AN OPTIMIZATION MODEL FOR EMPLOYEE AUTONOMY, MANAGERIAL CONTROL, AND EMPLOYEES' LIFE SATISFACTION

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ABSTRACT

This paper develops a mathematical model based on the prospect theory to identify the optimal guidelines of managerial practices in achieving employee's life satisfaction. The study first applies prospect theory to identify the impacts of employee autonomy and managerial control on employee's life satisfaction. Five propositions are developed to explain the phenomenon of employee's work-family conflict and their life satisfaction. Third, through the natural logarithms and multiple regression functions, conforming to the law of diminishing marginal utility, we learned the optimal values of employee life satisfaction resulting from employee autonomy and managerial control. Accordingly, we generate the optimal guidelines to exert managerial practices. The results present guidelines of managerial practices to maximize employee life satisfaction.

Keywords: prospect theory; managerial practices; autonomy; conflict; employee's life satisfaction

1. INTRODUCTION

In a highly competitive environment, strategic human resource management is one weapon for many firms or managers to survive in the marketplace. Recently, the issues related to manager-employee relationship have received a lot of attention from the academicians and practitioners (*e.g.*, Bifulco, 2011; Chick, 2011; Cochet, Dormann, & Ehrmann, 2008; Gilliland, Bello, & Gundlach, 2010; Hirst *et al.,* 2008; Mellewigt, Ehrmann, & Decker, 2011). In order to direct employees' behaviors, managerial control is adopted to guide them to behavior appropriately (Bifulco, 2011; Cochet *et al.*, 2008; Hirst *et al.,* 2008). On the one hand, employees are asking for autonomy so that they can be free from managerial influences, while on the other hand, managers attempt to control and manage employees through providing managerial knowledge, expectations, monitoring, discipline, and demands (Chick, 2011; Gilliland *et al.*, 2010; Mellewigt *et al.*, 2011). The gap between employee autonomy and managerial control contributes to the work-family conflict which becomes an integral component of manager-employee relationships (Baltes, Zhdanova, & Clark, 2011; Brunetto *et al.,* 2010; Qu & Zhao, 2012). Some studies argued that managers may get into arguments with employees when they consider the outcomes are important (Chick, 2011; Johnson, 2011; Henle, Reeve, & Pitts, 2010). Employees may enter into conflict when they have already invested highly into the outcome (Baltes *et al.*, 2011; Brunetto *et al.,* 2010; Green *et al.,* 2011). However, previous studies focusing on the balance between employee autonomy and managerial control simultaneously are limited and subject to further empirical validation. In addition, work-family conflict is believed to make a positive contribution to the development of employees' behavioral autonomy and self-governance (Baltes *et al.*, 2011; Liao, 2011; Qu & Zhao, 2012). Recent studies have emphasized that managerial control and employees' internalizing and externalizing behaviors have significant impacts on their life satisfaction, and employees' social support and work-family conflict are also associated with their life satisfaction (Brunetto *et al.,* 2010; Green *et al.*, 2011; Qu & Zhao, 2012). Thus, employee life satisfaction could be largely explained by employees' autonomy behaviors, managerial control behaviors, and perceived work-family conflict. However, previous studies have not tried to integrate these relevant variables (*i.e.*, employee autonomy, managerial control, conflict, and employee's life satisfaction) and develop a more comprehensive framework to show their relationships.

Finally, previous studies (*e.g.*, Baltes *et al.*, 2011; Hill *et al.*, 2010; Johnson, 2011; Qu & Zhao, 2012) all assume that the influences of autonomy and managerial control toward work-family conflict and employee life satisfaction are in linear relations. Employee's life satisfaction is associated with subjective judgment, which is equivalent to valuation. However, the prospect theory indicates that valuations are attached to changes rather than to a final state (Kahneman & Tversky, 1979). Based on the prospect theory, the value function is described as an S shape trajectory. S shape function implies that individual attitude toward a behavior is not constant. Instead, the value function varies with different situations. Kahneman and Tversky (1979) presented that

psychological principle favors risk aversion in the domain of gain and risk seeking in the domain of losses, as well as further proposed that the value function was defined by deviations from the reference point and was generally characterized as concave in the domain of gains and convex in the domain of losses. According to the idea of the prospect theory, we propose the employees will risk aversion in the domain of gain and risk seeking in the domain of losses and describe life satisfaction as nonlinear value function, which is altered by managerial control and employee autonomy. Prospect theory has been commonly applied to the field of economics, sociology, and psychology (*e.g.*, Merriman & Deckop, 2007; Park & Rothrock, 2007). Park and Rothrock (2007) focused on the effects of framing on decision making in a homeland missile defense context and proposed that positive framing promoted risk-averse behavior whereas negative framing promoted risk-seeking behavior. Merriman and Deckop (2007) further focused on risk preference and choice behavior, and investigated potential motivational effects associated with decision framing based on the prospect theory.

With regard to prospect theory, this study suggests that employees may set different reference points on their level of autonomy and managerial control due to their background and peer references. When employees perceive that the degree of autonomy is lower than their reference point and the degree of managerial control is higher than their reference point, employees will feel that they have a great deal of loss on the authority of self-determination and freedom. According to prospect theory, employees will risk seeking in the domain of losses (*i.e.*, the convex value function). On the other hand, if employees perceive that autonomy is higher or managerial control is lower than their reference point, they could accept such kind of treatment and the perceived life satisfaction will follow a concave function with diminishing return. Accordingly, employees will risk aversion in the domain of gain. Prospect theory has been adopted extensively in the literature of consumer behavior and decision making literature (*e.g.*, Coppejans, 2001), but is totally ignored in the studies of employees. A conceptual framework is developed based on series of literature review. This study investigates this issue through mathematical model development.

The purpose of this study is to evaluate employee's life satisfaction by integrating the perspectives of employee autonomy, managerial control, and work-family conflict based on a mathematical model. Away from previous linear relationship (*e.g.*, Baltes *et al.*, 2011; Hill *et al.*, 2010; Johnson, 2011; Qu & Zhao, 2012), this study suggests that employees will have higher level of life satisfaction if their autonomy is higher than the reference point while the managerial control is lower than the reference point. Five propositions are developed to explain the phenomenon of work-family conflict and their life satisfaction. This study expands the knowledge on prospect theory to develop the optimal model measurement of employee life satisfaction via intermediary variable with respect to work-family conflict. In sum, this study intends to raise three issues related to manager-employee strategies. First, the study first applies prospect theory to identify the impacts of employee autonomy and managerial control on employee's life satisfaction. Based on the concept of prospect theory, employees may perceive a concave life satisfaction function in the domain of gains, while they may perceive a convex life satisfaction function in the domain of losses. Second, this study creates four quadrants to explain the optimal value of employees' life satisfaction. Specifically, the "optimal value" represents the most appropriate level of employee autonomy and managerial control which manager should exert to maximize employees' life satisfaction.

