Table 6. The coefficient on DEC×ΔlnSALE×OPE is also significantly positive.

4.2.3. Controlling agency problems and other CEO characteristics
Chen et al. (2012) show that agency problems, such as managerial ‘empire building’, would increase cost stickiness. Free cash flow was used in the literature to proxy managers’ empire-building incentives (Jensen, 1986). Managers with high levels of free cash flow may invest in negative net present value projects and retain slack resources when revenues fall. Beyond agency problems, other CEO characteristics, such as age, gender, tenure, and whether or not he is the chairman of the board, may also have an impact on cost stickiness. In the robustness test, we adopt model (1) and further control free cash flow (FCF), CEO age, CEO gender, CEO tenure, and whether or not the CEO is the chairman of the board (CEO Duality). The regression results are reported in Table 7, confirming that our results are valid.
To address the concern that the results may be due to omitted variables or chance, we randomly assign the manufacturing background to CEOs in the sample, and we use the same percentage of manufacturing background CEOs in the actual data (17.74%). We repeat the regression 3000 times and record the coefficient on $DEC \times \Delta \ln \text{SALE} \times OPE$ for each regression. Figure 1, which reports the distribution of coefficient on $DEC \times \Delta \ln \text{SALE} \times OPE$, shows that the mean value is approximately zero. In our main result
in column (5) Table 4, the coefficient on $DEC \times \Delta \ln \text{SALE} \times OPE$ is 0.12. Figure 1 suggests that our estimated effect of manufacturing background CEOs on cost stickiness is unlikely spurious.

### 4.3. Mechanism analysis

This section discusses how manufacturing background CEOs reduce cost stickiness. We propose three mechanisms. First, manufacturing background CEOs pay more attention to cost management. Second, they adopt flexible production methods. Third, they inhibit the bullwhip effect in the supply chain. The three mechanisms all lead to reduced adjustment costs, which lessened the degree of cost stickiness. We then discuss these mechanisms in detail below.
Table 7. Controlling agency problems and other CEO characteristics.

