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## Prediction Models for Willingness to Support Private and Government Space Ventures: A Regression Study

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## Prediction Models for Willingness to Support Private and Government Space Ventures: A Regression Study

### Cover Page Footnote

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Research conducted by Pew Research Center (2018) found 72% of Americans believe it is essential the United States (US) remains a world leader in space exploration, and 65% of Americans believe the National Aeronautics and Space Administration (NASA) should maintain a key role in space exploration and ventures. Public opinion matters as it will drive support for US space ventures; however, no prior study has examined the factors that predict the public's willingness to support private or government-funded space ventures. Therefore, the purpose of the current study is to create and validate two statistical models of factors that significantly predict the public's willingness to support space ventures by either private industry or the government. This model development will be conducted using a two-stage study that explores the influence of 15 possible predictors of support for private and government space ventures. In stage 1, regression equations are developed for Willingness to Support Private Space Ventures and Willingness to Support Government Space Ventures. In stage 2, these equations are validated, and model fit tested. The following sections outline the findings from the literature, the methodology used in this study, and conclusions and industry recommendations.

## **Background**

### **A Brief History of Space Ventures**

Space was considered a central theater for the Cold War. The primary objective for this theater was first to land a man on the moon. Although the space race had one goal, the US and the Soviets' experiences and outcomes were significantly different. The US experienced multiple technological breakthroughs that provided many benefits to Western society, specifically through computer technologies and communications. In contrast, the Soviet citizens saw little to no innovation benefits (Erickson, 2018). Since the US put boots on the moon with the Apollo program, there have been extensive advancements driving down costs and reducing development time. Cross (2019) highlighted there are currently over 70 countries with space programs and projected the space economy will triple over the next 20 years. At the societal level, space exploration has been and remains a shared endeavor for the advancement of humankind (Cross, 2019).

The Apollo program's advancements reached beyond space, capturing the imagination of the American public and inspiring individuals to go into science and engineering. Around the Apollo moon landing, the US saw a spike in science and engineering bachelor's degrees (Markovich et al., 2020). Also, there are over 2,000 spinoff products, processes, and technologies from NASA space venture developments. Products include memory foam, the Global Positioning System (GPS), and cordless vacuums (Kennedy Space Center, 2018). The US's space capabilities were drastically reduced when the shuttle program retired in 2011, requiring a dependency on the Russian Soyuz capsule to deliver and retrieve US astronauts to and from the International Space Station (ISS) (Markovich et al., 2020).

The lack of a usable shuttle program created private contractors' opportunity to enter into commercialized space ventures. Companies such as SpaceX, Blue Origin, and Virgin Galactic are just three of the many looking to be leaders and contributors to space ventures. The pace of growth is rapidly increasing. SpaceX has successfully sent and returned US astronauts to and from the ISS in 2020, certifying them to start routine missions. Blue Origin is actively pursuing the products that would create what owner Jeff Bezos called *a road to space*. Other countries are also pursuing their place in space, potentially challenging the US's preeminence. Even with private space gaining momentum, NASA remains critical for the success of US space ventures. NASA's experiences and ability to coordinate large, complex teams will need to be shared and emulated. In addition, having companies like SpaceX and Blue Origin providing vehicles enable NASA to focus on larger

missions and exploration beyond the moon. This focus includes developing advanced technologies required for long-duration and deep space missions (Markovich et al., 2020). One example is NASA's Artemis program, a sister program to the Apollo missions from the 1960s. With the cooperation of private companies, NASA plans to return US boots to the moon by 2024. Partnering with private companies helps shift the economic climate through healthy competition and expanded innovation that reduces cost. Starting with the development of lunar capabilities, this enables the necessary technology growth for more extended space missions beyond the moon (Drake, n.d.)

### **Americans and Space Ventures**

Pew Research Center (2018) found most Americans support space ventures. Approximately one-third of participants posited private companies are the future of space exploration, while most of the remaining two-thirds envisioned NASA's continued involvement. The majority of participants (72%) considered it essential for the US to be a leader in space exploration, and even more participants (80%) thought the ISS a good investment (Pew Research Center, 2018). This positive public opinion is critical. As Huber et al. (2019) explain, favorable views of science influence both willingness to participate in or fund scientific research and the political outcomes (e.g., legislation) related to scientific issues.

### **Predictors Proposed in the Current Study**

#### ***Demographics***

This study's demographic predictors included gender, age, education level, ethnicity, political affiliation (partisanship), and religious affiliation (religiosity). Literature suggests American men are more supportive of US space ventures than American women (Cook et al., 2011; Nadeau, 2013). Cobb (2019) cited General Social Survey (GSS) data to highlight a growing gender-based gap supporting space ventures. According to Cobb (2019), females are less supportive of space exploration funding than males, possibly due to women's historical exclusion from and lack of representation of women in the US space program. NASA's decision to name the next era of space exploration after the goddess Artemis and the increase of female representation in space-related media (e.g., the film "Hidden Figures") is considered key to increasing awareness of and interest in space exploration among females (Cobb, 2019). Pew Research Center's (2018) findings also indicated men have more support for space-based scientific research and human space exploration than women and have more interest in space and astronomy in general.