2. LITERATURE REVIEW AND PROPOSITIONS DEVELOPMENT

Current literature has expressed the strong interest in the issues related to manager-employee relationship. Several studies focused on the issues of autonomy and controlling (*e.g.*, Bifulco, 2011; Chick, 2011; Cochet *et al.*, 2008; Fenton-O'Creevy, Gooderham, & Nordhaug, 2008; Henle *et al.*, 2010; Hirst *et al.,* 2008; Hornung & Rousseau, 2007; Tafti, Mithas, & Krishnan, 2007). In the context of autonomy, Tafti *et al.* (2007) firstly proposed that autonomy as an important component of a facilitating human resources policy can be defined as the extent to which workers have controls over their own schedules or control over the specific procedures in which they carry out their schedules. Hirst *et al.* (2008) indicated that high levels of autonomy will be seen as evidence of positive and trusting management practices, in turn enhancing employees' intrinsic motivation, and optimizing group and organizational processes, leading to enhanced organizational productivity. Cochet *et al.* (2008) suggested that autonomy not only fosters system-wide adaptability and satisfaction but also raises the costs from agency problems. Fenton-O'Creevy *et al.* (2008) explored determinants of subsidiary autonomy in setting human resource management practices within US-parented multinational enterprises (MNEs). Bifulco (2011) focused on the New Public Management in Italy and emphasized the importance of autonomy and freedom in present-day organizations. In the context of controlling, Henle *et al.* (2010) used the theory of planned behavior to investigate the antecedents of time theft and suggested that perceived behavioral control was significantly related to time theft intentions. Chick (2011) argued most people were control freaks and explained how they can be encouraged to accept change.

According to psychoanalytic theory, autonomous development, which is deemed as the process of self-determination, is a step toward higher personality functioning and ego maturation (Bifulco, 2011; Hirst *et al.,* 2008; Hornung & Rousseau, 2007). Hornung and Rousseau (2007) proposed that promoting worker autonomy

itself can be a critical precursor to successful implementation of certain forms of organizational change. Hirst *et al.* (2008) argued that autonomy-seeking behavior reduced emotional dependence upon his/her managers and encouraged an employee to explore other meaningful relationships. Baltes *et al.* (2011) further suggested that injunctive or subjective norms played an important role in his/her behavior and family relationship. Most employees prefer making decisions by themselves. Although some managers encourage their employees to cultivate autonomy in order to help them develop the ability of living independently, they normally exert managerial control in an attempt to protect their employee. However, most employees dislike being controlled. Johnson (2011) and Gilliland *et al.* (2010) contended that managers entered into arguments with employees when they thought that the outcomes are important. Similarly, employees were likely to enter into conflict when they had invested highly in the outcomes that were not approved by the managers.

According to Proost *et al.* (2010), conflict represents the level of tension, frustration, and disagreement in relationships. In fact, higher levels of employee autonomy or managerial control (*i.e.*, managers' subjective norms) are associated with poor qualities of manager-employee relationship and thus result in higher work-family conflict (Brunetto *et al.*, 2010; Gilliland *et al.*, 2010; Hill *et al.*, 2010; Liao, 2011; Qu & Zhao, 2012). Empirical findings regarding the complementarities among facilitating human resources practices suggest that worker autonomy can reduce barriers among workers and among functional units (Tafti *et al.*, 2007). Hornung and Rousseau (2007) suggested that autonomy positively affected employee role breadth self-efficacy and personal initiative, which in turn had positive though differential relationships with employee responses to change. Fenton-O'Creevy *et al.* (2008) proposed that work-life is characterized not only by powerful labour representative bodies but also by strong work legislation that constrains managerial autonomy in the firm. Work interference with family, family interference with work, and emotional stability may influence work-family conflict (Baltes *et al.*, 2011). According to social capital theory the supervisor-subordinate relationship (measured using leader-member exchange) depends upon employees' perceptions of work-family conflict (Brunetto et al., 2010). Hill *et al.* (2010) suggested that perceived schedule flexibility were generally related to less work-life conflict. Furthermore, Tafti *et al.* (2007) examined the relationship between firms' human resources practices and their information technology practices, and argued that autonomy was negatively associated with feeling of connectedness with members. When striving for autonomy, the tension and conflict in the relationship between employees and their family will cause many problems for manager-employees interaction (Liao, 2011). Baltes *et al.* (2011) argued that the effectiveness of training programs and interventions aimed at reducing work-family conflict levels of employees. Green et al. (2011) proposed that extensive work-family conflict at homes would disturb employees and cause them runaway. Drawing from these arguments, this study proposes the following propositions.

PROPOSITION 1. *Employee autonomy influences the work-family conflict.*

PROPOSITION 2. *Managerial control enhances the work-family conflict.*

Life satisfaction is important as it is an indicator how efficiently control mechanisms may work for employee-managers relationships (Mellewigt *et al.*, 2011). Employee's life satisfaction is defined as a cognitive evaluation of quality of an employee's overall life (Jang, Park, & Zippay 2011). Jang *et al.* (2011) proposed that there have positive relationships between the availability of scheduling control and work-life balance policies on the one hand, and job satisfaction and mental wellbeing, on the other. Green *et al.* (2011) proposed that effective management provided a protective effect to employees by influencing employees' knowledge, attitudes, and normative expectation. Quality of employees' life can be conceptualized from objective and subjective perspectives. The objective quality of life focuses on external conditions such as housing quality or income levels. The subjective quality of life concentrates on employees' fulfillment of their needs, goals, and wishes. For the purpose of this study, we only focus on employees' subjective life satisfaction.

The self-determination theory suggests that autonomy is a self-determination behavior that is freely endorsed by the external factors such as managerial control and cultural values and should be based on integrated values and interests (Cochet *et al.*, 2008; Fenton-O'Creevy *et al.*, 2008; Hirst *et al.*, 2008). Employees with higher levels of autonomy are able to engage in actions which can fulfill their values and interest. Hence, self-determination theory implies that employee autonomy can enhance life satisfaction. This statement is consistent with Hirst *et al.* (2008) argument that family-related factors such as psychological autonomy were associated with employee's life satisfaction. In addition, some studies have found a significant impact of managers' subjective norms on employee's life satisfaction (*e.g.*, Chick, 2011; Henle *et al.,* 2010; Mellewigt *et al.,* 2011; Suldo & Huebner, 2004; Zullig *et al.,* 2005). Chick (2011) highlighted that managers can encourage their people to accept, satisfy, or embrace organizational change and affect employees' satisfaction when organizational change was the norm. Mellewigt *et al.* (2011) argued that authoritative managerial behavior or behavior control significantly influences employees' life satisfaction. Henle *et al.* (2010) used the theory of planned behavior to investigate the antecedents of time theft and suggested that perceived behavioral control was significantly related to time theft intentions and satisfaction. Johnson (2011) proposed that effective management practices exerted a protective influence on employee behavior and judgment. Brunetto *et al.* (2010) further suggested that specific family-related factors, including family structure, work-family conflict, social support,

and authoritative management were associated with employees' life satisfaction. Accordingly, this study develops the following propositions.