|                   | (1) ΔlnCOST | (2) ΔlnCOST | (3) ΔlnCOST | (4) ΔlnCOST | (5) ΔlnCOST |
|-------------------|-------------|-------------|-------------|-------------|-------------|
| ΔlnSALE           | 0.946***    | 0.709***    | 0.702***    | 0.624***    | 0.661***    |
|                   | (0.15)      | (4.75)      | (4.68)      | (4.11)      | (4.34)      |
| ΔlnSALE×OPE       | −0.083***   | −0.084***   | −0.085***   | −0.082***   | −0.077***   |
|                   | (−6.05)     | (−6.14)     | (−6.15)     | (−5.92)     | (−5.60)     |
| ΔlnSALE×AINT      | −0.079***   | −0.078***   | −0.078***   | −0.078***   | −0.080***   |
|                   | (−7.62)     | (−7.61)     | (−7.59)     | (−7.56)     | (−7.78)     |
| ΔlnSALE×EINT      | 1.123**     | 1.128**     | 1.131**     | 1.109**     | 1.076**     |
|                   | (2.18)      | (2.19)      | (2.19)      | (2.15)      | (2.09)      |
| ΔlnSALE×GDPG      | −0.004      | 0.015       | 0.013       | 0.019       | 0.041       |
|                   | (−0.03)     | (0.11)      | (0.09)      | (0.14)      | (0.30)      |
| DEC×ΔlnSALE       | 0.061       | 0.372       | 0.374       | 0.511       | 0.484       |
|                   | (1.29)      | (1.01)      | (1.01)      | (1.36)      | (1.28)      |
| DEC×ΔlnSALE×OPE   | 0.125***    | 0.127***    | 0.127***    | 0.123***    | 0.119***    |
|                   | (3.54)      | (3.58)      | (3.58)      | (3.46)      | (3.33)      |
| DEC×ΔlnSALE×AINT  | 0.018       | 0.018       | 0.018       | 0.018       | 0.021       |
|                   | (0.73)      | (0.71)      | (0.71)      | (0.71)      | (0.82)      |
| DEC×ΔlnSALE×EINT  | −3.072***   | −3.063***   | −3.069***   | −3.061***   | −2.971***   |
|                   | (−2.87)     | (−2.86)     | (−2.87)     | (−2.86)     | (−2.78)     |
| DEC×ΔlnSALE×GDPG  | −0.121      | −0.140      | −0.134      | −0.130      | −0.150      |
|                   | (−0.32)     | (−0.37)     | (−0.36)     | (−0.35)     | (−0.40)     |
| DEC×ΔlnSALE×SD    | −0.049**    | −0.049**    | −0.049**    | −0.048**    | −0.047**    |
|                   | (−1.96)     | (−1.97)     | (−1.97)     | (−1.93)     | (−1.87)     |
| OPE               | 0.011***    | 0.012***    | 0.012***    | 0.011**     | 0.011**     |
|                   | (2.62)      | (2.65)      | (2.67)      | (2.57)      | (2.47)      |
| AINT              | 0.005       | 0.005       | 0.005       | 0.005       | 0.005       |
|                   | (1.09)      | (1.10)      | (1.12)      | (1.10)      | (1.17)      |
| EINT              | −0.370**    | −0.372**    | −0.372**    | −0.375**    | −0.364**    |
|                   | (−2.04)     | (−2.05)     | (−2.05)     | (−2.07)     | (−2.01)     |
| GDPG              | 0.137**     | 0.140**     | 0.140**     | 0.139**     | 0.137**     |
|                   | (2.56)      | (2.58)      | (2.59)      | (2.57)      | (2.52)      |
| SD                | −0.014***   | −0.014***   | −0.014***   | −0.014***   | −0.014***   |
|                   | (−3.18)     | (−3.16)     | (−3.16)     | (−3.13)     | (−3.16)     |
| ΔlnSALE×FCF       | −0.057***   | −0.056***   | −0.056***   | −0.056***   | −0.055***   |
|                   | (−3.34)     | (−3.37)     | (−3.35)     | (−3.28)     | (−3.21)     |
| DEC×ΔlnSALE×FCF   | 0.050       | 0.051       | 0.050       | 0.051       | 0.050       |
|                   | (1.03)      | (1.04)      | (1.03)      | (1.04)      | (1.02)      |
| FCF               | −0.009      | −0.008      | −0.008      | −0.008      | −0.009      |
|                   | (−1.52)     | (−1.49)     | (−1.49)     | (−1.50)     | (−1.58)     |
| ΔlnSALE×CEO Age   | 0.061       | 0.060       | 0.092**     | 0.081**     |
|                   | (1.60)      | (1.59)      | (2.34)      | (2.06)      |
| DEC×ΔlnSALE×CEO Age| −0.080    | −0.078      | −0.134      | −0.126      |
|                   | (−0.85)     | (−0.83)     | (−1.37)     | (−1.29)     |
| CEO Age           | −0.005      | −0.005      | −0.010      | −0.008      |
|                   | (−0.42)     | (−0.40)     | (−0.84)     | (−0.62)     |
| ΔlnSALE×CEO Gender| 0.009       | 0.009       | 0.009       | 0.009       |
|                   | (0.39)      | (0.40)      | (0.37)      | (0.37)      |
| DEC×ΔlnSALE×CEO Gender| −0.009 | −0.009      | −0.009      | −0.009      |
|                   | (−0.15)     | (−0.15)     | (−0.15)     | (−0.15)     |
| CEO Gender        | −0.005      | −0.005      | −0.005      | −0.005      |
|                   | (−0.70)     | (−0.71)     | (−0.71)     | (−0.68)     |
| ΔlnSALE×CEO Tenure| −0.030***   | −0.033***   | −3.23       | −3.53       |
|                   | (−2.33)     | (−2.35)     | (−2.00)     | (−1.99)     |
| DEC×ΔlnSALE×CEO Tenure| 0.052** | 0.054**     | 2.23        | 2.30        |
|                   | (2.02)      | (2.17)      | (2.00)      | (2.17)      |
| CEO Tenure        | 0.005**     | 0.006**     | 3.00        |
|                   | (2.02)      | (2.17)      | (2.00)      | (2.17)      |
| ΔlnSALE×CEO Duality| 0.039***   | 0.025       |
|                   | (3.00)      | (−0.74)     | (3.00)      | (−0.74)     |

(Continued)
4.3.1. The emphasis on cost management

Due to their unique work experience, manufacturing background CEOs are more likely to have valuable work experience in cost management. They are also more likely to invest in operations, improving efficiency and reducing costs. Therefore, we predict that manufacturing background CEOs decrease adjustment costs because they emphasise firms’ cost management.

We thus try to measure CEOs’ emphasis on cost management. Hu et al. (2021) pointed out that ‘management discussion and analysis (MD&A)’ in the annual report is managers’ review of the current year’s business situation and the outlook for the firm’s future development; therefore, using MD&A to capture managers’ subconscious perceptions and traits has been widely used in the literature. We then use textual analysis to extract cost-related words in MD&A to proxy CEOs’ emphasis on cost management.

