# The "Butterfly Effect" in Strategic Human Capital: Mitigating the Endogeneity Concern About the Relationship Between Turnover and Performance*

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**The "Butterfly Effect" in Strategic Human Capital: Mitigating the Endogeneity Concern About the Relationship Between Turnover and Performance**

**Research Summary:** Prior literature on the relationship between the departure of strategic human capital (SHC) and firm performance is equivocal. One source of this ambiguity is the potential endogeneity: is it the SHC departure that leads to poor firm performance, or is it poor firm performance leading to the SHC departure? We respond to repeated calls to address this issue by using the Fukushima nuclear accident in Japan as an exogenous event which triggered a "butterfly effect" that influenced the departure decisions of individuals working for firms near a nuclear plant in the U.S. but not the firms' performance. Our results provide strong evidence that the departure of strategic human capital undermines firm performance, and that the effect is amplified by the strength of employee-firm relationships.

**Managerial Summary:** This study shows that Japan's Fukushima nuclear accident prompted an increase in the departure of strategic human capital (SHC) working in firms in close proximity to nuclear plants in the U.S. It provides strong empirical evidence that the departure of SHC hurts firm performance and that firms which have a strong relationship with their employees suffer more. These findings suggest a potential downside to cultivating such relationships and highlight the ripple effects of unexpected external events on firm performance.

*"Does the flap of a butterfly's wings in Brazil set off a tornado in Texas?"*

*— Edward Lorenz (29 Dec 1972)*

## 1 | INTRODUCTION

A growing body of literature points to human capital as a source of sustainable competitive advantage (Coff, 1997; Hatch and Dyer, 2004). But unlike other types of competitive-advantage-yielding resources such as culture, intellectual property or reputation, human resources are not owned by the firm; employees can leave their employer any time. Consequently, research has long sought to isolate the mechanisms that prevent workers from leaving (Cambell, Coff and Kryscynski, 2012). This research is based on the assumption that the departure of employees with valuable, rare, inimitable, and non-substitutable knowledge, skills, and abilities (henceforth referred to as strategic human capital or SHC) has a negative effect on firm performance (Barney and Wright, 1998). While this assumption is justified, it overlooks the arguments advanced for the beneficial effects of turnover. These include the departure of poor performers (Staw, 1980), increased organizational effectiveness (Abelson and Baysinger, 1984), infusion of new knowledge/technology (Mobley, 1982), stimulation of changes in policy and practice (Johnson, Griffeth, and Griffin, 2000), opportunities for cost reduction (Dalton and Todor, 1982), and enhanced creativity (Godart, Shipilov, and Claes, 2014).

The aforementioned conflicting arguments are also reflected in the empirical findings. Although empirical evidence largely supports the harmful effects of turnover (for a review and a meta-analysis see Hausknecht and Trevor, 2011 and Hancock et al., 2013), some studies have found a positive relationship between turnover and performance (e.g., Bruton, Keels, and Shook 1996; Wayhan and Werner, 2000), while others report a curvilinear relationship (Glebbeek and Bax, 2004; Shaw, Gupta, and Delery, 2005; Godart, et al., 2014). To elucidate the various factors that could contribute to these inconsistent results, repeated calls have been made to address the potential presence of endogeneity or simultaneity between poor firm performance and the departure of strategic human capital (e.g., Gerhart, 2007, 2013; Wright and Ulrich, 2017). Our study aims to respond to these calls.

The key endogeneity concern in the SHC literature stems from workers' ability to change employers at will, making it difficult to conclude whether the departure of SHC leads to a decrease in performance or poor performance leads to higher departure rates, or alternatively whether an unobserved third factor influences both processes. We aim to tackle the endogeneity issue using an exogenous event that could have been expected to directly affect the departure of SHC but not firm performance—the Fukushima nuclear accident caused by the tsunami that followed the earthquake on 11 March 2011 in Japan. We expected the accident to prompt an increase in the departure of SHC working in firms in close proximity to nuclear plants in the U.S. by creating a perception of danger or threat, even though the latter were located thousands of miles away from the site of the accident. As per the observation from Edward Lorenz quoted at the beginning of the paper, the meltdown of the nuclear reactor in Japan would have a “butterfly effect” that triggered an increase in SHC departure rates in the U.S. However, we did not expect the event to directly affect the performance of these firms, which are outside Japan and have no affiliation with the Fukushima Daiichi nuclear power plant.

Using a matched sample of companies located close and far of a nuclear plant in the U.S., we find that the Fukushima accident induced a higher departure rate of SHC for the latter without directly affecting their performance. This tells us that we can use the Fukushima accident as an exogenous shock to test the effect of SHC departure on firm performance, which is found to be significantly negative. To further substantiate this effect, we examined whether it was moderated by the strength of the employee-firm (EF) relationship. Relationship-based employee governance mechanisms foster trust and commitment between the firm and its employees, and provide benefits in terms of increased efficiency, productivity, cooperation, and innovation, but are costly and take a long time to build (Gambeta, Koka, & Hoskisson, 2019; Harrison, Bosse, and Phillips, 2010; Mowday, Porter, and Steers, 1982). Hence, if the departure of SHC does indeed negatively affect firm performance, we would expect the strength of the EF relationship to make the impact of turnover on firm performance even worse, as we indeed find.