PROPOSITION 3. *Employee autonomy enhances employees' life satisfaction.*

PROPOSITION 4. *Managerial control influences employees' life satisfaction.*

Numerous studies have proposed that family conflict is associated with negative outcomes for employees, such as life dissatisfaction or delinquency (*e.g.*, Brunetto *et al.*, 2010; Green *et al.,* 2011; Liao, 2011). The focal employee's work-interfering-with-family behaviors were positively associated with the partner's reports of observed work-to-family conflict, resulting in negative emotional displays when discussing work and the partner's negative emotional displays were related to less career resilience and more turnover exploration by the focal employee (Green *et al.*, 2011). Both supervisor-subordinate relationship and employees' perceptions of work-family conflict may influence employees' perceptions of satisfaction (Brunetto *et al.*, 2010). Liao (2011) revealed that perceived organizational support and leader-member exchange partially mediated work-family conflict's influence on employee's satisfaction. Manager-employee relationship is an effective predictor of employee's life satisfaction (Jang *et al.*, 2011). Discords between employees and managers have negative impacts on employee's life satisfaction. Green *et al.* (2011) proposed that family conflict was the negative stress that may contribute to substantial declines in life quality and negative emotional displays for many employees. On the basis of these arguments, the fifth proposition is developed.

PROPOSITION 5. *The work-family conflict decrease employee's life satisfaction.*

3. MATHEMATICAL MODEL

Although the research framework has been identified, it is further evaluated based on prospect theory and mathematical models are employed to express such relationships. Mathematics, as the language of science, allows interplay between empirical and theoretical research (Shugan, 2002). Based on prospect theory, this study utilizes the concepts of natural logarithms and multiple regression functions, which conform to the law of diminishing marginal utility. It is suggested that individuals perceive their value function differently based on the domain of gain or the domain of loss. A value function is generally characterized as concave for gains (*i.e.*, risk aversion in the domain of gain) and convex for losses (*i.e.*, risk seeking in the domain of losses) and its slope is steeper for the losses than for the gains (Kahneman & Tversky, 1979).

Employees will make comparisons with peers or other people to set a reference point. Employees may easily set different reference points on their levels of autonomy and managerial control due to their background and peer references. In other words, reference points of employee autonomy and managerial control represent the employees' expectable or reasonable evaluation of employee autonomy and managerial control. When the degree of employee autonomy is lower than the reference point and the degree of managerial control is higher than their reference point, they will feel that they lose their self-determination and freedom (*i.e.*, the convex value function). Contrarily, employees will feel more self-determination and freedom when the degree of autonomy is higher than the reference point or/and the degree of managerial control is lower than their reference point (*i.e.*, the concave value function). Hence, this study specifies that the state is a loss when the degree of employee autonomy is lower than the reference point or/and the degree of managerial control is higher than reference point, whereas the state is a gain when the degree of autonomy is higher than the reference point or/and the degree of managerial control is lower than the reference point.

To obtain the optimization model for the employee autonomy, managerial control, and the employee's life satisfaction, two functions based on the prospect theory that delineate the impacts of employee autonomy and managerial control on the employee's life satisfaction are first derived, and shown in Figure 1a and Figure 1b.
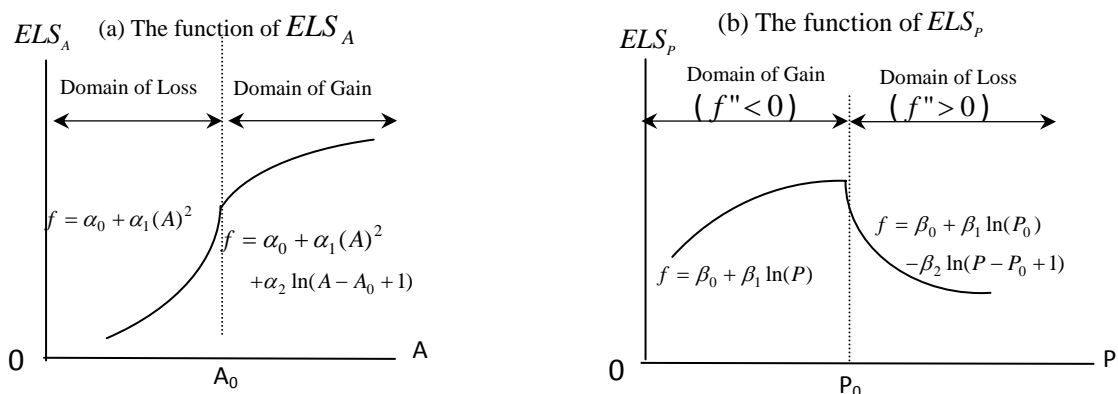
Note: A_0 = the reference point of employee autonomy; P_0 = the reference point of managerial control
 ALS_A = employee's life satisfaction on employee autonomy.
 ALS_P = employee's life satisfaction on managerial control.

Figure 1 The functions of employee's life satisfaction on employee autonomy and managerial control

According to proposition 3, employee's life satisfaction (ELS) will be influenced by employee autonomy (A). Based on the prospect theory, Figure 1a indicates that the function of employee's life satisfaction (ELS) on employee autonomy (A) is convex (*i.e.*, $ELS_A^{'} > 0$) when A is less than employee's reference point (A_0). Inversely, the function of value is concave when A is greater than employee's reference point. Accordingly, this study utilizes the concepts of quadratic equation and natural logarithmic function to develop the function of employee's life satisfaction on employee autonomy that conforms to the prospect theory, where α_0 and α_1 are the parameters consistent with the coefficients of regression that α_0 represents the constant and α_1 represents the degree of impact of employee autonomy on employee's life satisfaction. Function 2 shows that the function of the employee's life satisfaction on employee autonomy is convex for loss and concave for gain. According to proposition 4, the employee's life satisfaction (ELS) will be influenced by managerial control (P), where β_0 and β_1 are the parameters that β_0 and β_1 represent the constant and the degree of impact of managerial control on employee's life satisfaction, respectively.