When managers discuss cost in MD&A, the word ‘cost’ may not appear directly, but other terms such as ‘scrap rate’, ‘energy consumption’, etc. To avoid possible omissions or biases caused by setting similar words manually, we use a novel machine learning method (specifically word2vec) to extract cost-related words from MD&A. Word2vec is a word embedding model, it transforms words into relatively low-dimensional vectors according to the textual context. It obtains semantically similar words by calculating the similarity between the vectors. Using word2vec, Li et al. (2021) create a culture dictionary and score
the five corporate cultural values of innovation, integrity, quality, respect, and teamwork. We adopt a similar method of Li et al. (2021) to measure firms’ emphasis on cost management.

Specifically, the MD&A text is trained using the Continuous Bag-of-Words Model (CBoW) in word2vec, which predicts the target words based on the context by maximising the following objective function.

$$\max \sum_{w \in C} \log p(w|\text{Context}(w))$$

where $C$ is the text, $w$ is the central word, and $\text{Context}(w)$ is the context of the central word. In this paper, we set ‘production cost’ and ‘manufacturing cost’ as the seed words, and we obtained 32 related words. We then build three proxies for firms’ emphasis on cost management. First, $\text{InCostWords}$, measured as the logarithm of the frequency of cost-related words. Second, $\text{CostWords_index1}$, measured as the ratio of the frequency of cost-related words to the total number of characters in MD&A and multiply it by 100. Third, $\text{CostWords_index2}$, measured as the ratio of the frequency of cost-related words to the total number of words in MD&A and multiply it by 100.

We use the following regression model (2) to examine whether manufacturing background CEOs are associated with more emphasis on cost management.

$$y = \beta_0 + \beta_1 OPE + \sum \text{Controls} + \tau + \mu + \varepsilon$$

where $y$ includes $\text{InCostWords}$, $\text{CostWords_index1}$ and $\text{CostWords_index2}$. A set of control variables include: $\text{Market Value}$, measured by the logarithm of the market value of the equity; $\text{Sales Growth}$, measured by annual percentage growth in sales; $\text{Gross Margin}$, measured by one minus operating costs scaled by sales; $\text{Capital Intensity}$, measured by the ratio of fixed assets and total assets; $\text{Leverage}$, measured by the ratio of total debts and total assets; $\text{Firm Age}$, measured by the number of years from IPO; $\text{Market Index}$, measured following Wang et al. (2016); $\text{Top1}$, measured as the ratio of the shares held by the first shareholders to total shares; $\text{Independent}$, measured as the ratio of independent directors to all the directors on board; $\text{CEO Duality}$, measured as one if the CEO is also the chairman, and 0 otherwise; $\text{Manager shareholding}$, measured as the ratio of shares held by managers to total shares. Model (2) also controls year fixed effects ($\tau$) and firm fixed effects ($\mu$). $\varepsilon$ is the error term.

Table 8 reports the results. The estimates show that manufacturing background CEOs pay more attention to cost management, thus validating the first mechanism.

### 4.3.2. Flexible production

Flexible production is featured by small batches and diversification. It changes traditional ‘make-to-stock’ to ‘make-to-order’, which places greater demands on production and supply chain (D. Liang, 2018). By being an expert in manufacturing, a manufacturing background CEO is more likely to implement flexible production. Under flexible production, firms could adjust rescuers quickly, reducing adjustment costs and inhibiting cost stickiness.

Flexible production is essentially the ability to adjust resources in response to changes in demand (Upton, 1995). Firms adopting flexible production usually have higher inventory efficiencies (Eroglu & Hofer, 2011). In view of this, we use inventory
levels (Inventory Holding) and inventory days (Inventory Days) to proxy flexible production. Inventory Holding is measured as total inventories scaled by total assets, and Inventory Days is measured as total inventories scaled by operating costs and multiplied by 365.

We use model (2) to examine the effect of manufacturing background CEOs on Inventory Holding and Inventory Days. Columns (1) and (2) of Table 9 report the results, thus validating the second mechanism.

4.3.3. Bullwhip effect

The bullwhip effect could lead to more safety stock, employees, and materials. Moreover, the bullwhip effect also complicates firms’ cost management and leads to cost stickiness. Manufacturing background CEOs could conquer the bullwhip effect through several methods suggested by the literature (Bray & Mendelson, 2012; Lee et al., 2004; Lu et al., 2017). First, they could enhance the production process, decreasing lead time and excess stock. Second, they could integrate the supply chain and adopt JIT to reduce order size. Third, they could coordinate with supply chain partners to minimise information asymmetric in the supply chain. We thus conjecture that manufacturing background CEOs can

Table 8. The emphasis on cost management.