The main contribution of this study is to the SHC literature. First, it addresses the question of whether the departure of SHC causes a decline in firm performance but not the reverse relationship, that lies at the heart of this literature. Second, existing work on SHC concentrates on the positive aspects of building strong EF relationships, leaving the potential downside largely unexplored, yet our findings suggest that firms with strong EF relationships are more vulnerable to staff turnover. By exploring a potential risk of strong EF relationships, we provide a more balanced view of the effects of such mechanisms.

Our final contribution relates to our choice of exogenous event—the Fukushima nuclear accident. While increasing attention is being given to the impact of accidents and disasters on organizations and employees (Wenzel, Stanske and Lieberman, 2020), most research has examined the direct first-order effects of disasters (e.g., Muller and Kraussl, 2011; Pek, Oh and Rivera, 2018). For example, Tilcsik and Marquis (2013) examined how different types of natural disasters affected the philanthropic spending of locally headquartered *Fortune* 1,000 firms. We extend this growing body of literature by focusing on second-order or "butterfly" effects of accidents and disasters. Our results suggest that disasters may have an impact beyond their immediate, direct effects. In the SHC literature, prior studies of the departure of human capital have generally focused on factors under the influence of the focal firm, such as pay, job satisfaction or corporate social responsibility initiatives (Carnahan, Kryscynski, and Olson, 2017; Coff, 1997; Hom and Kinicki, 2001). By showing that an exogenous event such as the Fukushima nuclear accident can trigger a "butterfly effect" – significantly increase the departure of human capital from a firm located thousands of miles away – we underscore the need to pay more attention to external events that are beyond the firm's control and consider whether and how the risks they pose can be prospectively evaluated and managed.

## 2 | HYPOTHESES DEVELOPMENT

### 2.1. | Antecedents of SHC departure

Judging by the recent flurry of human capital-related studies in the strategy literature, the idea that SHC is a source of sustained competitive advantage has been broadly accepted (Barney and Wright, 1998). If correct, this implies that 1) the departure of SHC will negatively affect organizational performance, and 2) the more an organization bases its competitive advantage on its SHC, the greater the negative effect of its departure will be.

However, while intuitively appealing, employees with strategic value and alternative market opportunities do not leave firms randomly. Hence it is difficult to conclude whether a higher departure rate of human capital leads to a decrease in performance or poor performance leads to a higher departure rate, or whether an unobserved third factor influences both processes. To address this issue, we sought an exogenous event that would be expected to directly affect SHC departure but not firm performance, and that was unquestionably beyond the control of the firms examined. The event we chose was the Fukushima nuclear accident. Our expectation was that it would increase turnover among SHC working in close geographical proximity to nuclear plants in the U.S. – even though located thousands of miles away from Japan – by giving rise to the perception of an environmental threat that would make people question whether their job was worth the risk of falling victim to a similar accident.

Our expectation was based on three well-documented phenomena: people's tendency to show disproportionate fear and excessive reactions to (i) the risk of catastrophe (i.e., the "probability neglect"), (ii) risks that seem unfamiliar and hard to control, and (iii) salient risks (i.e., the "availability heuristic"). In short, the greater the harm a threat poses and the less predictable and more perceptible it is, the more people are likely to focus on the imagined bad outcome and ignore the fact that it is unlikely to re-occur (Slovic, 1987). Numerous examples show that the fear of a catastrophic outcome has driven people to extreme behavior, even when the likelihood of such an outcome is minuscule (e.g., Noll and Krier, 1990; Sunstein, 2003).

Both research and anecdotal reports provide preliminary evidence that the Fukushima nuclear accident prompted similar reactions. Following the Great East Japan Earthquake of magnitude 9.0, a 15-meter tsunami disabled the power supply and cooling of three Fukushima Daiichi reactors, causing a nuclear accident on 11 March 2011. Because of the high radioactive releases that ensued the accident was rated 7 on the International Nuclear and Radiological Event Scale (INES) and attracted intensive media coverage. Studies found that the Fukushima crisis tarnished the image of nuclear power (Leiserowitz, Maibach, Roser-Renouf, and Smith, 2011), and led to a widespread loss of faith in the safety of nuclear reactors (Kim, Kim, and Kim, 2013; Patil 2017), concluding that it was a ‘focusing event’, a crisis that generates massive media and public attention and ripple effects well beyond the disaster itself (Leiserowitz et al., 2011).