As to the function of the employee's life satisfaction on managerial control (ELS_P), an extremely high level of managerial control will restrict the development of employees. Accordingly, since employees dislike being controlled, the state in which the level of managerial control is lower than reference point (*i.e.*, $P \leq P_0$) can be seen as a gain for employees. However, several scholars have proposed that appropriate managerial behavior or behavior control, such as planning, approval, evaluation, monitoring, or revision process can enhance the ability, performance, and job satisfaction of employee. Tafti, Mithas, and Krishnan (2007) proposed that there was a general need for careful thinking about how to help knowledge workers perform optimally and traditional human resource management, in which managers were viewed as controllers and monitors of workers, and then managers were viewed as enforcers rather than as facilitators; their primary role was to control and monitor workers. Chick (2011) and Johnson (2011) strictly suggested that that managers can encourage their employees to accept, satisfy, or embrace organizational change and affect employees' satisfaction when organizational change was the norm. Johnson (2011) proposed that effective management practices exerted a protective influence on employee behavior and judgment. Therefore, most employees need the appropriate managerial control to develop or advance the ability in order to enhance the job satisfaction or life satisfaction when the managerial control is lower than reference point.

On the contrast, the state in which the level of managerial control is higher than reference point is regarded as the loss for employees. Accordingly, this study utilizes the concept of natural logarithmic function to develop the function of the employee's life satisfaction on managerial control (ELS_P) that conforms to the prospect theory. The function of the employee's life satisfaction (ELS) on managerial control (P) is as shown in Figure 1b and function 3. Figure 1b represents that the function of the employee's life satisfaction on managerial control is convex for lose and concave for gain. In addition, according to proposition 1, proposition 2, and proposition 5 the work-family conflict (C) will be influenced by employee autonomy and managerial control, and then impacts on the employee's life satisfaction. Therefore, this study employs the concept of multiple regression to develop the function of the employee's life satisfaction on work-family conflict (ELS_C) that shown in function 4, where γ_0, γ_1, θ_0, θ_1, and θ_2 are the parameters that β_0 and θ_0 represent the constant, the γ_1 represents the degree of impact of work-family conflict on employee's life satisfaction, as well as, θ_1, and θ_2 represent the degrees of impacts of employee autonomy and managerial control on work-family conflict, respectively. Based on these regards, the function of the employee's life satisfaction can be written as function (1). ELS_A, ELS_P, and ELS_C represent the impacts of employee autonomy, managerial control, and work-family conflict on employee's life satisfaction, respectively. Based on the levels of A and P, the values of the employee's life satisfaction are shown in Table 1.

$$ELS = f(A, P, C) = ELS_A + ELS_P + ELS_C \tag{1}$$

$$ELS_A = \begin{cases} \alpha_0 + \alpha_1 (A)^2 & , as \quad A \leq A_0 \\ \alpha_0 + \alpha_1 (A_0)^2 + \alpha_2 \ln(A - A_0 + 1) & , otherwise \end{cases} \tag{2}$$

$$ELS_P = \begin{cases} \beta_0 + \beta_1 \ln(P) & , as \quad P \leq P_0 \\ \beta_0 + \beta_1 \ln(P_0) - \beta_2 \ln(P - P_0 + 1) & , otherwise \end{cases} \tag{3}$$

$$ELS_C = \gamma_0 - \gamma_1 (C) = \gamma_0 - \gamma_1 [\theta_0 + \theta_1 (A) + \theta_2 (P)] \quad where \quad C = \theta_0 + \theta_1 (A) + \theta_2 (P) \tag{4}$$

Table 1 The value of employee's life satisfaction

		Employee autonomy (A)	
		$A \leq A_0$	$A > A_0$
Managerial control (P)	$P \leq P_0$	$f_{11}(A, P)$	$f_{12}(A, P)$
		$\alpha_0 + \beta_0 + \gamma_0 - \gamma_1\theta_0 + \alpha_1(A)^2 + \beta_1\ln(P)$ $-\gamma_1[\theta_1(A) + \theta_2(P)]$	$\alpha_0 + \beta_0 + \gamma_0 - \gamma_1\theta_0 + \alpha_1(A_0)^2$ $+\alpha_2\ln(A - A_0 + 1) + \beta_1\ln(P)$ $-\gamma_1[\theta_1(A) + \theta_2(P)]$
	$P > P_0$	$f_{21}(A, P)$	$f_{22}(A, P)$
		$\alpha_0 + \beta_0 + \gamma_0 - \gamma_1\theta_0 + \beta_1\ln(S_0)$ $+\alpha_1(A)^2 - \beta_2\ln(P - P_0 + 1)$ $-\gamma_1[\theta_1(A) + \theta_2(P)]$	$\alpha_0 + \beta_0 + \gamma_0 - \gamma_1\theta_0$ $+\alpha_1(A_0)^2 + \beta_1\ln(P_0) + \alpha_2\ln(A - A_0 + 1)$ $-\beta_2\ln(P - P_0 + 1) - \gamma_1[\theta_1(A) + \theta_2(P)]$

Based on the results of Table 1, the value of the employee's life satisfaction is explained with respect to four different states: (1) both the employees' perceived autonomy and perceived managerial control are lower than their reference point (*i.e.*, $f_{11}(A, P)$, $A \leq A_0$, and $P \leq P_0$); (2) employees' perceived autonomy is higher than their reference point A_0 and their perceived managerial control is lower than P_0 (*i.e.*, $f_{12}(A, P)$, $A > A_0$, and $P \leq P_0$); (3) employees' perceived autonomy is lower than their reference point A_0 and their perceived managerial control higher than P_0 (*i.e.*, $f_{21}(A, P)$, $A \leq A_0$, and $P > P_0$); (4) employees' perceived autonomy and their perceived managerial control are both higher than their reference point (*i.e.*, $f_{22}(A, P)$, $A > A_0$, and $P > P_0$). Since employees' views play a central role in this study, we assume that the major objective is to maximize employee's life satisfaction (ELS). Thus, how to implement a management practice to maximize life satisfaction of employee is of focal concern. In addition, there are social norms for employee autonomy and managerial control that can restrict the behaviors of employees. Therefore, the amounts or resources of employee autonomy and managerial control should be adjusted to maximize the life satisfaction of employees. In general, there are social norms for employee autonomy and managerial control that can restrict the behaviors of employees. Therefore, the amounts or resources of employee autonomy and managerial control should be adjusted to maximize the life satisfaction of employees. In this regard, to optimize employee's life satisfaction (ELS) under given resources (δ) which consistence with the concept of the autonomy-control duality. If the firm or manager places more emphasis on employee autonomy, more resources will be allocated to employee autonomy. Comparatively, resources allocated to managerial control will accordingly reduce. To capture these concepts, the subjective formula of a firm adjusts innovation strategy can be derived as $\tau_1(A) + \tau_2(P) \leq \delta$, where δ is parameter that represents given managerial resource of budget. In this regard, a mathematical model can be derived as function (5). Accordingly, the Lagrangean functions can be written as function (6) to function (9) (*i.e.*, L_{11}, L_{12}, L_{21}, and L_{22}). The optimal values of employee autonomy (A^*) and managerial control (P^*) can thus be summarized in Table 2.