|                  | (1)       | (2)       | (3)       |
|------------------|-----------|-----------|-----------|
|                  | lnCostWords | CostWords_index1 | CostWords_index2 |
| **OPE**          | 0.059***   | 0.006***   | 0.016***   |
|                  | (2.30)     | (3.14)     | (3.19)     |
| **Market Value** | −0.043**   | −0.002     | −0.007***  |
|                  | (−2.45)    | (−1.64)    | (−2.15)    |
| **Sales Growth** | −0.028     | −0.003*    | −0.009*    |
|                  | (−1.14)    | (−1.79)    | (−1.80)    |
| **Gross Margin** | −0.553***  | −0.049***  | −0.134***  |
|                  | (−5.42)    | (−6.74)    | (−6.63)    |
| **Capital Intensity** | 0.457*** | 0.039***   | 0.105***   |
|                  | (5.37)     | (6.33)     | (6.28)     |
| **Leverage**     | −0.036     | 0.006      | 0.013      |
|                  | (−0.56)    | (1.35)     | (1.07)     |
| **Firm Age**     | −0.207***  | −0.006*    | −0.022***  |
|                  | (−4.05)    | (−1.68)    | (−2.14)    |
| **Market Index** | −0.003     | 0.000      | 0.001      |
|                  | (−0.15)    | (0.30)     | (0.27)     |
| **Top1**         | 0.196*     | 0.015*     | 0.041*     |
|                  | (1.82)     | (1.93)     | (1.91)     |
| **Independent**  | 0.301*     | 0.016      | 0.044      |
|                  | (1.72)     | (1.28)     | (1.27)     |
| **CEO Duality**  | 0.022      | 0.003      | 0.010*     |
|                  | (0.77)     | (1.57)     | (1.72)     |
| **Manager Shareholding** | 0.109    | −0.011*    | −0.028     |
|                  | (1.18)     | (−1.74)    | (−1.56)    |
| **Constant**     | 2.607***   | 0.129***   | 0.413***   |
|                  | (5.46)     | (3.77)     | (4.40)     |
| **Firm FE**      | Yes        | Yes        | Yes        |
| **Year FE**      | Yes        | Yes        | Yes        |
| **N**            | 11804      | 11804      | 11804      |
| **Within R²**    | 0.1102     | 0.1303     | 0.1073     |
better deal with the impact of fluctuating demand from downstream customers and curb their bullwhip effect. By contrast, we do not expect manufacturing background CEOs to influence suppliers’ bullwhip effect.

We build two measures to proxy the bullwhip effect. First, we measure the bullwhip effect based on data of a single firm. We define the bullwhip effect as the ratio of the production volatility over the demand volatility, and document it as Amplification Ratio. Following Cachon et al. (2007) and Shan et al. (2014), we use sales to proxy demand, and we use the sum of operating cost and the increase in inventory in a year to proxy production. To calculate volatility, we use data of two years before, the current year, and two years after. We calculate the Amplification Ratio as follows:

\[
\text{Amplification Ratio} = \frac{\text{Var(Production)}}{\text{Var(Demand)}}
\]

Second, we measure the bullwhip effect based on data of two-layer supply chains. We manually collect information of sample firms’ customers and suppliers. We keep the listed customers and suppliers. Then we build 814 ‘sample firm – customer’ observations and 455 ‘supplier – sample firm’ observations. Following Z.Q. Yang et al. (2020), we calculate the bullwhip effect of sample firm (Bullwhip\text{\textsubscript{FocalFirm}}) and the bullwhip effect of their suppliers (Bullwhip\text{\textsubscript{Supplier}}) as follows:

Table 9. Flexible production and bullwhip effect.

