Discussion Paper Series

RIEB

Kobe University

DP2023-16

Pilots' Desire to Become Future Space Tourism Pilots: Polynomial Regression Using Response Surface Analysis

Robert A. GOEHLICH
Ralf BEBENROTH

August 21, 2023

Research Institute for Economics and Business Administration
Kobe University
2-1 Rokkodai, Nada, Kobe 657-8501 JAPAN

Pilots' Desire to Become Future Space Tourism Pilots: Polynomial Regression Using Response Surface Analysis

Goehlich, Robert A.[1]
Embry-Riddle Aeronautical University, Worldwide

Bebenroth, Ralf[2]
Kobe University, Japan

ABSTRACT

In this study, we investigated the impact of pilots' motivation on their desire to be space tourism pilots or to remain in their current occupation (adherence) by analyzing the feedback obtained from a survey questionnaire. Our sample consisted of 106 pilots with flying experience. In particular, we compared the pilots' intrinsic and extrinsic motivations to investigate two outcomes: the desire to become future *space* pilots or to remain as *air* pilots. Applying the self-determination theory, we found that intrinsic motivation mattered more than extrinsic motivation. Furthermore, by applying response surface analysis as our statistical tool, it was revealed that motivation for the desire to be space pilots differed from that for adherence. To be more precise, motivation (intrinsic and extrinsic) correlated positively with desire to become space pilots, with higher motivation being associated with a steeper increase. On the other hand, motivation correlated negatively with adherence (maintaining status quo). Moreover, pilots who experienced mid-level motivation preferred to stay at their "old" profession while highly motivated pilots are less hesitant to become space pilots. Further, we discovered that for desire a linear effect of motivation is predominant, while for adherence a quadratic effect of motivation is predominant. The managerial implications of the results are discussed.

Keywords: airline pilot, desire, adherence, extrinsic motivation, intrinsic motivation, response surface analysis, spaceline, space tourism pilot

JEL Classification: C12, D91, L93, M51, R41

---

[1] Embry-Riddle Aeronautical University, Worldwide, Europe Campus, Bessie-Coleman-Str. 7, 60549 Frankfurt, Germany, mobile: +49-(0)174-25-313-87, email: robert.goehlich@erau.edu, website: www.goehlich.com

[2] Kobe University, Research Institute for Economics and Business Administration (RIEB), 2-1, Rokodai, Nada-ku, Shinkan 1307, Kobe 657-8501, Japan, mobile: +81-(0)78-803-7021, email: rbeben@rieb.kobe-u.ac.jp, website: www.bebenroth.eu

1. INTRODUCTION

Space tourism is currently on the transition from a pioneer phase to an initial operational phase, having prominent supporters with billionaires such as Branson, Bezos, and Musk leading the hype of traveling to space (Hyland et al., 2021). While much attention is beginning to be focused on potential space tourists (e.g., Chang, 2020; Kluge et al., 2013; Mehran et al., 2023; Mesa-Arango et al., 2023; Olya & Han, 2020; Tasci et al., 2021), in this study, we investigate the topic of space tourism from the perspective of pilots themselves. We are interested to find out the extent to which current pilots aim to become space pilots, focusing on the degree and type of motivation vis-à-vis their desire or adherence to their existing profession. Without a clear understanding of the underlying psychological issues at hand, the endeavor to recruit space pilots might become a blind flight, so to speak. A recent popular news article drove the point home with this headline: "Do You Have What It Takes to be a Space Pilot?" (Airline Pilot Central, 2020).

Since the seminal work of self-determination by Deci and Ryan (1985), motivation has often been categorized as either extrinsic or intrinsic. One is extrinsically motivated when one performs a task to receive approval, recognition, status, or financial rewards (Deci & Ryan, 2015). In contrast, intrinsic motivation refers to a state in which the individual is driven by love and passion for performing a specific task (Deci & Ryan, 1985; Li et al., 2020). The self-determination theory highlights the role of motivation (especially intrinsic motivation) and shows how innate psychological needs are met by work fulfillment (Deci & Ryan, 1980, 1985; Rockmann & Ballinger, 2017; Ryan & Deci, 2000). In this study, the self-determination theory is used as a framework to explain the pilot's desire whether to become a space pilot or to remain as an airline pilot.

While there have been extensive studies on pilots' psychological behavior (e.g., Peyrat-Guillard & Grefe, 2020), research on the psychological behavior of airline pilots in transitioning to space tourism pilots, however, is in its infancy at this point in time. Even if space tourism is expected to become a new and growing industry in the near future, to the knowledge of the authors, there is not yet any research on air pilots' desire to become space pilots. Based on the importance and the pioneering character of this research, we aim to answer the following two research questions (*RQ*):

RQ1: How does a pilot's motivation affect the desire to become a space pilot?

RQ2: How does a pilot's motivation lead to adherence as a regular airline pilot instead of striving to become a space pilot?

We offer novel insights by extending the scope of this psychological investigation to current pilots. In particular, we want to investigate how motivational factors of pilots influence their desire to become space pilots and, the extent to which motivation affects the choice to adhere to their present positions, i.e., remain as regular pilots.

An online survey questionnaire (see appendix) was conducted, resulting in 106 pilots that met the criterion of having flight experience. The polynomial regressions and response surface analysis methodology (Edwards & Parry, 2018) that were applied enabled us to examine nonlinearity (Schönbrodt et al., 2018) that provided more comprehensive information. On one hand, we investigated matches of intrinsic and extrinsic motivations (on the congruent line). On the other hand, we investigated how a mismatch of intrinsic and extrinsic motivations led to different outcomes (on the incongruent line). Our significant statistical findings are as follows:

- First, motivation of pilots correlated positively to the desire of becoming a space pilot, and to a steeper increase as motivation became greater.
- Second, motivation correlated negatively to adherence; low adherence to remain in the airline business as a "regular" pilot was extremely dominant at high levels of motivation.
- Third, intrinsic motivation mattered more than extrinsic motivation regarding the desire of pilots to become space pilots.

Having discussed the objectives of our study, we shall present a literature review on airplane pilots and discuss our hypotheses development on motivation. This will be followed by the methodology of our response surface analysis model, and the presentation of the results. A discussion of the salient points is followed by managerial and policy implications as well as limitations of the study. The concluding section contains a brief summary.

2. LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

2.1. Pilots

Space tourism vehicles could be operated by newly educated pilots, regular pilots on the job receiving training, or the spacecraft could be completely automated. Extensive research on regular pilots has been conducted in the area of psychological behavior (e.g., Peyrat-Guillard & Grefe, 2020). However, to the knowledge of the authors, there is virtually no research on the psychological behavior of space pilots. Such pilots need much training and their numbers can be generated from scratch. Trained

pilots might also be persuaded to switch their profession to be space pilots. This is the focus of this study. The reasons are as follows:

Different types of pilots may assume the position of space pilot better than regular airline pilots. Goehlich et al. (2013) conclude that "fighter pilots and test pilots are generally the most qualified to be [future] space pilots" (p. 147). We contend that space tourism in future requires a high number of space pilots. However, just relying on former fighter pilots will not be adequate to meet market demand which is expected to increase. Therefore, it is important to investigate how airline pilots can be attracted to fill this gap. Also, one consideration is the extent to which spacecraft will be automated, thereby reducing the responsibility of the pilot for manual control so that they can be operated with ease by newly trained pilots.

Goehlich et al. (2013) also indicate that in the event of unforeseen misshapes such as spacecraft's malfunctioning, an experienced pilot is superior to a fully automated vehicle; naturally, space tourists would feel that they are in better hands with a qualified human pilot at the helm. A further finding was that such a space pilot is preferably a charismatic leader who can handle challenges under trying circumstances. The lack of a crew on board owing to the high costs of such personnel means that the space pilot himself must do more than just fly the spacecraft.

Observations of the development of the space tourism market indicate an increase in demand (e.g., Mesa-Arango et al., 2023) and sustainability (e.g., Paladini & Saha, 2023), and thus there will be a growing need for more space pilots. However, as reported by Russell (2023), there is a continuously growing shortage of pilots, e.g., in the US Air Force. We therefore contend that there is an inadequate supply of fighter pilots and test pilots to meet the demand for future space pilots. Sufficient supply of space pilots can only be realized by recruiting airline pilots to operate the expected high number of launches in the coming years. For example, UBS Investment Bank (2021) estimated the space tourism market to generate US$4 billion per year, 25% higher than their initial expectations in their 2019 report. According to UBS, these updated estimations are "driven by an influx of capital, more ambitious plans than our baseline, and technical progress" (UBS Investment Bank, 2021, para. 1). Hence, in this research, our sample comprised a large pool of commercial airline pilots. We investigated the impact of motivation on their desire to become future space pilots or to adhere to their current positions.