An examination of the media coverage of the Fukushima accident supports this conclusion, offering extensive examples of how people responded to the disaster. These include the holding of community meetings and discussions on nuclear issues across the U.S. (Knox, 2011b), rallies for nuclear safety (Knox, 2011a), stockpiling of potassium iodide tablets (Schneider, 2011), and people leaving their car's tank at least half full of gasoline in case they needed to quickly evacuate the area because of a nuclear accident (Donn, 2011).

A common finding in the human resource management literature is that the primary driver of employee turnover involves precipitating events or shocks that spur employees toward making judgments about their job (Holtom, Mitchell, Lee, and Eberly, 2008; Lee, Mitchell, Holtom, McDaniel, & Hill, 1999). Examples of such events include losing a loved one, being passed over for promotion, receiving a job offer, or having an argument with the boss (Holtom, Mitchell, Lee, & Inderrieden, 2005). While the Fukushima accident per se may not have been such a shock, we postulate that the attention and publicity it generated was so profound as to constitute one. The research reviewed above would suggest that the international media attention the disaster received, the vividness of its impact, and the outrage and fear it generated, kept people focused on the devastating outcome, while ignoring the fact that it was unlikely to re-occur. This, in turn, may have prompted people who worked near a nuclear facility to wonder whether their job was worth the risk of falling victim to a similar accident. Accordingly, we make the following hypothesis:

> **Hypothesis 1 (H1)** *Following the Fukushima nuclear accident in Japan, there will be a significant increase in the departure of strategic human capital in firms operating in close proximity to a nuclear facility in the U.S.*

### 2.2. | Strategic human capital (SHC) departure and firm performance

Management scholars investigating the relationship between employee departures and firm performance have produced a burgeoning literature on SHC that emphasizes the importance of human resources to firm performance (Campbell et al., 2012; Chadwick & Dabu, 2009; Coff, 1997; Hatch & Dyer, 2004). To build a human capital-based competitive advantage, firms need not only to attract valuable human capital (Chatain & Meyer-Doyle, 2017; Coff, 1997), but also to keep it from leaving (Coff & Kryscynski, 2011; Gardner, 2002; Groysberg, Lee, & Nanda, 2008). High turnover rates of SHC can deliver a blow to firm performance if existing routines are disrupted (Bluedorn, 1982; Dalton & Todor, 1979, 1982) or if experience, knowledge, and social capital are lost (Dess & Shaw, 2001; Nelson & Winter, 1982). A high departure rate can also make it difficult for those who remain to continue performing effectively (Ton & Huckman, 2008), may create anxiety among them, and send a negative signal to external stakeholders such as suppliers and customers about internal operations, exacerbating the situation and sending the firm into a spiral of poor performance.

However, a major empirical challenge to such arguments is the potential presence of endogeneity due to reverse causality. Moreover, not all employees have valuable, rare, inimitable, and non-substitutable knowledge, skills, or abilities. It is important to distinguish between the departure of strategic and non-strategic human capital. Departures of the former are particularly likely to have a negative effect on the firm’s resource base and undermine performance. We thus limit our analysis to departures of SHC and leverage the exogenous shock (i.e., the Fukushima nuclear accident) to develop a causal hypothesis:

> **Hypothesis 2 (H2)** *The departure of strategic human capital will lead to a decline in firm performance.*

### 2.3. | The moderating effects of Employee-firm (EF) relationship strength

Thus far we have focused on the effect of SHC departure on firm performance. We now extend our argument by considering how the strength of the EF relationship may amplify the impact of SHC departure on performance. Our rationale is that the more a firm invests in building and maintaining strong relationships with employees, the more damage SHC turnover will cause and the greater the subsequent decline in performance.

Underlying the formation of a cooperative and trust-based relationship between the firm and its employees is the belief that it can lead to a competitive advantage and result in enhanced firm performance (Harrison et al., 2010). By giving employees the ability to control how their roles are performed and creating a willingness to cooperate and share knowledge, strong EF relationships have been shown to decrease shirking and increase motivation, productivity, efficiency and innovation (Gambeta et al., 2019; Harrison et al., 2010), leading to enhanced firm performance (Arthur, 1994; Huselid, 1995; Bae and Lawler, 2000).

Despite the obvious benefits of a strong EF relationship, they are costly and take time to build. Developing a strong EF relationship may require expensive human resource practices such as worker involvement programs, health and safety programs, career opportunity and employee development programs, and work–life balance practices. Likewise, the trust, commitment, and norms of cooperation that these programs are designed to foster take a long time to build (Lane & Bachmann, 1998). It is also important to note that the trust and commitment that relationship-based governance mechanisms engender are specific to the individual: once the employee leaves, the relationship is lost. And once lost, it cannot be easily and quickly substituted by another. To the extent that a firm's investment in strong EF relationships corresponds to the value these are expected to deliver, we would expect it to amplify the negative impact of SHC departure on firm performance (H2). That is, the stronger the EF relationship, the greater the negative impact of departure on the firm's performance. Accordingly, we make the following prediction:

> **Hypothesis 3 (H3)** *The decline in firm performance caused by the departure of strategic human capital (H2) will be amplified by the strength of firm-employee relationship.*

## 3. | METHOD

### 3.1 | Data and sample

Our sample consists of all firms in the merged CRSP-Compustat database that have non-missing values for the variables required in our tests. The sample period covers three years prior to (i.e., 2008 to 2010) and three years after (i.e., 2012 to 2014) the Fukushima nuclear disaster, which occurred in 2011 (using an alternative sample period of two years before and two years after yielded similar results).