|                | (1) Inventory Holding | (2) Inventory Days | (3) Amplification Ratio | (4) Bullwhip\text{\textsubscript{FocalFirm}} | (5) Bullwhip\text{\textsubscript{Supplier}} |
|----------------|-----------------------|--------------------|-------------------------|---------------------------------------------|---------------------------------------------|
| **OPE**        | -0.005**              | -5.599**           | -0.047***               | -0.215**                                    | -0.016                                      |
|                | (-2.45)               | (-1.96)            | (-3.07)                 | (-2.00)                                     | (-0.07)                                     |
| **Market Value**| -0.012***             | -10.513***         | -0.005                  | -0.121                                      | 0.213                                       |
|                | (-9.42)               | (-5.42)            | (-0.48)                 | (-1.38)                                     | (1.34)                                      |
| **Sales Growth**| 0.006***              | -45.563***         | -0.135***               | -0.135                                      | 0.017                                       |
|                | (3.13)                | (-16.75)           | (-9.50)                 | (-1.14)                                     | (0.10)                                      |
| **Gross Margin**| -0.027***             | 292.858***         | -0.049                  | 0.743                                       | 0.623                                       |
|                | (-3.55)               | (25.60)            | (-0.77)                 | (1.09)                                      | (0.69)                                      |
| **Capital Intensity**| -0.029***             | -48.587***         | -0.077                  | -0.069                                      | 1.116                                       |
|                | (-4.56)               | (-5.11)            | (-1.55)                 | (-0.18)                                     | (1.60)                                      |
| **Leverage**   | 0.085***              | 117.078***         | -0.041                  | 0.222                                       | -0.585                                      |
|                | (17.64)               | (16.49)            | (-1.08)                 | (0.68)                                      | (-1.12)                                     |
| **Firm Age**   | -0.013***             | -12.071***         | 0.015                   | 0.026                                       | 0.114                                       |
|                | (-3.35)               | (-2.09)            | (0.17)                  | (0.74)                                      | (1.17)                                      |
| **Market Index**| 0.003*                | 3.311              | -0.016                  | -0.004                                      | -0.471**                                    |
|                | (1.90)                | (1.37)             | (-1.42)                 | (-0.05)                                     | (-2.46)                                     |
| **Top1**       | 0.015*                | -13.062            | -0.073                  | 1.023**                                     | -0.447                                      |
|                | (1.87)                | (-1.09)            | (-1.12)                 | (1.91)                                      | (-0.58)                                     |
| **Independent**| 0.030**               | 28.183             | 0.099                   | 0.793                                       | -0.191                                      |
|                | (2.29)                | (1.45)             | (0.98)                  | (0.95)                                      | (-0.16)                                     |
| **CEO Duality**| -0.004*               | -7.343**           | 0.013                   | 0.124                                       | 0.158                                       |
|                | (-1.83)               | (-2.34)            | (0.74)                  | (0.69)                                      | (0.65)                                      |
| **Manager Shareholding**| -0.005               | -4.518             | -0.030                  | -1.342**                                    | -0.791                                      |
|                | (-0.67)               | (-0.44)            | (-0.48)                 | (-1.96)                                     | (-0.84)                                     |
| **Constant**   | 0.422***              | 285.879***         | 1.110**                 | 2.838                                       | -1.372                                      |
|                | (11.95)               | (5.46)             | (2.26)                  | (1.44)                                      | (-0.32)                                     |
| **Firm FE**    | Yes                   | Yes                | Yes                     | Yes                                         | Yes                                         |
| **Year FE**    | Yes                   | Yes                | Yes                     | Yes                                         | Yes                                         |
| **N**          | 12433                 | 12433              | 9072                    | 814                                         | 455                                         |
| **Within R²**  | 0.111                 | 0.089              | 0.019                   | 0.072                                       | 0.091                                       |
We use model (2) to examine the effect of manufacturing background CEOs on Amplification Ratio, Bullwhip\textsubscript{FocalFirm}, and Bullwhip\textsubscript{Supplier}. Column (3) to (5) of Table 9 reports the results. The results show that manufacturing background CEOs are negatively associated with the bullwhip effect, whichever measurement is used. And consistent with our expectation, we find that manufacturing background CEOs do not significantly affect on their suppliers’ bullwhip effect. The results thus validate the third mechanism.

### 4.4. Cross-sectional analysis

The results in the prior section demonstrate that manufacturing background CEOs are associated with a lower degree of cost stickiness. We hypothesise that manufacturing background CEOs inhibit cost stickiness by decreasing adjustment costs. We then predict that a manufacturing background CEO can play a more significant role in cost management when it is more complicated. In this section, we propose that firms with higher demand uncertainty, higher assets intensity, or lower customer concentration should have more difficulty reducing cost, where the effect of manufacturing background CEOs should be more pronounced.

#### 4.4.1. Demand uncertainty

When facing higher demand uncertainty, it is more difficult to plan production and control costs. The manufacturing background CEOs’ ability to enhance production processes and integrate supply chains enables quick response to demand changes. We then predict that the effect of manufacturing background CEOs should be higher for firms facing higher demand uncertainty.

We build two proxies for demand uncertainty. First, following Irvine et al. (2015) and Cohen and Li (2019), we use the standard deviation of sales growth over the recent five years to measure demand uncertainty of sales (DU). Second, following Rao and Xu (2017) and Baker et al. (2016), we take the average of economic policy uncertainty indices for a year to measure economic policy uncertainty (EPU). We then divide the sample by the median of demand uncertainty of sales for each year and economic policy uncertainty, respectively. We examine the effect of manufacturing background CEOs on cost stickiness for each group.

Table 10 reports the results. The estimates show that the effect of manufacturing background CEOs is only significant for firms with higher demand uncertainty of sales and higher economic policy uncertainty. The results suggest that manufacturing background CEOs play a more critical role when firms face higher demand uncertainty.

#### 4.4.2. Asset intensity

Firms with higher asset intensity usually have a more sophisticated production process, making it more challenging to manage costs. The effect of manufacturing background CEOs on cost stickiness could be higher for these firms since they may enhance the
production process and use more flexible methods to manage cost, such as renting equipment (Holzhacker et al., 2015). We divide the sample into two groups by the median asset intensity for each year. The regression results are reported in Table 11. The results show that the effect of manufacturing background CEOs on cost stickiness is only significant in the firms with higher asset intensity.