According to Miani et al. (2021), aviation students are cognizant of the possibility of an oversupply of aviation professionals for different reasons. For instance, there could be a downturn in the industry due to a crisis (like the Covid-19 pandemic) leading to worldwide difficulty in supply chain, transportation, and demand. Also, avi-

ation students generally seek to further develop their skillset to be competitive following graduation. We contend that aviation pilots and especially ongoing pilots (still in training) may expect vacancies in the suborbital and orbital space industry as new employment opportunities emerge in the not-too-distant future.

2.2 Self-determination theory for pilots

Generally, individuals differ in their motivation to perform certain tasks (Herzberg, 1966; Porter & Lawler, 1968; Rockmann & Ballinger, 2017). In this interplay of motivation and personal needs, Deci and Ryan (1980, 1985, 2000, 2015) developed the self-determination theory. The theory suggests that people have innate psychological needs and that these needs are stimulated or triggered by different motivations. As self-motivation is integrated with personality characteristics reaching far beyond financial rewards, people search for fulfillment of their "meaning of life" (Demirbaş-Çelik & Keklik, 2019). In other words, discovering the meaning of life constitutes a distinctive desire to find a purpose in life.

The self-determination theory posits that intrinsic motivation can be distinguished from extrinsic motivation. With extrinsic motivation (EM), an individual is motivated when she/he performs a task in order to obtain rewards, e.g., approval, recognition, status, or financial benefits (Amabile et al., 1994; Deci, 1972; Deci & Ryan, 2015). The pilot's extrinsic motivation to switch to space flights was analyzed in this study as a construct taken from psychology literature. Intrinsic motivation (IM), on the other hand, refers to a state in the individual that is driven by love and passion for performing specific tasks rather than the expectation of receiving rewards or benefits (Deci & Ryan, 1985; Li et al., 2020). Amabile et al. (1994) contend that people with a passionate interest, curiosity, and love for their work often feel excited, engaged, and satisfied. Intrinsic motivation is the central element of creativity which keeps employees attached to their jobs and increases their focus. As a result, these employees manifest more creative behavior (Amabile, 1997; Gumusluoglu & Ilsev, 2009). In sum, individuals in these instances find satisfaction and interest by doing certain things rather than receiving rewards or approval from others (Grant, 2008). Also, Ali et al. (2020) suggest "that marketers and policymakers should focus on … the intrinsic motivation (enjoyment) of consumers for the success and adoption of green electronics products" (p. 281). In their latest study, Ryan and Deci (2020) state that "both intrinsic motivation and well-internalized (and thus autonomous) forms of extrinsic motivation predict an array of positive outcomes" (p. 1). We interpret the intrinsic motivation of pilots as a construct from psychology to fly tourists to space.

2.3. Hypothesis development for motivation matches

There is a plethora of psychological studies on motivation. The main findings show that higher motivation correlates positively with most of the outcome variables under investigation. López-Fernández et al. (2019) studied the impact of motivation on desire, while Walsh et al. (2005) examined the effect of motivation on satisfaction. Amabile et al. (1994) and Li et al. (2020) split motivation into intrinsic and extrinsic motivation. Likewise, there are studies on corporate social responsibility (CSR) on a match of external and internal CSR dimensions (Bolton, 2020; Hawn & Ioannou, 2016). For example, a study by Al-Shammari et al. (2022) found a positive association between scores in the match of internal and external motivations relating to CSR, leading to higher market performance. We extend these findings to aircraft pilots, looking at the relationship between motivation and the desire to become space pilots, as well as how motivation correlates with adherence to remain as regular pilots. We combine intrinsic and extrinsic motivation, i.e., matching them (as a congruent line) to desire and adherence respectively. Unlike adherence, the desire to become space pilot could be positively impacted by motivation. Pilots with high motivation should be more willing to become space pilots than those with low motivation. In contrast, pilots with high adherence and a low urgency of job change would be most unlikely to accept a switch to become space pilots; they would rather remain in their present jobs. Therefore, we postulate a positive correlation for motivation with desire ($H1_D$) and a negative relationship with adherence ($H1_A$).

$H1_D$: Aviation pilots with a match at higher intrinsic and extrinsic motivation positively correlate to the desire of becoming space pilots, than if motivation is low.

$H1_A$: Aviation pilots with a match at higher intrinsic and extrinsic motivation negatively correlate to the adherence to remain in their profession, than if motivation is low.

Economic theories are heavily focused on "returns to scale" to detect non-linear relationships (e.g., Wang & Wright, 2020). In natural sciences this phenomenon is well studied. For example, a linear increase in a predictor variable can lead to an exponential growth or decline of an outcome variable (e.g., propagation of algae). These findings are extended to human behavior studies. For instance, when the deadline of submitting an essay approaches, students' efforts increase exponentially. In a similar study, Steel and König (2006) find that a student's desire to study exponentially increases with a decrease in available time and the same student's desire to socialize exponentially decreases at the end of the time. We extrapolate these findings onto this study on pilots.

For our second hypothesis, we investigate the non-linear impact of a congruent match of intrinsic and extrinsic motivations on desire and adherence. A change in the

midrange levels of motivation does not impact outcome variables as much as it does at higher levels. To put it differently, the marginal effect of matched motivation on desire or adherence would be more pronounced for pilots with higher motivation than those with lower motivation. Therefore, we expect that an increase in the desire of pilots to become a space pilot is more pronounced for pilots with higher levels of motivation. On the other hand, a decrease in adherence is more pronounced also for pilots with higher levels of motivation. Therefore, we postulate a quadratic relationship for desire and adherence. By applying polynomial regression analysis, we expect a u-shape relationship for desire (*$H2_D$)* and an inverted u-shape relationship for adherence (*$H2_A$).*

$H2_D$: A match of intrinsic and extrinsic motivations of aviation pilots correlates with a steeper increase of desire to be space pilots at higher values of motivation compared to midrange levels of motivation.

$H2_A$: Aviation pilots with a match of midrange intrinsic and extrinsic motivations are more likely to remain in their profession compared to those with higher levels of motivation.

2.4. Hypothesis development for motivation mismatches

Besides investigating both types of motivation as a match, we also investigate the disparity of motivation by extracting intrinsic from extrinsic motivation. This is supported by the idea that both values (intrinsic and extrinsic) can be seen as being located at opposite ends. Recent research even postulates that intrinsic and extrinsic motivations are independent factors, each having unique outcomes (Amabile, 1997; Amabile et al., 1994; Grant et al., 2011; Rockmann & Ballinger, 2017). As such, a mismatch of intrinsic and extrinsic motivations can lead to different outcomes.

Our research is in line with previous psychological studies. Good et al. (2022) applied meta-analytic research on motivation for salesmen and found that intrinsic motivation was more significantly associated with performance than extrinsic motivation. Zeng et al. (2022), in their study on nurses, found that it was intrinsic motivation, rather than extrinsic motivation that significantly and positively affected work engagement in hospitals. According to Van den Broeck et al. (2021), "intrinsic motivation is the most important type of motivation for employee well-being, attitudes and behavior" (p. 240). Therefore, we propose that intrinsic motivation compared to extrinsic motivation (as the line of incongruence) correlates positively with a higher level of desire ($H3_D$) and negatively with adherence ($H3_A$) than a match. We hypothesize that:

$H3_D$: Aviation pilots' intrinsic motivation correlates more positively than extrinsic motivation with the desire of becoming space pilots.

$H3_A$: Aviation pilots' intrinsic motivation correlates more negatively than extrinsic motivation to adherence, i.e., remaining in their profession.

Furthermore, previous research indicates that both types of motivation jointly affect outcome variables in a non-linear fashion, a mismatch leading to lower scores for the dependent variable. Lee et al. (2021) found that both intrinsic and extrinsic motivations had a moderating role in impulse buying for traveler satisfaction in the context of airport duty-free shopping behavior. This means that the compounding effects of independent variables lead to higher scores by the dependent variables. Therefore, we propose that there is an inverted u-shape effect between the match of intrinsic and extrinsic motivations to desire and a u-shape effect to adherence respectively. If both motivations are more similar, we expect a higher outcome of desire ($H4_D$). However, we expect a lower adherence when the match of motivations is more similar ($H4_A$). Hence, we hypothesize that:

$H4_D$: Aviation pilots' match of intrinsic and extrinsic motivations correlates positively with the desire to become space pilots than if the values deviate.

$H4_A$: Aviation pilots' match of intrinsic and extrinsic motivations correlates negatively with adherence or maintaining status quo professionally than if the values deviate.