Information about all operating nuclear power plants in the U.S. was gathered from a nonprofit science advocacy organization, the Union of Concerned Scientists. Then, based on the headquarters information obtained from Compustat, we identified 797 firms located within 50 miles of any operating nuclear plant. These companies are considered as the "treatment" group companies. Next, we use the nearest neighborhood of propensity score matching (PSM) approach to identify one-on-one matching firms in the "control" group which are (1) located between 100 and 150 miles away from a nuclear plant, (2) in the same SIC-2-digit industry as the treated firms; and (3) with the nearest PSM score in the first stage PSM prediction model with the same control variables as the baseline regression. We merged these firms with Kinder, Lydenberg, Domini, & Co. (KLD) data to collect variables that measure the strength of EF relationship. Our final sample is a balanced panel, including a total of 9,564 firm-year observations (4,782 observations of 797 firms over six years in both the treatment group and the control group[1]). Results of paired samples *t*-tests on all control variables, reported in Online Appendix A, show no significant differences between the control and treatment groups. This suggests that our matching process is appropriate, and our control group is similar to the treatment group in several key variables such as number of employees, R&D intensity, firm size and sales growth.

### 3.2 | Measures

#### 3.2.1 | SHC departure

Our hypotheses pertain to a small population of employees who can be considered as "strategic" (Barney, 1991). Given that firm-level data on employee departures is not publicly available, and to be able to identify this distinct group of employees instead of counting all employees who left each firm each year, we define *SHC departure* as the proportion of stock options that are cancelled, forfeited, expired, or terminated during each year. The validity of this measure is based on the notion that firms typically give stock options only to a subset of key employees whom they particularly want to retain (Aboody et al., Lazear, 2004), and on prior research which suggests that a change in stock options is a good proxy for the loss of human capital as it typically occurs upon employee departure from the firm (Babenko & Sen, 2014; Carter & Lynch, 2004; Phua, Tham, & Wei, 2018). We collected this variable information from the Compustat database, which comprises data available after 2004.[2]

#### 3.2.2. | EF relationship strength

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[1] The PSM is conducted with replacement. Therefore, it is possible that a firm is selected as the control firm for more than one treated firm.

[2] As discussed later, using inventor turnover as an alternative measure of SHC departure produces similar results.

The KLD database, widely used in previous strategy research (e.g., Berman, Wicks, Kotha, & Jones, 1999; Hillman & Keim, 2001), annually compiles information on U.S. firms' employee relations practices and policies (covering union relations, no-layoff policy, employee involvement, retirement benefits strength, health and safety strength).[3] We measure *EF relationship strength* using each firm's "employee relations" score (i.e., total strength score).[4] A firm's EF relationship strength is coded 1 when its adjusted EF relationship score is higher than the industry median in the respective year, and 0 otherwise.[5]

### 3.2.3. | Firm performance

We measure firm performance as return on assets (*ROA*), i.e., net income divided by total assets. To account for potential time lag effects, we use the average ROA over three years ($ROA_{\_avg\_t+2}$). In our robustness checks we also use ROA in year t ($ROA_{\_t}$) and the average ROA over two years ($ROA_{\_avg\_t+1}$) and find similar results.

## 3.3 | Control variables

We first control for firm characteristics that may influence the dependent variables—SHC departure and/or firm performance (e.g., Crook, et al., 2011; Hancock, et al., 2013; Hitt, et al., 2001; Holtom et al., 2008; Huselid, Jackson, & Schuler, 1997). These include firm size (*Ln*(*Sales*)), measured by the natural logarithm of sales; leverage (*Lev*), measured by book value of debts (sum of current liabilities and long-term debt) divided by market value of assets (total book value of assets minus book value of equity plus market value of equity); market-to-book

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[3] As discussed later, additional analyses using employee-provided data collected from Glassdoor.com to measure EF relationship strength (which include employees' career opportunity, work–life balance, and compensation) generates consistent results.

[4] As a robustness check, we adjust total strength score by deducting its "cash profit sharing" score because cash profit sharing is likely to be highly correlated with our measure of SHC departure. Results remain unchanged when using the adjusted score.