Max employee's life satisfaction (ELS) Subject to $\tau_1(A) + \tau_2(P) \leq \delta$ (5)

$L_{11} = \alpha_0 + \beta_0 + \gamma_0 - \gamma_1\theta_0 + \alpha_1(A)^2 + \beta_1\ln(P) - \gamma_1[\theta_1(A) + \theta_2(P)] - \varepsilon_{11}[\tau_1(A) + \tau_2(P) - \delta]$ (6)

$L_{12} = \alpha_0 + \beta_0 + \gamma_0 - \gamma_1\theta_0 + \alpha_1(A_0)^2 + \alpha_2\ln(A - A_0 + 1) + \beta_1\ln(P) - \gamma_1[\theta_1(A) + \theta_2(P)] - \varepsilon_{12}[\tau_1(A) + \tau_2(P) - \delta]$ (7)

$L_{21} = \alpha_0 + \beta_0 + \gamma_0 - \gamma_1\theta_0 + \beta_1\ln(P_0) + \alpha_1(A)^2 - \beta_2\ln(P - P_0 + 1) - \gamma_1[\theta_1(A) + \theta_2(P)] - \varepsilon_{21}[\tau_1(A) + \tau_2(P) - \delta]$ (8)

$L_{22} = \alpha_0 + \beta_0 + \gamma_0 - \gamma_1\theta_0 + \alpha_1(A_0)^2 + \beta_1\ln(P_0) + \alpha_2\ln(A - A_0 + 1)$
$\quad - \beta_2\ln(P - P_0 + 1) - \gamma_1[\theta_1(A) + \theta_2(P)] - \varepsilon_{22}[\tau_1(A) + \tau_2(P) - \delta]$ (9)

Table 2 The optimal values of employee autonomy and managerial control

		Employee autonomy (A)	
		$A \leq A_0$	$A > A_0$
Managerial control (P)	$P \leq P_0$	$A^* = \dfrac{\delta\lambda_{11}\lambda_{12}}{\tau_1\lambda_{11}\lambda_{12} + 2\alpha_1\beta_1\tau_2}$ $P^* = \dfrac{2\delta\alpha_1\beta_1\tau_2}{\tau_1\lambda_{11}\lambda_{12} + 2\alpha_1\beta_1\tau_2}$	$A^* = \dfrac{\alpha_2\delta\lambda_{21} + \tau_2\beta_1\lambda_{22}(A_0 - 1)}{\tau_1\alpha_2\lambda_{21} + \tau_2\beta_1\lambda_{22}}$ $P^* = \dfrac{\beta_1\lambda_{22}[\delta - \tau_1(A_0 - 1)]}{\tau_1\alpha_2\lambda_{21} + \tau_2\beta_1\lambda_{22}}$
	$P > P_0$	$A^* = \dfrac{\lambda_{31}\lambda_{32}[\delta - \tau_2(P_0 - 1)]}{\tau_1\lambda_{31}\lambda_{32} + 2\alpha_1\beta_2\tau_2}$ $P^* = \dfrac{\lambda_{31}\lambda_{32}\tau_1(P_0 - 1) + 2\delta\alpha_1\beta_2}{\tau_1\lambda_{31}\lambda_{32} + 2\alpha_1\beta_2\tau_2}$	$A^* = \dfrac{\alpha_2\lambda_{41}[\delta - \tau_2(P_0 - 1)] + \tau_2\beta_2\lambda_{42}(A_0 - 1)}{\tau_1\alpha_2\lambda_{41} + \tau_2\beta_2\lambda_{42}}$ $P^* = \dfrac{\beta_2\lambda_{42}[\delta - \tau_1(A_0 - 1)] + \tau_1\alpha_1\lambda_{41}(P_0 - 1)}{\tau_1\alpha_2\lambda_{41} + \tau_2\beta_2\lambda_{42}}$

Notes: $\lambda_{11} = \varepsilon_{11}\tau_1 + \gamma_1\theta_1$, $\lambda_{12} = \varepsilon_{11}\tau_2 + \gamma_1\theta_2$, $\lambda_{21} = \varepsilon_{12}\tau_2 + \gamma_1\theta_2$, $\lambda_{22} = \varepsilon_{12}\tau_1 + \gamma_1\theta_1$, $\lambda_{31} = \gamma_1\theta_2 + \varepsilon_{21}\tau_2$, $\lambda_{32} = \varepsilon_{21}\tau_1 + \gamma_1\theta_1$, $\lambda_{41} = \gamma_1\theta_2 + \varepsilon_{22}\tau_2$, and $\lambda_{42} = \varepsilon_{22}\tau_1 + \gamma_1\theta_1$

According to the results of Table 2, the optimal guidelines for management practices in terms of employee autonomy and managerial control can be obtained. When the degree of employee autonomy and managerial control are lower than the reference point (*i.e.*, $A \leq A_0$ and $P \leq P_0$), autonomy supportive management is suggested as a dominant strategy to maximize employee's life satisfaction if the value of $\dfrac{\delta\lambda_{11}\lambda_{12}}{\tau_1\lambda_{11}\lambda_{12} + 2\alpha_1\beta_1\tau_2}$ (*i.e.*, A^*) is greater than the value of $\dfrac{2\delta\alpha_1\beta_1\tau_2}{\tau_1\lambda_{11}\lambda_{12} + 2\alpha_1\beta_1\tau_2}$ (*i.e.*, P^*) or if $\lambda_{11}\lambda_{12} \geq 2\alpha_1\beta_1\tau_2$. Furthermore, both the optimal values of employee autonomy and managerial control consistent with the degree of employee autonomy and managerial control are lower than the reference point (*i.e.*, $A^* \leq A_0$ and $P^* \leq P_0$) (see Appendix A). Therefore, Theorem 1 characterizes the optimal guideline for managerial practices as $A \leq A_0$ and $P \leq P_0$ based on the prospect theory.