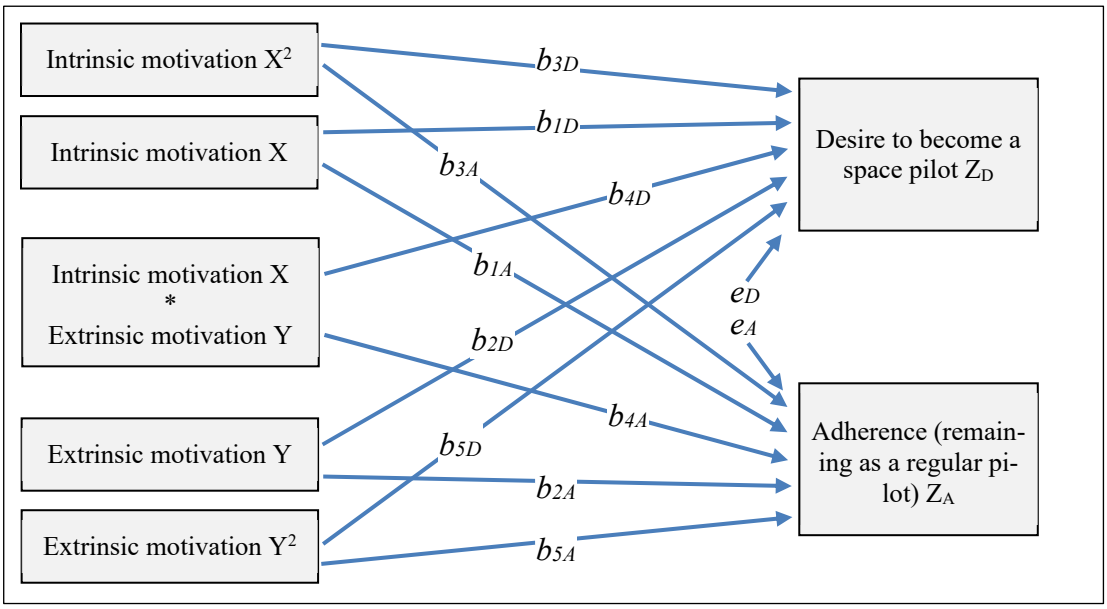
3. MODEL AND METHODOLOGY

3.1 Research model

Based on the hypotheses proposed in the previous section, we constructed a conceptual model (Figure 1) consisting out of two predictors and two independent outcome variables represented by two second-order polynomial regressions. Our independent model is adapted from the interdependent (dyadic) model of Schönbrodt et al. (2018). However, we describe how intrinsic and extrinsic motivations influence desire, and also the extent to which motivation leads aircraft pilots not to switch profession, i.e., not to become space pilots. After introducing the procedures and participants as well as measures, the method and analytic approach is discussed.

Figure 1

Research model with visualization of its regression paths and associated coefficients



3.2 Procedures and participants

The survey was offered to pilots of all types and ranks belonging to Embry-Riddle Aeronautical University, including students, alumni, or faculty. It is to say, students enrolled also take various subjects (e.g., statistics or accounting) that are unrelated to their professional career. Many of the students, in fact, consist of professional pilots.

An invitation letter with the survey link was presented on Embry-Riddle Aeronautical University's internal website as well as on diverse forums. The pilots were from one of more than 120 campus locations worldwide. Hence, we had access to more than 30,000 potential participants.

A total of 125 participants responded to the online survey "Space Pilots" in the period from May 2022 to May 2023. The survey's mean completion time was 6 minutes. As the focus was on pilots with flying experience, 106 participants met this requirement. In terms of pilot type, 26 of the sample were airline pilots, 6 fighter pilots, 1 test pilot, 42 pilots in training, 8 Unmanned Aerial Vehicle (UAV) pilots, 9 instructor pilots, and 14 others. The "pilots in training" terminology corresponds to pilots with typical flight experience, but still being under the supervision of a licensed instructor (FAA, n.d.). Years of flight experience ranged from 1 to 50, with a mean year of 8 (SD = 9.5 years). In terms of contract, 36 pilots were tenured and 70 were non-tenured. Regarding nationalities, 73 participants were from the US, 13 from Europe, 9 from Asia, and 11 were from other countries. The sample primarily comprised 81 men, 23 women, and 2 who

preferred not to reveal their gender. The participants had a mean age of 34 (SD = 13.0 years).

3.3 Measures

The questionnaire included items on desire and adherence intentions, competition, motivation as well as demographics. All the items were derived from theoretical considerations and from previous constructs in psychological literature (e.g., Ghufran et al., 2022; Rahman et al., 2022). Participants' responses were scored on a 7-point Likert-type scale format ranging from 1 (strongly disagree) to 7 (strongly agree).

The *desire* construct (survey items D1–D6) was amended from López-Fernández et al. (2019). It consisted of six items in line with our study to measure participants' overall desire to become space pilots. A sample item reads as: "I expect that the effort of becoming a space pilot is worth it." Nevertheless, one reverse item (D6) did not load well and was, therefore, excluded from the desire construct. The remaining five items showed adequate consistency (Cronbach's alpha = 0.84).

The *adherence* construct (survey items A1–A3) was taken from Walsh et al. (2005) and amended to suit the context of this study. A sample question reads as: "I will wait and see what other pilots experience after they switch to space tourism flights." The scale consisted of three items, with adequate internal consistency (Cronbach's alpha = 0.79).

The *intrinsic motivation* construct (survey items I1–I5) was taken from Amabile et al. (1994) and Li et al. (2020), and amended to the context of this study on pilots. A sample question reads as: "I feel excited when I have new ideas." The scale was formed out of five items with a strong internal consistency (Cronbach's alpha = 0.88).

Extrinsic motivation (survey items E1–E5) was also amended from the scale of Amabile et al. (1994) and Li et al. (2020). The original questionnaire had five items. A sample item reads: "I want other people to find out how good I manage flights as a pilot." Also in this construct, one question (E4) did not load well, and was therefore removed. The remaining four items formed the extrinsic motivation construct, providing sufficient consistency (Cronbach's alpha = 0.70).

There were three more items in the questionnaire shown (survey items C1–C3), the *competitor* construct, that was taken from Walsh et al. (2005) and amended to suit the context of this study. A sample question reads as: "I see new firms offering space tourism flights, instead of classical airlines." However, this construct showed insufficient consistency (Cronbach's alpha = 0.60)—probably due to the inhomogeneity of organization types to which the pilots are affiliated to—and was not further analyzed.

3.4 Method and analytic approach

We used the R tool version 2023.03.1 (R Core Team, 2023) for our statistical analysis owing to its flexibility to automate routines. We applied response surface analysis (RSA), R package version 0.10.6, a technique based on polynomial regressions (Schönbrodt, 2023). Using this approach, we were able to visualize the relationship between two predictor variables x (intrinsic motivation) and y (extrinsic motivation) with an outcome variable z (desire or adherence). RSA enables curvilinear effects to be handled and graphed, unlike linear regressions that tend to oversimplify relationships and thus mask the real relationship between variables (Edwards, 2002; Shanock et al., 2010).

Applying RSA, two different lines were investigated. The first line that goes from the bottom left to the top right is called "line of congruence." The second line that goes from top left to bottom right is called "line of incongruence." While the first line shows how a match of independent variables correlates to a dependent variable, the second line investigates how the difference of both variables correlates to a dependent variable. To investigate congruent and incongruent paths of intrinsic and extrinsic motivation to desire and adherence respectively, we added the following regression parameters to our desire and adherence model in Equation 1 and 2 (Rodrigues, 2021; Schönbrodt et al., 2018):

$$Desire\ Z_D = b_{0D} + b_{1D}X_{IM} + b_{2D}Y_{EM} + b_{3D}X_{IM}^2 + b_{4D}X_{IM}Y_{EM} + b_{5D}Y_{EM}^2 + e_D \quad (1)$$

$$Adherence\ Z_A = b_{0A} + b_{1A}X_{IM} + b_{2A}Y_{EM} + b_{3A}X_{IM}^2 + b_{4A}X_{IM}Y_{EM} + b_{5A}Y_{EM}^2 + e_A \quad (2)$$

The equations included linear, quadratic, and interaction terms, besides the error terms e_D and e_A. The polynomial regression parameters b_0–b_5 that define the characteristic of the surface were used to determine the response surface parameters a_1–a_4 in Equation 3 to 6 (Shanock et al., 2010):

$$a_1 = b_1 + b_2 \quad (3)$$

$$a_2 = b_3 + b_4 + b_5 \quad (4)$$

$$a_3 = b_1 - b_2 \quad (5)$$

$$a_4 = b_3 - b_4 + b_5 \quad (6)$$

The response surface parameters a_1–a_4 were used to test the hypotheses (Barranti et al., 2017; Schönbrodt et al., 2018). In the following, we adjusted the questions a_1–a_4 to motivation:

- a_1*: Slope of LOC.* Does the match of motivation on higher levels have a different outcome on desire/adherence than on lower levels?
- a_2*: Curvature of LOC.* Does the match of motivation on extreme levels have a different outcome than a match on midrange levels?
- a_3*: Slope of LOIC.* Does a mismatch of intrinsic versus extrinsic motivation in one direction (X > Y) lead to a higher outcome than the other way around (X < Y)?
- a_4*: Curvature of LOIC.* Does a match of intrinsic and extrinsic motivations lead to a different outcome from a mismatch?