[5] We use a dummy variable rather than a continuous variable because the distribution of the KLD measure is highly skewed. The average EF relationship strength is .416, which means that in 75 percent of the cases the KLD index is zero. We ran a robustness check using the continuous measure; results were similar but weaker.

ratio (*M/B*), measured by the market value of total equity divided by the book value of total equity; free cash flow (*Cash/Total sales*), measured by cash holding divided by total sales; capex intensity (*Capex/Total sales*), measured by capital expenditure divided by total sales; R&D intensity (*R&D/Total sales*), measured by R&D expenses divided by total sales[6]; sales growth, measured by the ratio of sales over previous year sales; stock market return (*Return*), calculated as the firm's annual stock return for the previous fiscal year.

Given that corporate governance mechanisms may influence the firm policy and performance (e.g., Larcker & Tayan, 2015; Finkelstein, Hambrick, & Cannella, 2009), we also control for corporate governance factors, such as *Board size*, measured by the total number of directors, with data collected from BoardEx, and *Board independence*, measured by the ratio of the number of independent directors to the total number of directors. Finally, we control for industry fixed effects in all models.

### 3.4. | Empirical model

H1 suggests that firms located close to a nuclear facility in the U.S. would have experienced an increase in SHC departure after the Fukushima nuclear accident. To test this hypothesis, we use difference-in-differences (DID) analysis (Meyer, 1995; Singh & Agrawal, 2011), in which firms located within 50 miles of a nuclear facility comprise the treatment group, and matching firms located between 100 and 150 miles away from a nuclear facility comprise the control group. The variable *Nuclear proximity* is a dummy variable, coded as 1 when a firm belongs to the treatment group, and 0 when it belongs to the control group. The event in our DID analysis is the Fukushima nuclear accident in 2011. We then code the variable *Post* as 1 for three years after the

[6] We follow prior research to create a scaled measure to adjust the firm size effect (Aggarwal, 2020; Bharath & Dittmar, 2010).

event (2012 to 2014), and 0 for three years before the event (2008 to 2010). Our regression model to test H1 is as follows:

$$SHC\ departure = \delta_1 * Nuclear\ proximity * Post + \delta_2 * Nuclear\ proximity + \delta_3 * Post + \text{control variables} + \text{residual} \quad \ldots\ldots (1)$$

where we examine the coefficient of $\delta_1$**Nuclear proximity*Post* which captures the DID effect. The DID analysis allows us to control for the general trend of departure of SHC in the U.S. over time and thus to attribute causality to the exogenous Fukushima nuclear event, or the "butterfly effect" rippling over from Japan to the U.S.

To test H2, which claims a causal effect of SHC departure on firm performance, we first use the above equation (1) to generate the predicted value of turnover (*Predicted SHC departure*) for each firm-year observation. In other words, the exogenous event in Fukushima is considered as an instrumental variable which directly impacts SHC departure from US firms (as a first-stage analysis) but not their performance[7]. We test H2 as follows:

$$ROA = \delta_1 * Predicted\ SHC\ departure + \text{control variables} + \text{residual}, \quad \ldots\ldots (2)$$

where we examine the coefficient of $\delta_1$**Predicted SHC departure*, which should be negative if our hypothesis is supported.

To test H3, which predicts that EF relationship strength will amplify the negative effect of SHC departure on firm performance, we use the following model specification:

$$ROA = \delta_1 * Predicted\ SHC\ departure * EF\ relationship\ strength + \delta_{2w} * Predicted\ SHC\ departure + \delta_3 * EF\ relationship\ strength + \text{control variables} + \text{residual}, \quad \ldots\ldots (3)$$

[7] In a recent article, Atanasov and Black (2020) highlight the potential limitations of shock-based instrumental variable designs, drawing attention to the fact that even exogenous events may not truly randomize the treated and control groups because individuals differ in their response to the shock. The authors provide a good-practice checklist for such designs, which we carefully follow by ensuring that our sample has been properly matched, trimmed, and balanced, and that it met the requirement of common support and covariate balance.

where we expect the coefficient of $\delta_1$**Predicted SHC departure*EF relationship strength* to be negative.[8]

## 4 | FINDINGS

### 4.1. | Main results

Table 1 reports descriptive statistics and correlations. Tests indicate a maximum/mean variance inflation factor (VIF) of 3.01/1.63 across the regression models, well below the suggested threshold of 10 for the risk of multicollinearity (Cohen, Cohen, West, & Aiken, 2003).

=== Insert Table 1 here ===

Before reporting the regression results for H1, we present Figure 1, which shows the parallel trend of the dependent variable—SHC departure—for the treatment (solid line) and control (dotted line) firms. Consistent with H1, before the Fukushima nuclear event the two groups of firms were similar or “parallel”. After the event in 2011, the treatment firms had a higher rate of SHC departure.