Per Nadeau (2013), the Apollo Generation has long been assumed to constitute the majority of NASA supporters, causing NASA to focus on increasing appeal to younger generations to gain the support of future taxpayers. In reality, most support for space ventures comes from Generations X and Y, with the Apollo generation also exhibiting high support levels (Nadeau, 2013). McCarthy (2019) discusses the American public's growing support for US space ventures, pointing out the support for a Mars mission is also specifically increasing. In 2019, Gallup data indicated that 65% of US adults aged 18-29 favored a government-funded human-crewed mission to Mars, compared with 59% in 1999 (McCarthy, 2019). Support also increased among other age groups, but most notably among adults aged 50-64 (48% in 2019 compared with 35% in 1999) and 65+ (46% in 2019 compared with 21% in 1999) (McCarthy, 2019). Private space ventures also seem to be growing in favor among younger Americans. Pew Research Center (2018) reported 63% of millennials are interested in space tourism. Among those uninterested in space tourism, 28% cited age or health as prohibitive (Pew Research Center, 2018).

Literature also indicates a relationship between education and support for space ventures, such that support increases with education. In Nadeau's (2013) study, participants with greater

scientific literacy and appreciation for science were more supportive of maintaining space venture budgets. In contrast, participants with an appreciation for science and who had completed more college-level science courses were more supportive of increasing budgets. Pew Research Center (2018) found fairly consistent opinions of government space ventures across different education levels, except for postgraduate degree holders being more supportive of prioritizing government space-based scientific research than those with high school-level or less education. Cobb (2011) stated Americans with high levels of education may be more likely to understand the highly technical subject of space ventures and their spinoffs, explaining the higher levels of support among this group.

In the 1960s, US spending on the Apollo program was not viewed favorably by many civil rights activists and Americans living in poverty, who maintained the funding could have been used to address poverty in the US (Greene, 2019). The majority of Americans did not think the Apollo program was worth the expense, but the African American community was highly vocal in expressing this dissatisfaction (Greene, 2019). Nadeau (2013) briefly commented on this, stating the “old social order of the 1960s”, referring to upper-class, White Apollo Generation-aged men with “higher educational prospects” has long been assumed by NASA to remain the staunchest supporter of government space ventures. Aside from this study, ethnicity is limited in studies of Americans' support for space ventures. Ethnicity is included in this study, as civil rights are returning to the forefront of American news and politics.

There are conflicting findings regarding the influence of political affiliation on support for space ventures. Nadeau (2013) stated support for space ventures is apolitical. Cobb (2011) determined Republicans exhibit the greatest support for space ventures, followed by Democrats and Independents, who showed more or less support in specific years. Burbach (2019) concluded since the Cold War, pro-military Republicans have likely also been pro-space. In contrast, Democrats have often been both anti-military and anti-space (Burbach, 2019). Burbach (2019) also stated Democratic views are changing such that opposition to defense spending does not also mean opposition to space funding, but pro-environment Democrats are likely also pro-space. Neither party shows a preference for space funding over social welfare spending (Burbach, 2019). Pew Research Center (2018) further commented on the Republican and Democratic opinions about space ventures' priorities. Both parties consider asteroid monitoring a top priority, but climate monitoring and basic scientific research are of greater import to Democrats (Pew Research Center, 2018). As such, support for space ventures is likely bipartisan, but for different reasons (Burbach, 2019).

Like ethnicity, the role of religious affiliation is seldom included in studies of support for space ventures. Koren (2018) wrote about the relationship between religion and the US space program. Religion was one of the ideological differences between the US and Soviet Union during the space race, which could be considered a competition between God-living people and godless people (Koren, 2018). Astronauts have been known to comment on their religious views publicly. In the earliest days of human-crewed space exploration, Buzz Aldrin took communion on the moon, and Apollo 8 astronauts read the book of Genesis over the radio (Koren, 2018). Very recently, former Vice President Mike Pence incorporated religiosity into formal addresses about space ventures. For some, integrating Catholic or Christian perspectives in space exploration alienates the nonreligious or people of different faiths. Koren (2018), however, suggests Pence's approach to combining faith with nationalism could instead be “on message,” citing the findings of Ambrosius (2015), who stated evangelicals (as compared with other religious groups) have less knowledge of, interest in, and support for space ventures. Ambrosius (2015) said it is crucial to

understand the relationship between religion and space policy, as evangelicals comprise a large portion of the Republican party, and negative opinions could significantly impact the future of space exploration.

### ***Familiarity with Space Ventures***

The mere exposure theory explains a liking or preference for a stimulus increases with repeated exposure to it (Zajonc, 2001). Therefore, attitudes can be shaped by familiarity. For example, De Vries et al. (2017) found investors exhibited familiarity bias in their investment decisions. In space ventures, familiarity can be increased by exposure to information found online and offline. Therefore, this study included overall familiarity as a predictor and predictors related to social media, the news, and face-to-face communication to examine this phenomenon.