For transparency, we first interpreted all RSA parameters in isolation. We then interpreted them jointly as recommended by Humberg et al. (2019).

4. RESULTS

4.1 Linear correlations

Linear correlations, means, and standard deviations for the four constructs (desire, adherence, intrinsic motivation, and extrinsic motivation) and control variables are shown in Table 1. As projected by the theory of self-determination, intrinsic and extrinsic motivations had a positive linear correlation with desire (r = .77 and .33, p < .001), while only intrinsic motivation showed a negative linear correlation with adherence (r = -.26, p < .01). Intrinsic and extrinsic motivations were positively correlated with each other (r = .44, p < .001), justifying the application of RSA to test curvilinear effects.

Table 1

Correlation Analysis, Means, and Standard Deviations

Constructs/ Variables	1	2	3	4	5	6	7	8	9	10
1. Desire	1									
2. Adherence	-.35***	1								
3. IM	.77***	-.26**	1							
4. EM	.33***	-.08	.44***	1						
5. Flight years	-.02	-.09	-.18	-.28**	1					
6. Age	-.11	-.18	-.12	-.23*	.62***	1				
7. Contract type	.08	-.14	-.07	-.01	.35***	.14	1			
8. Pilot type	-.08	.14	-.19*	-.20*	.46***	.22*	.60***	1		
9. Nationality	.00	.03	.01	-.13	-.13	-.08	-.29**	-.33***	1	
10. Gender	-.05	.03	.10	.21*	-.17	-.05	-.18	-.24*	-.09	1
M	5.47	3.85	5.93	4.97	8.29	34.1	0.34	0.40	0.69	0.22
SD	1.31	1.53	1.09	1.27	9.47	12.59	0.48	0.49	0.47	0.41

Note. $^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$; IM = intrinsic motivation; EM = extrinsic motivation
Measurement. Contract type grouped into: 1 = permanent employee, 0 = time-contracted employee; pilot type grouped into: 1 = airline, fighter, test, and instructor pilot, 0 = student, UAV, and other pilot; nationality grouped into: 1 = USA, 0 = Europe, Asia, and others; gender grouped into: women = 1, men = 0.

4.2 RSA for desire

Results of RSA related to desire are shown in Table 2 and illustrated in Figure 2. In the figure, the LOC, LOIC, ridge line, a bagplot (i.e., a bivariate extension of a boxplot) are shown on the regression surface and the corresponding contour projection in XY plane. Results indicated a significant association between the linear intrinsic motivation term and desire ($\beta = 0.73$, $SE = 0.12$, $p < .001$).

Our first hypothesis $H1_D$ was supported. Aircraft pilots' match of intrinsic and extrinsic motivations at higher values correlated positively with a higher desire to become space pilots than when the match of motivations was low. We found significance for the slope along the line of congruence, i.e., a linear additive effect ($a_1 = 0.73$, $p < .001$). The positive a_1 coefficient indicated that desire was higher when intrinsic motivation and extrinsic motivations matched at higher levels. The relatively high value of a_1 resulted in a steep upward slope of the LOC.

The second hypothesis $H2_D$ received support. Aircraft pilots' quadratic match of intrinsic and extrinsic motivations correlated more positively at higher values than at mid-levels. In other words, we found significance for the curvature of the line of congruence ($a_2 = 0.10$, $p < .05$). We detected a slightly positive value of a_2 to have a small distinct convex surface shape with a curved LOC. Considering $H1_D$ and $H2_D$

together, high (intrinsic and extrinsic) motivation correlated significantly with a higher desire and a steeper increase as motivation became higher.

The third hypothesis on desire, *H3D*, was also supported. Pilots' intrinsic motivation mattered more than their extrinsic motivation with regard to the desire to become space pilots. We found significance for the slope along the line of incongruence (a_3 = 1.02, $p < .001$). In other words, the positive a_3 coefficient indicated that it was rather intrinsic motivation that drove our results as evidenced by the steep slope upwards of the LOIC.

Our fourth hypothesis, *H4D*, did not receive support (a_4 = 0.05, p = .671). Whether the pilots' intrinsic and extrinsic motivations matched or deviated from one another did not matter regarding their desire to become a space pilot. Therefore, we did not find a significant curvature on the LOIC for the construct desire.

Table 2

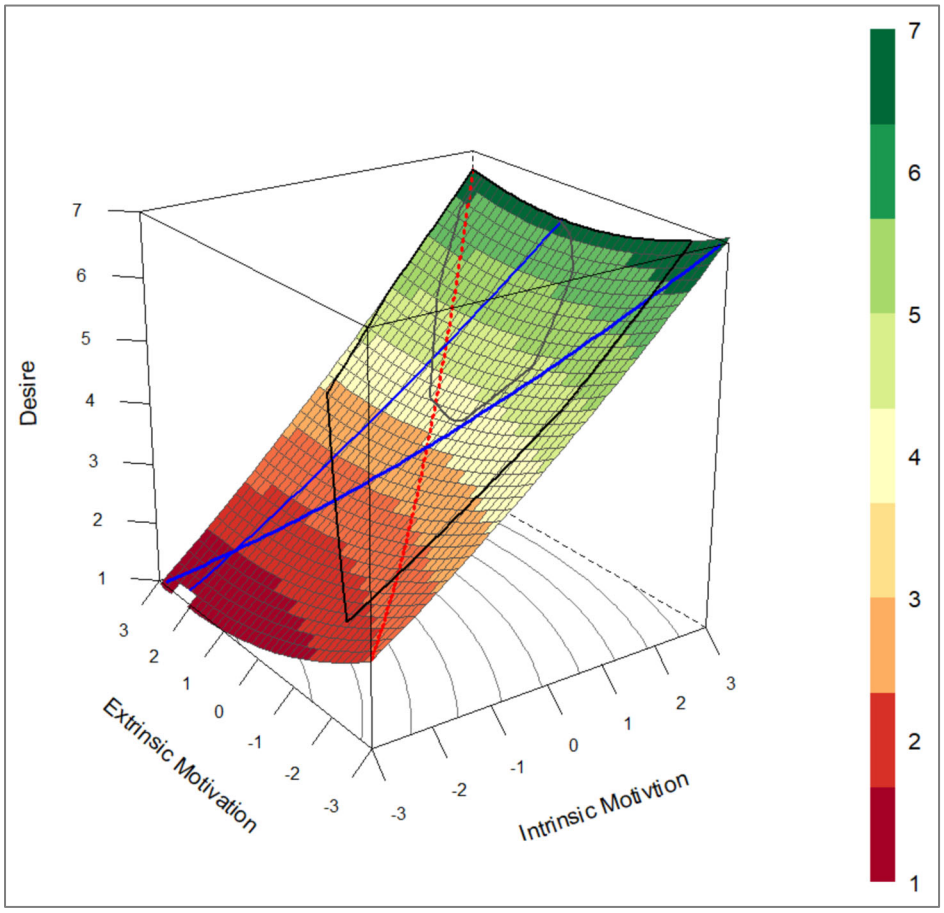
Desire - Polynomial Regression and RSA Parameters

Variable	Estimate	*SE*	95% CI	*t*-ratio	*p*-value	sig
Polynomial Regression Parameters						
b_0: Constant	3.605	0.175	[3.262, 3.95]	2.774	< .001	***
b_1: IM	0.875	0.118	[0.643, 1.11]	0.732	< .001	***
b_2: EM	-0.148	0.160	[-0.461, 0.16]	-0.145	.353	
b_3: IM^2	0.024	0.051	[-0.076, 0.12]	0.060	.635	
b_4: IM * EM	0.028	0.058	[-0.085, 0.14]	0.065	.632	
b_5: EM^2	0.049	0.032	[-0.014, 0.11]	0.105	.130	
Response Surface Parameters						
a_1: Congruence slope	0.73	0.102	[0.527, 0.926]		< .001	***
a_2: Congruence curvature	0.10	0.045	[0.012, 0.189]		.026	*
a_3: Incongruence slope	1.02	0.262	[0.510, 1.536]		< .001	***
a_4: Incongruence curvature	0.05	0.107	[-0.164, 0.254]		.671	

Note. $^{+}p < .1$; $^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$; SE = standard error; CI = confidence interval; IM = intrinsic motivation; EM = extrinsic motivation.