Theorem 1. *To maximize employee's life satisfaction, the optimal guideline of management strategy is that the managers must focus on the employee autonomy if the value of $\lambda_{11}\lambda_{12}$ is greater than the value of $2\alpha_1\beta_1\tau_2$ given that both levels of employee autonomy and managerial control are lower than the reference point (i.e., $A \leq A_0$ & $P \leq P_0$). Otherwise, the managers must focus on managerial control.*

While both employee autonomy and managerial control can influence employee's life satisfaction, Theorem 1 supports the optimal guideline of management strategy that can distinguish employee autonomy and managerial control for the contribution of employee's life satisfaction. In other words, both levels of employee autonomy and managerial control are lower than the reference point, employee autonomy and managerial control can improve the employee's life satisfaction under different conditions. When the condition that the value of $\lambda_{11}\lambda_{12}$ is greater than the value of $2\alpha_1\beta_1\tau_2$ holds, the managers should place its emphasis on employee autonomy to maximize employee's life satisfaction. When the degree of employee autonomy is higher than the reference point and the level of managerial control is lower than the reference point (*i.e.*, $A > A_0$ and $P \leq P_0$), autonomy supportive management is suggested as a dominant strategy to maximize employee's life satisfaction if the value of $\dfrac{\alpha_2\delta\lambda_{21} + \tau_2\beta_1\lambda_{22}(A_0 - 1)}{\tau_1\alpha_2\lambda_{21} + \tau_2\beta_1\lambda_{22}}$ (*i.e.*, A^*) is greater than the value of $\dfrac{\beta_1\lambda_{22}[\delta - \tau_1(A_0 - 1)]}{\tau_1\alpha_2\lambda_{21} + \tau_2\beta_1\lambda_{22}}$ (*i.e.*, P^*) or if $\beta_1\lambda_{22}(\tau_1 + \tau_2)(A_0 - 1) \geq \delta(\beta_1\lambda_{22} - \alpha_2\lambda_{21})$. Therefore, Theorem 2 characterizes the optimal guideline of managerial practices as $A > A_0$ and $P \leq P_0$ based on the prospect theory.

Theorem 2. *To maximize employee's life satisfaction, the optimal guideline of management strategy is that the managers must focus on the employee autonomy if the value of $\beta_1\lambda_{22}(\tau_1 + \tau_2)(A_0 - 1)$ is greater than the value of $\delta(\beta_1\lambda_{22} - \alpha_2\lambda_{21})$ given that level of employee autonomy is higher than the reference point and the level of managerial control is lower than the reference point (i.e., $A > A_0$ and $P \leq P_0$). Otherwise, the managers must focus on managerial control.*

In other words, Theorem 2 indicates that given that level of employee autonomy is higher than the reference point and the level of managerial control is lower than the reference point, employee autonomy and managerial control can improve the employee's life satisfaction under different conditions. When the condition that the value

of $\beta_1\lambda_{22}(\tau_1+\tau_2)(A_0-1)$ is greater than the value of $\delta(\beta_1\lambda_{22}-\alpha_2\lambda_{21})$ holds, the managers should place its emphasis on employee autonomy to maximize employee's life satisfaction. When the degree of employee autonomy is lower than the reference point and the level of managerial control is higher than the reference point (i.e., $A \le A_0$ and $P > P_0$), autonomy supportive management is suggested as a dominant strategy to maximize

employee's life satisfaction if the value of $\dfrac{\lambda_{31}\lambda_{32}[\delta-\tau_2(P_0-1)]}{\tau_1\lambda_{31}\lambda_{32}+2\alpha_1\beta_2\tau_2}$ is more than the value of

$\dfrac{\lambda_{31}\lambda_{32}\tau_1(P_0-1)+2\delta\alpha_1\beta_2}{\tau_1\lambda_{31}\lambda_{32}+2\alpha_1\beta_2\tau_2}$ or if $\lambda_{31}\lambda_{32}[\delta-(\tau_1+\tau_2)(A_0-1)] \ge 2\delta\alpha_1\beta_2$. Therefore, Theorem 3 characterizes the

optimal guideline of managerial practices as $A \le A_0$ and $P > P_0$ based on the prospect theory. Accordingly, Theorem 3 suggests that given that level of employee autonomy is lower than the reference point and the level of managerial control is higher than the reference point, employee autonomy and managerial control can improve the employee's life satisfaction under different conditions. When the condition that the value of $\lambda_{31}\lambda_{32}[\delta-(\tau_1+\tau_2)(A_0-1)]$ is greater than the value of $2\delta\alpha_1\beta_2$ holds, the managers should place its emphasis on employee autonomy to maximize employee's life satisfaction.

Theorem 3. *To maximize employee's life satisfaction, the optimal guideline of management strategy is that the managers must focus on the employee autonomy if the value of $\lambda_{31}\lambda_{32}[\delta-(\tau_1+\tau_2)(A_0-1)]$ is greater than the value of $2\delta\alpha_1\beta_2$ given that level of employee autonomy is lower than the reference point and the level of managerial control is higher than the reference point (i.e., $A \le A_0$ and $P > P_0$). Otherwise, the managers must focus on managerial control.*

When both levels of employee autonomy and managerial control are higher than the reference point (*i.e.*, $A > A_0$ and $P > P_0$), autonomy supportive management is suggested as a dominant strategy to maximize

employee's life satisfaction if the value of $\dfrac{\alpha_2\lambda_{41}[\delta-\tau_2(P_0-1)]+\tau_2\beta_2\lambda_{42}(A_0-1)}{\tau_1\alpha_2\lambda_{41}+\tau_2\beta_2\lambda_{42}}$ (*i.e.*, A^*) is greater than the

value of $\dfrac{\beta_2\lambda_{42}[\delta-\tau_1(A_0-1)]+\tau_1\alpha_1\lambda_{41}(P_0-1)}{\tau_1\alpha_2\lambda_{41}+\tau_2\beta_2\lambda_{42}}$ (*i.e.*, P^*) or if $\lambda_{41}(\alpha_2\tau_2-\alpha_1\tau_1)(P_0-1)$

$+\beta_2\lambda_{42}(\tau_1+\tau_2)(A_0-1) \ge \delta(\beta_2\lambda_{42}-\alpha_2\lambda_{41})$. Therefore, Theorem 4 characterizes the optimal guideline of managerial practices as $A > A_0$ and $P > P_0$ based on the prospect theory.

Theorem 4. *To maximize employee's life satisfaction, the optimal guideline of management strategy is that the managers must focus on the employee autonomy if the value of $\lambda_{41}(\alpha_2\tau_2-\alpha_1\tau_1)(P_0-1)+\beta_2\lambda_{42}(\tau_1+\tau_2)(A_0-1)$ is more than the value of $\delta(\beta_2\lambda_{42}-\alpha_2\lambda_{41})$ given that both levels of employee autonomy and managerial control are higher than the reference point (i.e., $A > A_0$ and $P > P_0$). Otherwise, the managers must focus on managerial control.*

Specifically, Theorem 1 to Theorem 4 characterize the optimal guidelines of management strategy that employee autonomy and managerial control can improve the employee's life satisfaction under different conditions.