4.4.3. Customer concentration
Customer concentration may also moderate the association of manufacturing background CEOs and cost stickiness. For a firm with a concentrated customer base, they may have deeper cooperation with their customers (X.Y. Wang & Gao, 2017). Therefore, firm may get customers’ demand information earlier, and response quickly to the demand fluctuation. For firms with a diversified customer base, managers’ ability to coordinate with customers is more critical, so manufacturing background CEOs are more likely to play a more significant role in this situation.

| Table 10. The impact of demand uncertainty. |
|-----------------------------------------------|
| (1)                        | (2)                        | (3)                        | (4)                        |
| **DU** is high **ΔlnCOST** | **DU** is low **ΔlnCOST** | **EPU** is high **ΔlnCOST** | **EPU** is low **ΔlnCOST** |
| ΔlnSALE                    | 0.947***                   | 1.063***                   | 0.992***                   | 0.973***                   |
| (31.15)                    | (29.11)                    | (29.76)                    | (37.30)                    |
| ΔlnSALE×OPE                | −0.131***                  | 0.004                      | −0.153***                  | −0.003                      |
| (−5.66)                    | (0.15)                     | (−7.10)                    | (−14)                      |
| ΔlnSALE×AINT               | −0.059***                  | −0.038                     | −0.066***                  | −0.088***                  |
| (−3.37)                    | (−1.52)                    | (−4.03)                    | (−8.84)                    |
| ΔlnSALE×EINT               | 1.801**                    | −1.551                     | 0.071                      | 2.293***                   |
| (2.17)                     | (−1.49)                    | (0.08)                     | (3.21)                     |
| ΔlnSALE×GDPG               | 0.019                      | −0.238                     | −0.111                     | −0.151                     |
| (0.09)                     | (−0.95)                    | (−0.39)                    | (−0.85)                    |
| DEC×ΔlnSALE                | 0.023                      | 0.017                      | 0.006                      | 0.022                      |
| (0.31)                     | (0.20)                     | (0.07)                     | (0.33)                     |
| DEC×ΔlnSALE×OPE            | 0.164***                   | 0.055                      | 0.209***                   | −0.032                     |
| (2.78)                     | (0.78)                     | (3.72)                     | (−0.61)                    |
| DEC×ΔlnSALE×AINT           | −0.008                     | −0.014                     | 0.024                      | 0.035                      |
| (−0.20)                    | (−0.24)                    | (0.57)                     | (0.97)                     |
| DEC×ΔlnSALE×EINT           | −3.206*                    | −0.200                     | −5.365***                  | −3.130***                  |
| (−1.83)                    | (−0.09)                    | (−2.78)                    | (−2.15)                    |
| DEC×ΔlnSALE×GDPG           | −0.177                     | −0.472                     | 0.225                      | 0.151                      |
| (−0.31)                    | (−0.71)                    | (0.33)                     | (0.30)                     |
| DEC×ΔlnSALE×SD             | −0.026                     | −0.045                     | 0.001                      | −0.056                     |
| (−0.62)                    | (−1.00)                    | (0.03)                     | (−1.56)                    |
| OPE                        | 0.011                      | 0.003                      | 0.016**                    | 0.001                      |
| (1.14)                     | (0.47)                     | (2.15)                     | (0.22)                     |
| AINT                       | 0.003                      | 0.001                      | 0.009                      | 0.018***                   |
| (0.36)                     | (0.19)                     | (1.34)                     | (3.10)                     |
| EINT                       | −0.659*                    | 0.325                      | −0.637***                  | −0.477*                    |
| (−1.87)                    | (1.16)                     | (−2.09)                    | (−1.93)                    |
| GDPG                       | 0.287***                   | 0.198***                   | 0.296***                   | −2.036*                    |
| (2.98)                     | (3.28)                     | (3.29)                     | (−1.83)                    |
| SD                         | −0.018**                   | −0.006                     | −0.013*                    | −0.006                     |
| (−2.06)                    | (−1.06)                    | (−1.84)                    | (−1.07)                    |
| Constant                   | −0.015                     | −0.038***                  | −0.025**                   | 0.185*                     |
| (−1.16)                    | (−4.38)                    | (−2.02)                    | (1.87)                     |
| Firm FE                    | Yes                        | Yes                        | Yes                        | Yes                        |
| Year FE                    | Yes                        | Yes                        | Yes                        | Yes                        |
| N                          | 4699                       | 4533                       | 5881                       | 6552                       |
| Within R²                  | 0.879                      | 0.819                      | 0.851                      | 0.874                      |
We measure customer concentration (CC) following Patatoukas (2012). Since Chinese listed firms are encouraged to disclose their top five customers, we measure customer concentration as the sum of the squares of the purchasing ratios of a firm’s top five customers. We divide the sample into two groups by the median customer concentration for each year. The regression results are reported in Table 12, which shows that the effect of manufacturing background CEOs on cost stickiness is only significant for firms with lower customer concentration.