Figure 2

Response surface plot of participants' congruent and incongruent lines of intrinsic and extrinsic motivations correlating with desire



Note. Line of congruence (LOC) = red dotted; line of incongruence (LOIC) = blue thick; ridge line = blue thin; bag plot = black lines.

4.3 RSA for adherence

Results related to adherence from the polynomial regression are shown in Table 3, and graphically illustrated in Figure 3. The polynomial shows a significant association between the quadratic intrinsic motivation term and adherence (β = -0.735, *SE* = 0.099, $p < .001$).

Our first hypothesis $H1_A$ stated that aviation pilots with a match of higher intrinsic and extrinsic motivations abide weaker (had lower adherence) to remain in their profession. To our surprise, we found a significant but positive (not negative) correlation along the line of congruence, i.e., a linear additive effect ($a_1 = 0.48$, $p < .05$). In

other words, the positive a_1 coefficient indicated that adherence was higher at higher levels of motivation than at lower ones. However, we had to interpret the meaning in combination with *H2A*. While the relatively weak *p*-value of a_1 resulted in a moderate upward slope of the LOC only, the effect was predominated by a relatively strong *p*-value of a_2.

Our second hypothesis *H2A* was supported: aviation pilots with a match of intrinsic and extrinsic motivations at midrange levels chose to remain in their profession than a match at higher or lower levels of motivation. In other words, we found a significant curvature of the line of congruence (a_2 = -0.32, $p < .001$). The negative value of a_2 resulted in an inverted u-shape surface with a strongly curved LOC. This indicated that adherence was higher when intrinsic and extrinsic motivations matched at midrange levels compared to extreme values. Considering *H1A* and *H2A* together, adherence significantly decreased at higher values of intrinsic and extrinsic motivation.

Our third and fourth hypotheses (*H3A–H4A*) were not supported (a_3 = 0.47, p = .246; a_4 = -0.16, p = .339). The pilots' intrinsic motivation did not matter more than their extrinsic motivation when choosing to remain in their profession; this was not indicated in the slope nor in the curvature.

Table 3

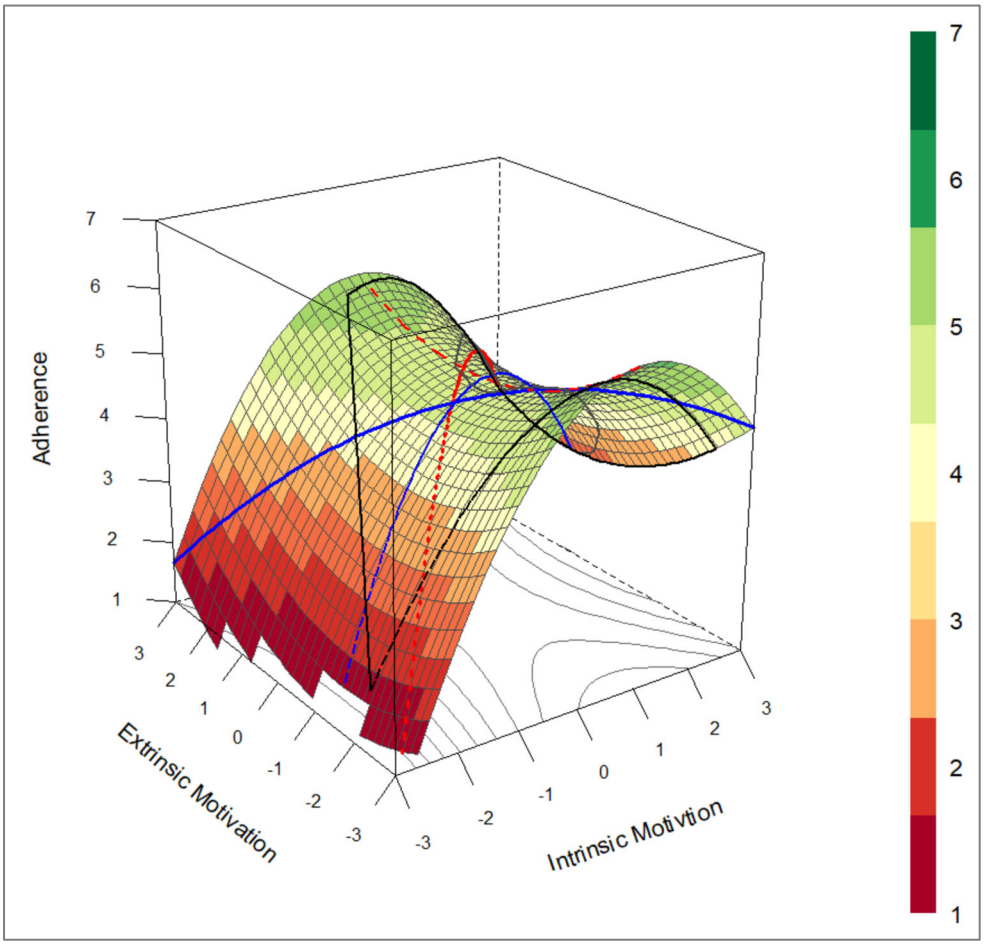
Adherence - Polynomial Regression and RSA Parameters

Variable	Estimate	*SE*	95% CI	*t*-ratio	*p*-value	sig
Polynomial Regression Parameters						
b_0: Constant	4.546	0.247	[4.061, 5.03]	2.995	< .001	***
b_1: IM	0.476	0.254	[-0.022, 0.97]	0.341	.061	+
b_2: EM	0.008	0.207	[-0.397, 0.41]	0.007	.969	
b_3: IM^2	-0.346	0.099	[-0.540, -0.15]	-0.735	< .001	***
b_4: IM * EM	-0.075	0.092	[-0.256, 0.10]	-0.152	.413	
b_5: EM^2	0.107	0.057	[-0.004, 0.22]	0.199	.060	+
Response Surface Parameters						
a_1: Congruence slope	0.48	0.227	[0.039, 0.93]		.033	*
a_2: Congruence curvature	-0.32	0.087	[-0.485, -0.14]		< .001	***
a_3: Incongruence slope	0.47	0.404	[-0.323, 1.26]		.246	
a_4: Incongruence curvature	-0.16	0.171	[-0.500, 0.17]		.339	

Note. $^{+}p < .1$; $^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$; SE = standard error; CI = confidence interval; IM = intrinsic motivation; EM = extrinsic motivation.

Figure 3

Response surface plot of participants' congruent and incongruent lines of intrinsic and extrinsic motivations correlating with adherence



Note. Line of congruence (LOC) = red dotted; line of incongruence (LOIC) = blue thick; ridge line = blue thin; bag plot = black lines.

5. DISCUSSION AND PRACTICAL IMPLICATIONS

Applying the self-determination theory, we investigated how pilots' motivation correlated with their desire to become space pilots or to remain as airline pilots (adherence). We extended research from previous psychological literature by applying response surface analysis and polynomial regression analysis to study how motivation correlated with pilots' desire to become space pilots as well as the correlation of pilots' motivation with their professional adherence.

5.1 Theoretical implications

We extended the self-determination theory by taking cognizance of the fact that motivation is a multi-structured concept, inadequately measurable as a single category. Corroborating the idea of splitting motivation into two factors, we obtained proof that intrinsic motivation is especially important for consideration, rather than extrinsic motivation. Indeed, we are aware that other studies include even more categories of motivation. For example, Howard et al. (2000) split factors for self-determination into six factors. However, we are with mainstream research dividing motivation into solely two factors.

While there is a plethora of two-dimensional research on motivation predicting a positive correlation with desire (e.g., López-Fernández et al., 2019), we applied polynomial regression analysis with RSA that allows us to enhance the correlations in a three-dimensional space. In corroborating previous literature, we found that highly motivated people (as a higher match) correlated with positive performance (Amabile et al., 1994; Li et al., 2020; Walsh et al., 2005).

We received somewhat supportive results for adherence. RSA showed its practicability in this respect. While linear regression did only show a significant relationship at a $p < .01$ level between intrinsic motivation and adherence, by applying polynomial regression analysis, we found a significant correlation at a $p < .001$ level with the quadratic term of intrinsic motivation (IM^2) and adherence.

Our findings provided support for our introduced hypothesis. While desire was explained by intrinsic motivation, adherence was only partly explained as illustrated in Fig. 2. It shows that pilots who are very highly *or* very lowly intrinsically motivated are willing to change their jobs to become space pilots. However, we had expected that only high intrinsically motivated pilots would change their jobs. This can be explained by including a so-called bag plot, with 50% of points in the inner bag, and the range of the complete sample in the outer bag, excluding outliers (Rousseeuw et al., 1999). The more the surface is away from the bag plot, the more imprecise is the form. Taking this into account, most of the points lay in areas of high intrinsic motivation, resulting in a precise form, while the surface characteristics for low intrinsic motivation were more uncertain and thus difficult to prognosticate any interpretation.