4. CONCLUSIONS AND DISCUSSIONS

The purpose of this study is to evaluate the employee's life satisfaction by integrating the perspectives of employee autonomy, managerial control, and work-family conflict. In contrast to a linear relationship, this study suggests that employees will have higher level of life satisfaction if their autonomy is greater than the reference point, while the managerial control is lower than the reference point. Five propositions are developed to explain the phenomenon of work-family conflict and the employee's life satisfaction. This study expands the knowledge on prospect theory to develop the optimal model measurement of the employee's life satisfaction via intermediary variable with respect to work-family conflict. The study first applies prospect theory to identify the impacts of employee autonomy and managerial control on employee's life satisfaction. Based on the concept of prospect theory, employee may perceive a concave life satisfaction function in the domain of gain, while they may perceive a convex life satisfaction function in the domain of loss. Accordingly, this study creates four quadrants to explain the optimal value of employee's life satisfaction. By means of a mathematical model, the study first applies prospect theory to identify the impacts of employee autonomy and managerial control on the employee's life satisfaction. And then, this study creates four quadrants to explain the optimal value of the employees' life satisfaction. According to the mathematical model, four theorems are developed. The results present some very useful guidelines for management practices, suggesting to decrease work-family conflict and increase the employee's life satisfaction that may be different from the traditional management theory. In the

traditional managerial theory, managerial practices could be divided into four quadrants: (1) when managers perceive that both values of employee autonomy and managerial control are low (*i.e.*, $A \leq A_0$ and $P \leq P_0$), they should encourage their employees to develop their autonomy and enhance the level of control, (2) when managers perceive that value of employee autonomy is large but the value of managerial control is not sufficient (*i.e.*, $A > A_0$ and $P \leq P_0$), they should depress their employees in developing their autonomy and enhance the level of control, (3) when managers perceive that the value of employee autonomy is low but the value of managerial control is too large (*i.e.*, $A \leq A_0$ and $P > P_0$), they should depress their employees in developing their autonomy and reduce the level of control, and (4) when managers perceive that both values of employee autonomy and managerial control are too large(*i.e.*, $A > A_0$ and $P > P_0$), they should depress their employees in developing their autonomy and reduce the level of control.

Furthermore, theorem 1 suggests that manager should focus on employee autonomy if the optimal value of employee autonomy is greater than that of managerial control, otherwise manager must focus on managerial control. These results are meaningful since without consideration of the utility value of life satisfaction, it may mislead managers in adjusting the level of employee autonomy or managerial control. To analyze the model, some assumptions are set since strong assumptions produce powerful models (Shugan, 2002). The specific assumptions may limit the generality of results such as the reverse impact of work-family conflict on employee autonomy. Since the prospect theory is adopted to explain the optimal strategies, the special natural logarithms and multiple regression functions are employed to reflect the employee's life satisfaction function. Furthermore, this study gives a rigorous and robust explanation of the impact of managerial practices, and develops the optimal decision model for managerial practices to probe the employee's life satisfaction. There are several ideas for extending the future research in the employee's life satisfaction. First, future research can empirically test the model and replace the symbols of the mathematical model with the values of the coefficients from empirical research to illustrate the contribution of this model. Second, a comparative static analysis would allow us to clarify and highlight the influence of each parameter on the optimal values that are not biased by the samples. Third, future research may develop other dimensions more precisely to improve managerial practices, such as characteristics of industries. In addition, this study assumes that managers hold the levers of power and can optimally configure their employee's life experience based on the managerial perspective. Further research can develop a conceptual model based on the employee's perspective or based on both perspectives.

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Appendix A: Proofs of the $A^* \leq A_0$ and $P^* \leq P_0$

When the degree of employee autonomy and managerial control are lower than the reference point (*i.e.*, $A \leq A_0$ and $P \leq P_0$), the optimal values of employee autonomy (A^*) is equal to $\dfrac{\delta \lambda_{11} \lambda_{12}}{\tau_1 \lambda_{11} \lambda_{12} + 2\alpha_1 \beta_1 \tau_2}$ and managerial control (P^*) is equal to $\dfrac{2\delta \alpha_1 \beta_1 \tau_2}{\tau_1 \lambda_{11} \lambda_{12} + 2\alpha_1 \beta_1 \tau_2}$.

A1. Proofs of the optimal values of employee autonomy and managerial control (i.e., A^* and P^*)

When the degree of employee autonomy and managerial control are lower than the reference point, the Lagrangean functions can be written as L_{11}:

$$L_{11} = \alpha_0 + \beta_0 + \gamma_0 - \gamma_1 \theta_0 + \alpha_1 (A)^2 + \beta_1 \ln(P) - \gamma_1 [\theta_1(A) + \theta_2(P)] - \varepsilon_{11} [\tau_1(A) + \tau_2(P) - \delta]$$

Corresponding to the optimal employee autonomy (A^*),

$$\frac{\partial L_{11}}{\partial A} = 0 \Rightarrow 2\alpha_1 A - \gamma_1 \theta_1 - \varepsilon_{11} \tau_1 = 0 \Rightarrow 2\alpha_1 A = \gamma_1 \theta_1 + \varepsilon_{11} \tau_1 \tag{A1}$$

Similarly, we obtain the optimum managerial control (P^*) as follows,

$$\frac{\partial L_{11}}{\partial P} = 0 \Rightarrow \frac{\beta_1}{P} - \gamma_1 \theta_2 - \varepsilon_{11} \tau_2 = 0 \Rightarrow P(\gamma_1 \theta_2 + \varepsilon_{11} \tau_2) = \beta_1 \tag{A2}$$

$$\frac{\partial L_{11}}{\partial \varepsilon_{11}} = 0 \Rightarrow \tau_1(A) + \tau_2(P) = \delta \tag{A3}$$

For the derive the solutions, dividing (A1) by (A2) can obtain

$$\frac{(A1)}{(A2)} \Rightarrow \frac{2\alpha_1 A}{P(\gamma_1\theta_2 + \varepsilon_{11}\tau_2)} = \frac{\gamma_1\theta_1 + \varepsilon_{11}\tau_1}{\beta_1}$$

$$\Rightarrow 2\alpha_1 A\beta_1 = P(\varepsilon_{11}\tau_1 + \gamma_1\theta_1)(\varepsilon_{11}\tau_2 + \gamma_1\theta_2)$$

$$\Rightarrow P = \frac{2\alpha_1 A\beta_1}{(\varepsilon_{11}\tau_1 + \gamma_1\theta_1)(\varepsilon_{11}\tau_2 + \gamma_1\theta_2)} \tag{A4}$$