### 4.5. Further analysis

Business-finance integration indicates a combination of operations and finance in the management (Y.X. Wang & Li, 2020). When a manufacturing background CEO is also a financial expert, besides enhancing production and inhibiting the bullwhip effect, he may be more sensitive to cost changes, better at analysing financial data and using financial tools. A combination of operations information and financial information could further facilitate decision-making. All of which ultimately affect cost stickiness. As pointed out by He et al., (2019), CEOs with rich professional experiences could be more valuable...
than CEOs with single professional experience since different professional experiences could together shape managers’ styles. We then predict that CEOs with manufacturing and finance backgrounds have a more substantial inhibiting effect on cost stickiness than CEOs with only manufacturing backgrounds.

We find that 19.59% of observations in our sample have finance background CEOs (FIN), and only 2% of observations have CEOs with both manufacturing and finance backgrounds (OpeFIN). Table 13 shows the regression results. The regression in column (1) of Table 13 is the same as the regression in column (5) of Table 4. Column (1) indicates that manufacturing background CEOs are negatively associated with cost stickiness. Column (2) indicates that the association between finance background CEOs and cost stickiness is insignificant. In column (3), we examine the effect of CEOs with both manufacturing and finance backgrounds (OpeFIN), and CEOs with manufacturing but no finance backgrounds (Ope_NoFin). The point estimate for DEC×ΔlnSale×OpeFIN is 0.327, and the point estimate for DEC×ΔlnSale×Ope_NoFin is 0.099, their difference is significant.

| Table 12. The impact of customer concentration. | (1) CC is high | (2) CC is low |
|-----------------------------------------------|---------------|---------------|
| $\Delta \ln \text{SALE}$ | 1.060*** | 1.000*** |
| | (27.80) | (27.31) |
| $\Delta \ln \text{SALE} \times \text{OPE}$ | −0.097*** | −0.157*** |
| | (−3.68) | (−6.31) |
| $\Delta \ln \text{SALE} \times \text{AINT}$ | −0.080*** | −0.095*** |
| | (−4.24) | (−4.56) |
| $\Delta \ln \text{SALE} \times \text{EINT}$ | −0.286 | −0.048 |
| | (−0.30) | (−0.04) |
| $\Delta \ln \text{SALE} \times \text{GDPG}$ | −0.585** | 0.201 |
| | (−2.12) | (0.75) |
| DEC×ΔlnSALE | −0.136 | −0.007 |
| | (−1.42) | (−0.08) |
| DEC×ΔlnSALE×OPE | 0.089 | 0.196*** |
| | (1.27) | (3.04) |
| DEC×ΔlnSALE×AINT | 0.007 | 0.065 |
| | (0.15) | (1.27) |
| DEC×ΔlnSALE×EINT | 0.247 | −2.347 |
| | (0.12) | (−0.89) |
| DEC×ΔlnSALE×GDPG | 1.237 | −0.456 |
| | (1.59) | (−0.60) |
| DEC×ΔlnSALE×SD | −0.051 | −0.095*** |
| | (−1.09) | (−2.05) |
| OPE | 0.021** | 0.010 |
| | (2.24) | (1.14) |
| AINT | −0.011 | 0.009 |
| | (−1.31) | (1.08) |
| EINT | 0.561 | −0.393 |
| | (1.58) | (−0.95) |
| GDPG | 0.091 | 0.108 |
| | (0.35) | (0.48) |
| SD | −0.011 | −0.013* |
| | (−1.32) | (−1.73) |
| Constant | −0.003 | −0.011 |
| | (−0.11) | (−0.40) |
| Firm FE | Yes | Yes |
| Year FE | Yes | Yes |
| N | 3843 | 3843 |
| Within $R^2$ | 0.864 | 0.863 |
(with the p-value of 0.03). The results thus validate our conjecture that CEOs with both manufacturing and finance backgrounds have a more substantial inhibiting effect on cost stickiness than CEOs with only manufacturing backgrounds.