5.2 Managerial implications

The outcomes of this study offer insights for HR managers in airline companies with intentions to enter the aerospace market offering tourists flights to space (i.e., as

a spaceline organization). Our findings shed light on how airline pilots could be potential candidates to fill the vacancies for space pilots, taking into account their intrinsic and extrinsic motivations whether to become space pilots or to remain as airline pilots.

For policy makers, our findings provide the basis for developing a regulatory framework to explore these possibilities. Policy implications and managerial takeaways should consider the desire of motivated regular pilots to become future space tourism pilots in the context of their intrinsic and extrinsic motivations. Our results can be clustered into intrinsic and extrinsic motivation drivers.

As shown in our study, the desire to become a space pilot can be driven by strong intrinsic motivation. Such highly motivated pilots are likely to be excited by the opportunity to fly to space just by doing their job. As indicated in our questionnaire survey which also provided space for additional comments, a young pilot in training mentioned: “I think becoming a space pilot would be an absolute dream come true!” A middle-aged airline pilot wrote: “You made me think of becoming a space pilot!” An older airline pilot commented: “I’m near the end of my active flying years but I would love to fly to space if I can pass the physical.” Clearly, such statements show the enthusiasm of some pilots to become space pilots.

We also contend that extrinsic motivation can drive the desire of fighter pilots to fly to space. These pilots differ from regular airline pilots in their extrinsic motivation. In our sample, we had only a few (six) fighter pilots. These fighter pilots generally stay in their job only for a limited time (usually up to 10 years at the US Air Force) without having any assurance of a long-term career. Hence, fighter pilots need to seek new career paths after their military services are completed. To this end, a shift into the market for space pilot seems to be more likely for fighter pilots than for regular airline pilots.

In essence, the recommendation to HR managers in the airline business is that job announcements for space pilot vacancies would generate sufficient demand on their own. As for policy makers in the aerospace industry, the logical request arises to define, specify, and establish a framework that clearly states regulatory guidelines and requirements for hiring firms.

Regarding switching intentions, there is low adherence among highly motivated regular pilots, with high intrinsic motivation being the key driver for switching to a spaceline. One of the participants commented: “[Being a] space pilot would be a promising new career. I would definitely consider switching to this market if I had the opportunity.”

Unlike intrinsic motivation, extrinsic motivation is of minor importance as pilots with switching intentions are not likely to be attracted only by rewards such as

comparatively higher salaries. Our study shows that extrinsic motivation is not likely to draw candidates to meet the demand for space pilots, neither from the pool of new student pilots, nor from existing pilots.

We offer some further practical implications. Efthymiou et al. (2021) show that most important motivators for pilots to remain at an airline are: "being based at home, a competitive salary [and] job security" (p. 7). It could mean that airline pilots might be driven by extrinsic motivation to switch to another *air*line, doing primarily the same job. However, our study demonstrates that extrinsic motivation is not a principal motive for pilots to switch their profession to become *spac*e pilots. The fascination for space, a passion for exploring space, and such factors play a more important role. Monetary rewards alone cannot motivate pilots to switch to be space pilots.

In essence, the recommendation to HR managers in the airline industry or perhaps a separate spaceline industry is that they have to clearly define what space pilot candidates can expect in terms of flying to space. While not prioritizing financial rewards, they should highlight the new, exciting opportunities that space tourism can offer to space pilots. The recommendation for policy makers is to highlight the opportunities and risks of becoming space pilots rather than remaining as regular pilots.

5.3 Limitations

This study has several limitations. This study is a first attempt to align motivation of pilots with their desire to become space pilots.

The space tourism market for pilots is yet to be fully developed. Therefore, the imagination of a regular pilot to become a space tourism pilot is interpreted by pilots in different ways. Furthermore, as pilots are busy people with tight schedules and have hardly any time to be contacted for questionnaire surveys, the number of participants in this study was, not unexpectedly, rather low. Another relevant issue is that the ethical guidelines of Institutional Review Board (IRB) approval affected the questions to the extent that authors were not able to ask more personal questions. However, it should be mentioned that we selected only participants with flight experience. We collected data based on only one questionnaire for each participant. Although it is common nowadays to conduct questionnaire surveys twice so that the surveys cover independent and dependent questions separately, our setting did not allow us this option. It would be unrealistic or unreasonable to assume that we could have the pilots' attention and cooperation twice (for the return). Therefore, all the questions were compiled in one questionnaire.

Our study was posted on the university's main internal website, thus reaching out to different types of pilots from, e.g., the airlines, armed forces, or rescue organizations. Having received a high degree of heterogeneity in our replies, our findings are

not exclusively confined to airline pilots. However, our results are more robust for industry types and firms as our sample represent the population of (regular) pilots.

6. CONCLUSION

Our study shows that motivated pilots correlate positively with a higher desire to become space pilots. We also find a quadratic relationship, e.g., that a steeper increase in desire is seen at higher levels of motivation. On the other hand, we find motivation having a negative correlation with adherence. Thus, our results indicate that lowly motivated pilots would rather opt out of becoming space pilots and prefer to remain in the airline industry as "regular" pilots. Also here, we find a quadratic relationship, that a steeper decrease in adherence is seen at higher levels of motivation. Finally, and supported by the self-determination theory, a pilot's intrinsic motivation matters more than her or his extrinsic motivation in regard to the desire to become a space pilot or to remain as a regular pilot. Thus, the take-away for (future) HR managers of a spaceline would be to define clear commitments on the job tasks as a space pilot (such as the minimum expected flights to space—related to intrinsic motivation) rather than on the salary—related to extrinsic motivation.

ACKNOWLEDGMENTS

This joint research originated in the Alexander von Humboldt Foundation (AvH Foundation) network where both authors are alumni since 2003. The authors gratefully acknowledge support from the AvH Foundation for this project leading to a research stay at Kobe University for the first author from April to July 2023. The authors thank also Embry-Riddle Aeronautical University's faculty for posting the questionnaire invitation letter on the main internal website and diverse forums as well as all participating pilots for taking the time to complete the survey.

The views reported in this paper are those of the authors alone and not those of any institution. All errors and omissions that remain are the authors' sole responsibility.

DECLARATIONS

Conflict of interest. The authors have no conflicts of interest to declare that are relevant to the content of this article.

Funding. The leading author acknowledge support from the Alexander von Humboldt Foundation for a research stay at Kobe University in 2023.

Ethical approval. The survey had the approval of the ERAU Institutional Review Board (IRB) and is registered with No. 22-141.

REFERENCES

Airline Pilot Central. (2020, May 26). *Do you have what it takes to be a space pilot?* https://www.airlinepilotcentral.com/articles/news/do-you-have-what-it-takes-to-be-a-space-pilot.html

Ali, F., Ashfaq, M., Begum, S., & Ali, A. (2020). How "green" thinking and altruism translate into purchasing intentions for electronics products: The intrinsic-extrinsic motivation mechanism. *Sustainable Production and Consumption, 24*, 281–291. https://doi.org/10.1016/j.spc.2020.07.013

Al-Shammari, M. A., Al-Shammari, H., & Banerjee, S. N. (2022). CSR discrepancies, firm visibility and performance: A mediated moderation analysis. *Management Decision, 60*(6), 1560–1584. https://doi.org/10.1108/MD-01-2021-0024

Amabile, T. M. (1997). Motivating creativity in organizations: On doing what you love and loving what you do. *California Management Review, 40*(1), 39–58. https://doi.org/10.2307/41165921

Amabile, T. M., Hill, K. G., Hennessey, B. A., & Tighe, E. M. (1994). The work preference inventory: Assessing intrinsic and extrinsic motivational orientations. *Journal of Personality and Social Psychology, 66*(5), 950–967. https://psycnet.apa.org/doi/10.1037/0022-3514.66.5.950

Barranti, M., Carlson, E. N., & Côté, S. (2017). How to test questions about similarity in personality and social psychology research: Description and empirical demonstration of response surface analysis. *Social Psychological & Personality Science, 8*(4), 465–475. https://doi.org/10.1177/1948550617698204

Bolton, B. (2020). Internal vs. external corporate social responsibility at U.S. Banks. *International Journal of Financial Studies, 8*(4), 65–. https://doi.org/10.3390/ijfs8040065

Chang, E. Y.-W. (2020). From aviation tourism to suborbital space tourism: A study on passenger screening and business opportunities. *Acta Astronautica*, *177*, 410–420. https://doi.org/10.1016/j.actaastro.2020.07.020