Table 2 reports the DID analyses predicting SHC departure (H1). Model 1 only includes *Nuclear proximity* (1 indicates the treatment group), *Post* (1 indicates post-Fukushima nuclear event observations), and their interaction term, which captures the DID effect. *Nuclear proximity*Post* has a positive effect ($\beta = 0.025$, $p = .000$). In terms of magnitude, the result suggests that after the 2011 Fukushima nuclear event, the increase in SHC departure among firms in close proximity to a nuclear power plant was 0.025 higher than that of the control firms, or 28% (i.e., 0.025/0.089) of the sample mean. In Model 2 we further include a list of control

[8] We do not use firm fixed effect instrumental variable (EF-IV) regression to test H3 because the strength of EF-relationship does not vary much within firms over time. Instead, in additional analyses, we split the sample into high vs. low EF-relationship subsamples and run a separate FE-IV regression for each. Results are similar but weaker.

variables—firm characteristics and governance factors—and the DID interaction effect of *Nuclear proximity*Post* remains strong (β = 0.024, $p$ = .000), thus further supporting H1.

=== Insert Figure 1 and Table 2 here ===

Table 3 reports the results of testing H2 (i.e., increased SHC departure will lead to a decrease in firm performance) and H3 (i.e., EF relationship strength will moderate the SHC departure–performance relationship). As discussed above, a key challenge in examining the relationship between employee turnover and (poor) firm performance is the potential for reverse causality. To address this concern, we employ a two-step instrumental variable analysis using the exogenous event as the instrumental variable. In the first step we regress *SHC departure* on *Post, Nuclear proximity*, the interaction of *Nuclear proximity* and *Post*, and various control variables, as shown in Table 2. Using the data in column 3 we calculate the predicted value of SHC turnover (*Predicted SHC departure*). Then, in the second step, we regress *Firm performance* ($ROA_{\_avg\_t+2}$) on this predicted value. Model 1 of Table 3 includes the control variables and Model 2 adds the theoretical variable. The effect of *Predicted SHC departure* is negative (β = -0.456, $p$ = .007), suggesting that a one standard deviation increase in *Predicted SHC departure* leads to a 1.5 percentage point decrease in ROA (i.e., -0.456*0.033), thus supporting H2.

In Model 3 we further add the main effect of *EF relationship strength,* and its interaction with *Predicted SHC departure*. The KLD data coverage is limited, which reduces the sample used to test H3 to 5,909 observations. The interaction term is negative (β = -0.381, $p$ = .017), indicating that the decrease in firm performance caused by SHC departure is greater the stronger the EF relationship, thus supporting H3. In terms of effect size, when EF relationship strength increases from low (dummy=0) to high (dummy=1), ROA further decreases by1.26 additional percentage points ((i.e., -0.381*0.033).

=== Insert Table 3 here ===

### 4.2 | Additional Analyses

We conducted a series of additional analyses to further validate our arguments and findings.

#### 4.2.1 | SHC departure as measured by inventors' turnover

Given the importance of inventors' human capital (Agarwal, Ganco and Ziedonis, 2009; Chemmanur, Kong, Krishnan & Yu, 2019), as a robustness check we use their turnover rates as an alternative measure of SHC departure. Using United States Patent and Trademark Office data on inventors' patent affiliation change to identify whether and when they depart from one firm to work for another, we calculate the number of inventors who left each firm each year (Brav, Jiang, Ma, & Tian, 2018). As reported in the Online Appendix B, we use this data to estimate the effect of the Fukushima nuclear accident on the proportion of inventors who left each firm each year (Model 1), as well as on the total number of inventors who worked in each firm (Model 2). The results are consistent with our main findings.

#### 4.2.2 | EF relationship strength measured by Glassdoor data

In our main analysis we measure EF relationship strength using the KLD index. To ensure the robustness of this measure, we also calculate an alternative measure using three ratings which employees can give employers on Glassdoor.com: career opportunities, work-life balance, and compensation. These ratings range from 1 to 5, higher scores indicating better employee treatment. We create a dummy variable of *EF relationship strength*, coded 1 if the sum of the three ratings is above the sample's median, and 0 otherwise. We rerun our analyses and report these results in Online Appendix C. Despite the fact that Glassdoor's coverage is limited because its ratings are voluntary, the results are similar to those obtained using the KLD index, thus further supporting H3.

### 4.2.3. | Potential Location Biases

Although our DID research design supports the causal claim that SHC departure was triggered by the Fukushima nuclear disaster, a potential concern is that nuclear power plant locations may be correlated with other environmental factors, such as lower population and economic growth rates, that may also affect SHC departure and our results. Hence, in addition to addressing these concerns by employing stringent matching criteria in our DID research design and including several control variables, we also examine population trends in the U.S. in the years before and after the Fukushima nuclear accident. We find that the average population growth rate between 2010 and 2012 of the 21 states that had a nuclear facility was 1.72 percent, while the average population growth rate of the 29 states that did not have a nuclear facility was only 1.38 percent. Thus, the differences in SHC departure rates between the treated and control groups are unlikely to be driven by the overall economic environment of the states in which they are located. To further alleviate potential concerns that our results are driven by location trends, we re-estimated the models predicting SHC turnover using subsamples of firms located on the East and West coasts. There were no significant differences between the two sets of results. In addition, we ran regressions excluding firms in California and New York (the most represented Eastern and Western states in our sample observations), and the results remain essentially the same.