Substituting (A4) into subjective equation can obtain

$$\tau_1(A) + \tau_2(P) = \delta \Rightarrow \tau_1 A + \frac{2\alpha_1 A\beta_1\tau_2}{(\varepsilon_{11}\tau_1 + \gamma_1\theta_1)(\varepsilon_{11}\tau_2 + \gamma_1\theta_2)} = \delta$$

$$\Rightarrow A[\tau_1(\varepsilon_{11}\tau_1 + \gamma_1\theta_1)(\varepsilon_{11}\tau_2 + \gamma_1\theta_2) + 2\alpha_1\beta_1\tau] = \delta(\varepsilon_{11}\tau_1 + \gamma_1\theta_1)(\varepsilon_{11}\tau_2 + \gamma_1\theta_2)$$

$$\Rightarrow A^* = \frac{\delta(\varepsilon_{11}\tau_1 + \gamma_1\theta_1)(\varepsilon_{11}\tau_2 + \gamma_1\theta_2)}{\tau_1(\varepsilon_{11}\tau_1 + \gamma_1\theta_1)(\varepsilon_{11}\tau_2 + \gamma_1\theta_2) + 2\alpha_1\beta_1\tau}$$

Let $\lambda_{11} = \varepsilon_{11}\tau_1 + \gamma_1\theta_1$; $\lambda_{12} = \varepsilon_{11}\tau_2 + \gamma_1\theta_2$

$$\Rightarrow A^* = \frac{\delta\lambda_{11}\lambda_{12}}{\tau_1\lambda_{11}\lambda_{12} + 2\alpha_1\beta_1\tau} \tag{A5}$$

(A5) is the solution of optimal employee autonomy. Combining (A5) and (A4) can obtain the solution of optimal managerial control (P^*) as $\dfrac{2\delta\alpha_1\beta_1\tau_2}{\tau_1\lambda_{11}\lambda_{12} + 2\alpha_1\beta_1\tau_2}$.

A2. Proofs of the optimal values of employee autonomy lower than the reference point (i.e., $A^* \leq A_0$)

ELS_A, ELS_P, and ELS_C represent the impacts of employee autonomy, managerial control, and work-family conflict on employee's life satisfaction, respectively.

$$ELS = f(A, P, C) = ELS_A + ELS_P + ELS_C$$

$$ELS_A = \begin{cases} \alpha_0 + \alpha_1(A)^2 & ,as\ A \leq A_0 \\ \alpha_0 + \alpha_1(A_0)^2 + \alpha_2\ln(A - A_0 + 1) & ,otherwise \end{cases}$$

$$ELS_P = \begin{cases} \beta_0 + \beta_1\ln(P) & ,as\ P \leq P_0 \\ \beta_0 + \beta_1\ln(P_0) - \beta_2\ln(P - P_0 + 1) & ,otherwise \end{cases}$$

$$ELS_C = \gamma_0 - \gamma_1(C) = \gamma_0 - \gamma_1[\theta_0 + \theta_1(A) + \theta_2(P)] \quad where \quad C = \theta_0 + \theta_1(A) + \theta_2(P)$$

Accordingly, when the degree of employee autonomy and managerial control are lower than the reference point, the Lagrangean functions can be written as below:

$$L_{11} = \alpha_0 + \beta_0 + \gamma_0 - \gamma_1\theta_0 + \alpha_1(A)^2 + \beta_1\ln(P) - \gamma_1[\theta_1(A) + \theta_2(P)] - \varepsilon_{11}[\tau_1(A) + \tau_2(P) - \delta]$$

Therefore, the optimal values of employee autonomy (A^*) is equal to $\dfrac{\delta\lambda_{11}\lambda_{12}}{\tau_1\lambda_{11}\lambda_{12} + 2\alpha_1\beta_1\tau_2}$ and managerial control (P^*) is equal to $\dfrac{2\delta\alpha_1\beta_1\tau_2}{\tau_1\lambda_{11}\lambda_{12} + 2\alpha_1\beta_1\tau_2}$ under the condition of the degree of employee autonomy and managerial control are lower than the reference point(i.e., $A \leq A_0$ and $P \leq P_0$). Based on the domains of the functions of definition of ELS_A and ELS_P, the optimal values of employee autonomy and managerial control are lower than the reference point (i.e., $A^* \leq A_0$ and $P^* \leq P_0$). The detail proofs are shown as follows,

$$(\varepsilon_{11}\tau_1 + \gamma_1\theta_1)\ (\varepsilon_{11}\tau_2 + \gamma_1\theta_2)\ (\tau_1 A_0 - \delta)\ + (2A_0\alpha_1\beta_1\tau_2) \geq 0$$

$$\because \lambda_{11} = \varepsilon_{11}\tau_1 + \gamma_1\theta_1 \quad and \quad \lambda_{12} = \varepsilon_{11}\tau_2 + \gamma_1\theta_2$$

$$\Rightarrow \lambda_{11}\lambda_{12}(\tau_1 A_0 - \delta) + 2A_0\alpha_1\beta_1\tau_2 \geq 0$$

$$\Rightarrow A_0\tau_1\lambda_{11}\lambda_{12} + 2A_0\alpha_1\beta_1\tau_2 - \delta\lambda_{11}\lambda_{12} \geq 0$$

$$\Rightarrow A_0\tau_1\lambda_{11}\lambda_{12} + 2A_0\alpha_1\beta_1\tau_2 \geq \delta\lambda_{11}\lambda_{12}$$

$$\Rightarrow A_0 \geq \frac{\delta\lambda_{11}\lambda_{12}}{\tau_1\lambda_{11}\lambda_{12} + 2\alpha_1\beta_1\tau_2} = A^*$$

Therefore, the condition of $A^* = \dfrac{\delta\lambda_{11}\lambda_{12}}{\tau_1\lambda_{11}\lambda_{12} + 2\alpha_1\beta_1\tau_2} \leq A_0$ holds.

A3. Proofs of the optimal values of managerial control lower than the reference point (i.e., $P^* \leq P_0$)

$$P_0\tau_1(\varepsilon_{11}\tau_1 + \gamma_1\theta_1)(\varepsilon_{11}\tau_2 + \gamma_1\theta_2) + 2\alpha_1\beta_1\tau_2(P_0 - \delta) \geq 0$$
$$\because \lambda_{11} = \varepsilon_{11}\tau_1 + \gamma_1\theta_1 \quad \text{and} \quad \lambda_{12} = \varepsilon_{11}\tau_2 + \gamma_1\theta_2$$

$$\Rightarrow P_0\tau_1\lambda_{11}\lambda_{12} + 2\alpha_1\beta_1\tau_2(P_0 - \delta) \geq 0$$
$$\Rightarrow P_0\tau_1\lambda_{11}\lambda_{12} + 2P_0\alpha_1\beta_1\tau_2 \geq 2\delta\alpha_1\beta_1\tau_2$$
$$\Rightarrow P_0 \geq \frac{2\delta\alpha_1\beta_1\tau_2}{\tau_1\lambda_{11}\lambda_{12} + 2\alpha_1\beta_1\tau_2} = P^*$$

Therefore, the condition of $P^* = \dfrac{2\delta\alpha_1\beta_1\tau_2}{\tau_1\lambda_{11}\lambda_{12} + 2\alpha_1\beta_1\tau_2} \leq P_0$ holds.

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