Table 13. The impact of CEOs with both manufacturing and finance backgrounds.

|                | (1) ΔlnCOST | (2) ΔlnCOST | (3) ΔlnCOST |
|----------------|-------------|-------------|-------------|
| ΔlnSALE        | 0.960***    | 0.958***    | 0.960***    |
|                | (52.54)     | (51.45)     | (52.57)     |
| ΔlnSALE×OPE    | −0.082***   |             |             |
|                | (−5.96)     |             |             |
| ΔlnSALE×FIN    |             | −0.011      |             |
|                |             | (−0.89)     |             |
| ΔlnSALE×OpeFin|             |             | −0.164***   |
|                |             |             | (−4.40)     |
| ΔlnSALE×Ope_NoFin|          |             | −0.071***   |
|                |             |             | (−4.94)     |
| ΔlnSALE×AINT   | −0.073***   | −0.074***   | −0.073***   |
|                | (−7.23)     | (−7.33)     | (−7.19)     |
| ΔlnSALE×EINT   | 1.179**     | 1.244**     | 1.140**     |
|                | (2.29)      | (2.41)      | (2.21)      |
| ΔlnSALE×GDPG   | −0.033      | −0.045      | −0.035      |
|                | (−0.24)     | (−0.32)     | (−0.25)     |
| DEC×ΔlnSALE    | 0.037       | 0.045       | 0.037       |
|                | (0.80)      | (0.98)      | (0.78)      |
| DEC×ΔlnSALE×OPE| 0.124***   |             |             |
|                |             | (3.49)      |             |
| DEC×ΔlnSALE×FIN|             | 0.053       |             |
|                |             | (1.62)      |             |
| DEC×ΔlnSALE×OpeFin|       |             | 0.327***   |
|                |             |             | (3.17)      |
| DEC×ΔlnSALE×Ope_NoFin| |             | 0.099***   |
|                |             |             | (2.68)      |
| DEC×ΔlnSALE×AINT| 0.014      | 0.016       | 0.013       |
|                | (0.57)      | (0.64)      | (0.54)      |
| DEC×ΔlnSALE×EINT| −3.194***  | −3.343***   | −3.139***   |
|                | (−2.99)     | (−3.12)     | (−2.94)     |
| DEC×ΔlnSALE×GDPG| −0.122     | −0.092      | −0.116      |
|                | (−0.33)     | (−0.25)     | (−0.31)     |
| DEC×ΔlnSALE×SD | −0.041*     | −0.041*     | −0.041*     |
|                | (−1.67)     | (−1.67)     | (−1.70)     |
| OPE            | 0.011***    |             |             |
|                | (2.60)      |             |             |
| FIN            | 0.004       |             |             |
|                | (0.88)      |             |             |
| OpeFin         |             |             | 0.018       |
|                |             |             | (1.52)      |
| Ope_NoFin      |             |             | 0.011***    |
|                |             |             | (2.30)      |
| AINT           | 0.011***    | 0.011***    | 0.011***    |
|                | (2.64)      | (2.63)      | (2.58)      |
| EINT           | −0.382**    | −0.396**    | −0.377**    |
|                | (−2.11)     | (−2.18)     | (−2.08)     |
| GDPG           | 0.155***    | 0.153***    | 0.154***    |
|                | (2.90)      | (2.85)      | (2.89)      |
| SD             | −0.013***   | −0.013***   | −0.013***   |
|                | (−2.95)     | (−2.99)     | (−2.96)     |
| Constant       | −0.007      | −0.005      | −0.007      |
|                | (−1.04)     | (−0.78)     | (−1.02)     |
| Firm FE        | Yes         | Yes         | Yes         |
| Year FE        | Yes         | Yes         | Yes         |
| N              | 12433       | 12433       | 12433       |
| Within R²      | 0.858       | 0.858       | 0.858       |
5. Conclusion

Cost control is critical for firms’ survival. Prior studies have investigated the negative effect of managers’ agency problems on cost stickiness. However, fewer studies have explored managers’ positive role in inhibiting cost stickiness. We take a unique perspective of CEOs’ manufacturing background and examine its effect on cost stickiness. The analysis reveals four main findings. First, manufacturing background CEOs could decrease cost stickiness. A series of robustness tests validate our hypothesis. Second, manufacturing background CEOs place more emphasis on firms’ cost management, they are more likely to adopt flexible production to decrease inventory, and they are better able to cope with the bullwhip effect. These mechanisms lead to reduced adjustment costs and cost stickiness. Third, the impact of manufacturing background CEOs on cost stickiness is more pronounced for firms with high demand uncertainty, high assets intensity, and low customer concentration. Finally, CEOs with manufacturing and finance backgrounds have a more substantial inhibiting effect on cost stickiness.

Our findings have several implications for the firm. First, since managers with manufacturing backgrounds could play an essential role in cost management, firms should pay attention to their career advancement. Second, manufacturing background CEOs play a more critical role in situations where cost management is complex, such as high demand uncertainty, high asset intensity, and low customer concentration. Lastly, firms should provide employees with training in various areas and opportunities for job rotation.

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