## 5 | DISCUSSION

Overall, our findings provide strong evidence that the departure of SHC leads to a decrease in firm performance. By using the Fukushima nuclear accident to mitigate endogeneity concerns, we are able to establish a clear causal relationship between the departure of a firm's SHC and its performance. In so doing, this study attests to the significant impact of SHC on firm performance and its competitive advantage. Our results also suggest that firms that have strong EF relationships are more sensitive to SHC departure than those that do not. Prior literature has generally concentrated on the positive aspects of building and maintaining a strong EF relationship, leaving the potential downside largely unexplored. Our findings underscore a potential risk from cultivating strong EF relationships and call for further research to improve understanding of the uncertainties and risks associated with relationship-based employee governance mechanisms. Future research should also examine the ripple effects of unexpected external events like the Fukushima accident more generally.

The call for research is particularly timely given the COVID-19 outbreak. The pandemic has affected organizations worldwide, highlighting how vulnerable they are to circumstances beyond their control. At a time of global disruption, how the risks such incidents pose can be evaluated and managed is a question of increasing importance.

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**Figure 1: Parallel Tests**

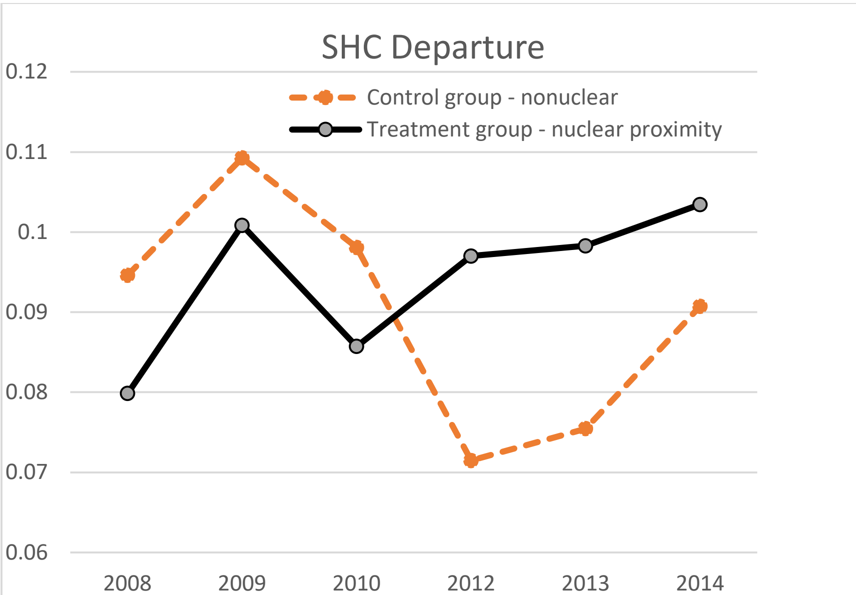


**Table 1: Descriptive data and correlations**

| | Mean | S.D. | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (1) SHC departure | 0.089 | 0.122 | | | | | | | | | | | | |
| (2) ROA$_{_avg_t+2}$ | 0.006 | 0.132 | -0.224 | | | | | | | | | | | |
| (3) Board size | 2.415 | 0.346 | -0.106 | 0.212 | | | | | | | | | | |
| (4) Board independence | 0.603 | 0.134 | -0.009 | 0.002 | -0.366 | | | | | | | | | |
| (5) Ln(Sales) | 6.336 | 2.141 | -0.171 | 0.438 | 0.64 | -0.203 | | | | | | | | |
| (6) Lev | 0.147 | 0.155 | 0.071 | 0.000 | 0.088 | -0.038 | 0.146 | | | | | | | |
| (7) M/B | 2.379 | 2.712 | -0.127 | 0.092 | 0.018 | -0.035 | 0.068 | -0.194 | | | | | | |
| (8) Cash/Sales | 0.118 | 0.140 | 0.126 | -0.328 | -0.291 | 0.025 | -0.283 | -0.336 | 0.151 | | | | | |
| (9) Capex/Sales | 0.034 | 0.046 | -0.047 | -0.034 | -0.037 | -0.048 | 0.11 | 0.094 | 0.068 | 0.085 | | | | |
| (10) R&D/Sales | 0.092 | 0.388 | 0.043 | -0.520 | -0.135 | -0.029 | -0.329 | -0.14 | 0.087 | 0.336 | 0.002 | | | |
| (11) Sales growth | 1.052 | 0.249 | -0.099 | 0.093 | -0.052 | 0.007 | -0.081 | -0.093 | 0.138 | -0.168 | -0.169 | 0.118 | | |
| (12) Return | 0.168 | 0.573 | -0.023 | 0.142 | -0.034 | -0.007 | 0.014 | 0.117 | -0.108 | -0.014 | -0.015 | -0.001 | 0.125 | |
| (13) EF relationship Strength* | 0.417 | 0.937 | -0.073 | 0.072 | 0.258 | -0.044 | 0.369 | 0.043 | 0.068 | -0.078 | 0.010 | -0.020 | -0.031 | 0.026 |