Deci, E. L. (1972). Intrinsic motivation, extrinsic reinforcement, and inequity. *Journal of Personality and Social Psychology, 22,* 113–120. https://doi.org/10.1037/h0032355

Deci, E. L., & Ryan, R. M. (1980). The empirical exploration of intrinsic motivational processes. In *Advances in Experimental Social Psychology* (Vol. 13, pp. 39–80). Elsevier Science & Technology. https://doi.org/10.1016/S0065-2601(08)60130-6

Deci, E. L., & Ryan, R. M. (1985). *Intrinsic motivation and self-determination in human behavior.* Berlin: Springer Science & Business Media. https://doi.org/10.1007/978-1-4899-2271-7

Deci, E. L., & Ryan, R. M. (2000). The "what" and "why" of goal pursuits: Human needs and the self-determination of behavior. *Psychological Inquiry, 11*(4), 227–268. https://doi.org/10.1207/S15327965PLI1104_01

Deci, E. L., & Ryan, R. M. (2015). Self-determination theory. *International Encyclopedia of the Social & Behavioral Sciences, 91*, 486–491. https://doi.org/10.1016/B978-0-08-097086-8.26036-4

Demirbaş-Çelik, N., & Keklik, İ. (2019). Personality factors and meaning in life: The mediating role of competence, relatedness and autonomy. *Journal of Happiness Studies, 20*(4), 995–1013. https://doi.org/10.1007/s10902-018-9984-0

Efthymiou, M., Usher, D., O'Connell, J. F., Warnock-Smith, D., & Conyngham, G. (2021). The factors influencing entry level airline pilot retention: An empirical study of Ryanair. *Journal of Air Transport Management, 91*, 101997–. https://doi.org/10.1016/j.jairtraman.2020.101997

Edwards, J. R. (2002). Alternatives to difference scores: Polynomial regression analysis and response surface methodology. In F. Drasgow & N. Schmitt (Eds.), *Measuring and analyzing behavior in organizations: Advances in measurement and data analysis* (pp. 350–400). Hoboken, NJ: Pfeiffer.

Edwards, J. R., & Parry, M. E. (2018). On the use of spline regression in the study of congruence in organizational research. *Organizational Research Methods, 21*(1), 68–110. https://doi.org/10.1177/1094428117715067

FAA. (n.d.). *What are the differences in the types of pilot licenses (certificates)?* https://www.faa.gov/faq/what-are-differences-types-pilot-licenses-certificates

Ghufran, M., Ali, S., Ariyesti, F. R., Nawaz, M. A., Aldieri, L., & Xiaobao, P. (2022). Impact of COVID-19 to customers switching intention in the food segments: The push, pull and mooring effects in consumer migration towards organic food. *Food Quality and Preference, 99*, 104561–. https://doi.org/10.1016/j.foodqual.2022.104561

Goehlich, R. A., Anderson, J. K., Harrold, N. N., Bemis, J. A., Nettleingham, M. T., Cobin, J. M., Zimmerman, B. R., Avni, B. L., Gonyea, M. D., & Ilchena, N. Y. (2013). Pilots for space tourism. *Space Policy, 29*(2), 144–153. https://doi.org/10.1016/j.spacepol.2013.03.011

Good, V., Hughes, D. E., Kirca, A. H., & McGrath, S. (2022). A self-determination theory-based meta-analysis on the differential effects of intrinsic and extrinsic motivation on salesperson performance. *Journal of the Academy of Marketing Science, 50*(3), 586–614. https://doi.org/10.1007/s11747-021-00827-6

Grant, A. M. (2008). Does intrinsic motivation fuel the prosocial fire? Motivational synergy in predicting persistence, performance, and productivity. *Journal of Applied Psychology, 93*(1), 48–58. https://doi.org/10.1037/0021-9010.93.1.48

Grant, A. M., Nurmohamed, S., Ashford, S. J., & Dekas, K. (2011). The performance implications of ambivalent initiative: The interplay of autonomous and controlled motivations. *Organizational Behavior and Human Decision Processes, 116*, 241–251. http://dx.doi.org/10.1016/j .obhdp.2011.03.004

Gumusluoglu, L., & Ilsev, A. (2009). Transformational leadership, creativity, and organizational innovation. *Journal of Business Research, 62*, 461–473. http://dx.doi.org/10.1016/j.jbusres.2007.07.032

Hawn, O., & Ioannou, I. (2016). Mind the gap: The interplay between external and internal actions in the case of corporate social responsibility: Mind the gap: External and internal actions. *Strategic Management Journal, 37*(13), 2569–2588. https://doi.org/10.1002/smj.2464

Herzberg, F. (1966). Work and the nature of man. Cleveland, OH: World Publishing.

Howard, J. L., Gagné, M., Van den Broeck, A., Guay, F., Chatzisarantis, N., Ntoumanis, N., & Pelletier, L. G. (2020). A review and empirical comparison of motivation scoring methods: An application to self-determination theory. *Motivation and Emotion, 44*(4), 534–548. https://doi.org/10.1007/s11031-020-09831-9

Humberg, S., Nestler, S., & Back, M. D. (2019). Response surface analysis in personality and social psychology: Checklist and clarifications for the case of congruence hypotheses. *Social Psychological & Personality Science, 10*(3), 409–419. https://doi.org/10.1177/1948550618757600

Hyland, J., Johnson, E. M., & Gorman, S. (2021, July 9) Factbox: Branson, Bezos and Musk—three space tourism pioneers. *Reuters.* https://www.reuters.com/lifestyle/science/branson-bezos-musk-three-space-tourism-pioneers-2021-07-09

Kluge, G., Stern, C., Trammer, M., Chaudhuri, I., Tuschy, P., & Gerzer, R. (2013). Commercial suborbital space tourism-proposal on passenger's medical selection. *Acta Astronautica, 92*(2), 187–192. https://doi.org/10.1016/j.actaastro.2012.08.005

Lee, J. I., Ren, T., & Park, J. (2021). Investigating travelers' multi-impulse buying behavior in airport duty-free shopping for Chinese traveler: Intrinsic and extrinsic motivations. *Journal of Air Transport Management, 92*, 102023–. https://doi.org/10.1016/j.jairtraman.2021.102023

Li, W., Bhutto, T. A., Xuhui, W., Maitlo, Q., Zafar, A. U., & Ahmed Bhutto, N. (2020). Unlocking employees' green creativity: The effects of green transformational leadership, green intrinsic, and extrinsic motivation. *Journal of Cleaner Production, 255*, 120229–. https://doi.org/10.1016/j.jclepro.2020.120229

López-Fernández, D., Ezquerro, J. M., Rodríguez, J., Porter, J., & Lapuerta, V. (2019). Motivational impact of active learning methods in aerospace engineering students. *Acta Astronautica, 165*, 344–354. https://doi.org/10.1016/j.actaastro.2019.09.026

Mehran, J., Olya, H., & Han, H. (2023). Psychology of space tourism marketing, technology, and sustainable development: From a literature review to an integrative framework. *Psychology & Marketing, 40*(6), 1130–1151. https://doi.org/10.1002/mar.21795

Mesa-Arango, R., Pineda-Jaramillo, J., Araujo, D. S. A., Bi, J., Basva, M., & Viti, F. (2023). Missions and factors determining the demand for affordable mass space tourism in the United States: A machine learning approach. *Acta Astronautica, 204*, 307–320. https://doi.org/10.1016/j.actaastro.2023.01.006

Miani, P., Kille, T., Lee, S.-Y., Zhang, Y., & Bates, P. R. (2021). The impact of the COVID-19 pandemic on current tertiary aviation education and future careers: Students' perspective. *Journal of Air Transport Management, 94,* 102081. https://doi.org/10.1016/j.jairtraman.2021.102081

Olya, H. G. T., & Han, H. (2020). Antecedents of space traveler behavioral intention. *Journal of Travel Research, 59*(3), 528–544. https://doi.org/10.1177/0047287519841714

Paladini, S., & Saha, K. (2023). The quest for sustainability in lower orbit: Conceptual models for space tourism. *The International Journal of Tourism Research, 25*(3), 333–349. https://doi.org/10.1002/jtr.2568

Peyrat-Guillard, D., & Grefe, G. (2020). The psychological bonds between airline pilots and their work: From passion to reason. *Shapes of Tourism Employment: HRM in the Worlds of Hotels and Air Transport, 4*, 173–186. https://doi.org/10.1002/9781119751342.ch11

Porter, L. W., & Lawler, E. E., III. (1968). *Managerial attitudes and performance.* Homewood, IL: Richard D. Irwin.