**Note: N=5,909. Raw scores from KLD data. Other (1)-(12) variables: N=9,564*

## Table 2: DID Analysis Predicting SHC Departure (H1)

| VARIABLES | (1)<br>SHC Departure *t* | (2)<br>SHC Departure *t* |
|---|---|---|
| **(H1) Nuclear proximity*Post** | **0.025** | **0.024** |
| | **(0.000)** | **(0.000)** |
| Post | -0.016 | -0.005 |
| | (0.000) | (0.285) |
| Nuclear proximity | -0.007 | -0.006 |
| | (0.098) | (0.120) |
| Board size *t-1* | | 0.018 |
| | | (0.018) |
| Board independence *t-1* | | -0.028 |
| | | (0.074) |
| Ln(Sales) *t-1* | | -0.010 |
| | | (0.000) |
| Lev *t-1* | | 0.112 |
| | | (0.000) |
| M/B *t-1* | | -0.005 |
| | | (0.000) |
| (Cash /Sales) *t-1* | | 0.093 |
| | | (0.000) |
| (Capex/Sales) *t-1* | | -0.149 |
| | | (0.000) |
| (R&D/Sales) *t-1* | | -0.003 |
| | | (0.606) |
| Sales growth *t-1* | | -0.034 |
| | | (0.000) |
| Return *t-1* | | -0.009 |
| | | (0.000) |
| Constant | 0.094 | 0.153 |
| | (0.000) | (0.000) |
| Observations | 9,564 | 9,564 |
| Adjusted R-squared | 0.053 | 0.109 |
| Industry FE | YES | YES |

## Table 3: Predicting Firm Performance Measure by ROA_$_{avg_t+2}$ (H2 and H3)

| VARIABLES | (1)<br>ROA $_{\_avg\_t+2}$ | (2)<br>ROA $_{\_avg\_t+2}$ | (3)<br>ROA $_{\_avg\_t+2}$ |
|---|---|---|---|
| **(H2) Predicted SHC departure** | | **-0.456** | -0.216 |
| | | **(0.007)** | (0.312) |
| **(H3) Predicted SHC departure*<br>EF relationship strength_dummy *t-1*** | | | **-0.381** |
| | | | **(0.017)** |
| EF relationship strength_dummy *t-1* | | | 0.021 |
| | | | (0.161) |
| Post | -0.019 | -0.015 | -0.004 |
| | (0.000) | (0.000) | (0.113) |
| Nuclear proximity | 0.001 | 0.004 | -0.004 |
| | (0.782) | (0.388) | (0.205) |
| Board size *t-1* | -0.046 | -0.038 | 0.006 |
| | (0.000) | (0.000) | (0.460) |
| Board independence *t-1* | 0.022 | 0.010 | -0.019 |
| | (0.128) | (0.498) | (0.152) |
| Ln(Sales) *t-1* | 0.024 | 0.019 | 0.004 |
| | (0.000) | (0.000) | (0.075) |
| Lev *t-1* | -0.142 | -0.091 | -0.064 |
| | (0.000) | (0.000) | (0.003) |
| M/B *t-1* | 0.004 | 0.002 | 0.003 |
| | (0.000) | (0.076) | (0.045) |
| (Cash /Sales) *t-1* | -0.133 | -0.091 | 0.050 |
| | (0.000) | (0.000) | (0.042) |
| (Capex/Sales) *t-1* | -0.093 | -0.163 | -0.127 |
| | (0.067) | (0.008) | (0.035) |
| (R&D/Sales) *t-1* | -0.140 | -0.141 | -0.146 |
| | (0.000) | (0.000) | (0.000) |
| Sales Growth *t-1* | 0.049 | 0.033 | 0.035 |
| | (0.000) | (0.000) | (0.000) |
| Return *t-1* | 0.035 | 0.031 | 0.030 |
| | (0.000) | (0.000) | (0.000) |
| Constant | -0.055 | 0.012 | 0.005 |
| | (0.025) | (0.687) | (0.895) |
| Observations | 9,564 | 9,564 | 5,909 |
| Adjusted R-squared | 0.489 | 0.490 | 0.423 |
| Industry FE | YES | YES | YES |

The standard errors are adjusted for heteroscedasticity and clustering by matched pair. P-value in parentheses.