R Core Team. (2023). The R project for statistical computing (RStudio version 2023.03.1) [computer software]. The R Foundation. https://www.r-project.org

Rahman, S. M., Carlson, J., Gudergan, S. P., Wetzels, M., & Grewal, D. (2022). Perceived omnichannel customer experience (OCX): Concept, measurement, and impact. *Journal of Retailing, 98*(4), 611–632. https://doi.org/10.1016/j.jretai.2022.03.003

Rockmann, K. W., & Ballinger, G. A. (2017). Intrinsic motivation and organizational identification among on-demand workers. *Journal of Applied Psychology, 102*(9), 1305–1316. https://doi.org/10.1037/apl0000224

Rodrigues, A. C. (2021). Response surface analysis: A tutorial for examining linear and curvilinear effects. *Revista de Administração Contemporânea, 25*(6), e200293. https://doi.org/10.1590/1982-7849rac2021200293.en

Rousseeuw, P. J., Ruts, I., & Tukey, J. W. (1999). The bagplot: A bivariate boxplot. *The American Statistician, 53*(4), 382–387. https://doi.org/10.1080/00031305.1999.10474494

Russell, B. R. (2023). The United States Air Force pilot diversity dilemma. *Equality, Diversity and Inclusion an International Journal*. https://doi.org/10.1108/EDI-10-2022-0297

Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *The American Psychologist, 55*(1), 68–78. https://doi.org/10.1037/0003-066X.55.1.68

Ryan, R. M., & Deci, E. L. (2020). Intrinsic and extrinsic motivation from a self-determination theory perspective: Definitions, theory, practices, and future directions. *Contemporary Educational Psychology, 61*, 101860–. https://doi.org/10.1016/j.cedpsych.2020.101860

Schönbrodt, F. D. (2023). RSA: Response surface analysis (R package version 0.10.6) [computer software]. https://cran.r-project.org/web/packages/RSA

Schönbrodt, F. D., Humberg, S., Nestler, S., & Carlson, E. (2018). Testing similarity effects with dyadic response surface analysis. *European Journal of Personality, 32*(6), 627–641. https://doi.org/10.1002/per.2169

Shanock, L. R., Baran, B. E., Gentry, W. A., Pattison, S. C., & Heggestad, E. D. (2010). Polynomial regression with response surface analysis: A powerful approach for examining moderation and overcoming limitations of difference scores. *Journal of Business and Psychology, 25*(4), 543–554. https://doi.org/10.1007/s10869-010-9183-4

Steel, P., & König, C. J. (2006). Integrating theories of motivation. *The Academy of Management Review, 31*(4), 889–913. https://doi.org/10.5465/AMR.2006.22527462

Tasci, A. D. A., Fyall, A. D., & Fu, X. (2021). Social representations of space travel: Modeling the antecedents and outcomes. *The International Journal of Tourism Research, 23*(4), 611–635. https://doi.org/10.1002/jtr.2430

UBS Investment Bank. (2021, July 20). *Future of space tourism: Lifting off? Or has COVID-19 stunted adoption? The not-so-long road to the space future...* https://www.ubs.com/global/en/investment-bank/in-focus/2021/space-tourism.html

Van den Broeck, A., Howard, J. L., Van Vaerenbergh, Y., Leroy, H., & Gagné, M. (2021). Beyond intrinsic and extrinsic motivation: A meta-analysis on self-determination theory's multidimensional conceptualization of work motivation. *Organizational Psychology Review, 11*(3), 240–273. https://doi.org/10.1177/20413866211006173

Walsh, G., Groth, M., & Wiedmann, K.-P. (2005). An examination of consumers' motives to switch energy suppliers. *Journal of Marketing Management, 21*(3–4), 421–440. https://doi.org/10.1362/0267257053779091

Wang, T., & Wright, G. C. (2020). Increasing returns to scale within limits: A model of ICT and its effect on the income distribution and occupation choice. *Journal of Economic Theory, 189*, 105105–. https://doi.org/10.1016/j.jet.2020.105105

Zeng, D., Takada, N., Hara, Y., Sugiyama, S., Ito, Y., Nihei, Y., & Asakura, K. (2022). Impact of intrinsic and extrinsic motivation on work engagement: A cross-sectional study of nurses working in long-term care facilities. *International Journal of Environmental Research and Public Health, 19*(3), 1284–. https://doi.org/10.3390/ijerph19031284

APPENDIX – SURVEY: SPACE PILOTS

RECRUITMENT LETTER

SPACE PILOTS: Your motivation to become a space tourism pilot

Dear Pilot,

Space tourism flights have already started and mass transporting of interested passengers could become a reality soon. For this, pilots are needed. This survey is concerned with how much you, as a pilot, are motivated to become a future space tourism pilot. The survey is being offered to pilots of all types, ranks, and locations who are ERAU students, alumni, faculty, or staff. The survey will be evaluated anonymously. It consists of three main sections and should not take more than five minutes to complete. The risks of participating in this study are no greater than what is experienced in daily life. The survey has the ERAU approval IRB No. 22-141. Thank you very much for your participation.

Survey link: https://forms.office.com/Pages/ResponsePage.aspx?id=Y8kxabcHVkGrDjXR95A1uC-1WWDKdjtKpMLcEP-A3cpUODdZVDVJQVVUUloxVUlRR1ZHVTVMRko3Qi4u

With best regards,

Dr. Dr. Robert A. Goehlich
Adjunct Assistant Professor
Embry-Riddle Aeronautical University, Worldwide
www.goehlich.com

INFORMED CONSENT FORM

SPACE PILOTS: Your motivation to become a space tourism pilot

Purpose: While most studies on space tourism are focused on the profitability of aerospace firms and space tourists' willingness to pay for their tickets, this study is centered on the impact of the pilot's motivation on his or her desire to be a space pilot or to remain as a regular pilot. The survey should not take more than 5 minutes to complete.

Risks: The risks of participating in this study are no greater than what is experienced in daily life.

Benefits: The benefit to you as a participant is to contribute to a pioneering knowledge base about pilots' motivation to become future space pilots.

Confidentiality: The data in this study will be handled with confidentiality. Respondents are anonymous. Responses to this survey will be housed on a secure drive and only used for research purposes. The data collected may be used for future research studies or distributed to another investigator for future research studies without additional informed consent from you.

Compensation: There is no compensation offered for taking part in this study.

Contact: If you have any questions or would like additional information about this study, please contact Robert Goehlich at robert.goehlich@erau.edu. For any concerns or questions as a participant in this research, contact the Institutional Review Board (IRB) at 386-226-7179 or via email to teri.gabriel@erau.edu.

Voluntary Participation: Your participation is voluntary, and you may withdraw from the study at any time and for any reason.

CONSENT: Clicking the button below to start the survey means that you are providing informed consent to participate in this voluntary survey. If you do not wish to participate, simply close the browser.

QUESTIONS

1. How strong is your desire to become a space pilot?
D1. I desire to become a space pilot.
D2. I desire to obtain a space pilot license.
D3. I think I have enough skills to become a space pilot.
D4. With reasonable effort, I believe I can become a space pilot.
D5. I expect that the effort of becoming a space pilot is worth it.
D6. (-) I would worry about my future job security if I switched to becoming a space pilot.

2. How would you answer the following statements about expectations and competitors?
A1. I will wait and see what other pilots experience after they switch to space tourism flights.
A2. I will wait and see how the market for space tourism flights develops.
A3. Switching to space tourism flights would be too troublesome at the moment.

C1. Other organizations have a generally higher chance of providing space tourism flights.
C2. Other organizations have a better reputation for space tourism flights.
C3. I see new firms offering space tourism flights, instead of classical airlines.

3. How would you answer the following statements about motivation?
I1. I enjoy tackling flight tasks that are completely new.
I2. I enjoy improving existing ideas on space tourism flights.
I3. I feel excited when I have new ideas.
I4. I feel like becoming more engaged in the development of space tourism flights.
I5. I like to try out new adventures.
E1. I am strongly motivated by the recognition I can earn as a space pilot.
E2. I often think about rewards, salary, or promotions.
E3. I want other people to find out how good I manage flights as a pilot.
E4. (-) I'm concerned about how other people are going to react to my idea to become a space pilot.
E5. I think a new contract as a space pilot will offer better financial benefits.

4. What is your current contract?
Tenured; Time-contracted; Independent; Private (i.e., hobby); Others

5. What kind of pilot are you mainly?
Airline pilot; Fighter pilot; Test pilot; Student pilot (i.e., in training); Others

6. How many years of experience do you have as a pilot?
[number]

7. What is your age (in years)?
[number]

8. What is your nationality?
[text]

9. What is your gender?
Female; Male; Non-binary; Prefer not to say

10. Please write in the box below if you have any additional comments.
[text]