**Space Ventures on Social Media.** Social media predictors considered in this study included time spent on social media and the number of platforms used, the number of space-related social media accounts followed, and posts seen, and trust in information on social media. Social media is popular in the US, especially among young adults, women, and those with higher education levels (Hruska & Maresova, 2020; Pew Research Center, 2019). In 2019, an estimated 72% of the American adult population utilized social media, double the number of users in 2009 (Pew Research Center, 2019). One study further concluded that most American adults use two platforms, and younger adults often use platforms multiple times per day (Hruska & Maresova, 2020). Organizations such as NASA and its affiliate labs and astronauts, companies like SpaceX and Blue Origin, and advocacy groups like the Coalition for Deep Space Exploration (CDSE) utilize social media for communicating information about space exploration. This technology is a powerful public relations strategy. Collins et al. (2016) argued that social media, unlike traditional media, enables two-way communication and could revolutionize how academic and scientific information is shared online with a more significant population. Per Zajonc's (2001) mere repeated exposure theory, government and private space ventures' affinity may increase with exposure to space-related social media accounts and posts. The internet is the primary source of science and technology information for Americans. Still, a lack of quality control measures makes social media platforms ideal tools for the spread of misinformation, which can sway public opinion, legislation, and funding (Brossard & Scheufele, 2013; Huber et al., 2019). That being said, a recent study found Americans trust information on social media more readily when it is shared by a trusted source, regardless of the credibility of the information's source (American Press Institute, 2017). Content shared by a trusted source is more likely to be re-posted, and the source is more likely to be recommended and followed on social media (American Press Institute, 2017).

**Space Ventures in the News.** Pew Research Center (2018) determined Americans who pay more attention to space news believe the US should be a world leader in space exploration and prioritize space-based scientific research more than other Americans. These individuals are divided in their support for government vs. private space ventures, whereas other Americans are more supportive of NASA's continued involvement in space ventures (Pew Research Center, 2018). For example, Americans who pay more attention to space news are more interested in space tourism and have more confidence in private companies' ability to build safe and reliable vehicles (Pew Research Center, 2018). However, the study revealed only a small portion (7%) of the American public keeps up with space news (Pew Research Center, 2018). Shearer (2018) notes the most common news source – television – is declining in popularity. The radio and news websites remain common news sources, but social media is also emerging as a source of news for many Americans. This shift in news consumption can be attributed to various factors, including

young adults' reliance on numerous sources of information and the highly curated nature of social media content (Pentina & Tarafdar, 2014; Shearer, 2018).

**Space Ventures in Face-to-face Conversations.** People also gather and share information through in-person correspondence. Siemens (2011) considered face-to-face communication more influential than electronic communication due to the presence of context clues, the ability to provide clarification more rapidly, and the reduced likelihood of omitting critical details. Huete-Alcoer (2017) stated consumers trust word-of-mouth more than traditional advertising. NASA has taken advantage of word-of-mouth marketing. Van den Hurk (2013) described the agency's 2009 NASA Social program as a strategy for communicating its initiatives to groups that it usually wouldn't reach. During the 2013 government shutdown, NASA Social enabled 1,500 people to reach over 12.5 million people with just 4,000 tweets – and that was only on Twitter.

### ***Perceived Value of Space Ventures***

Zauner et al. (2015) called consumer-perceived value, or the assessed utility of a product given its cost and benefits, an important source of competitive advantage. Bainbridge (2015) analyzed historical poll data and determined that Americans' conceptualization of space ventures depends on how they view other current events and space ventures in relation. For example, Bainbridge (2015) explained how in the 1960s, Americans were concerned with the "prestige contest" between the US and the Soviet Union and associated dominance in space ventures with prestige (p. 59). Recent poll data indicate Americans do perceive space ventures as valuable. In the Pew Research Center's (2018) findings, climate monitoring was identified as the most important priority and lunar or Martian expedition to Americans' least important priorities. This outcome is consistent with Bainbridge's conclusions, as the public is more concerned with saving this planet than exploring other bodies.

### **Current Study**

The purpose of this study is to identify predictors for Americans' willingness to support private and government space ventures. This study included 15 predictor variables: gender, age, ethnicity, education level, political affiliation, religiosity, time spent on social media, number of social media platforms used, number of space-related profiles followed on social media, number of space-related posts seen on social media, trust in information on social media, familiarity with space ventures, the perceived value of space ventures, time spent reading or watching the news, and time spent discussing space ventures offline. The dependent variables were willingness to support private space ventures and willingness to support government space ventures. A copy of the scale for the dependent variables can be found in Appendix A.

### **Methodology**

#### **Participants**

A total of 638 adults from the US participated in this study via Amazon® Mechanical Turk® (MTurk). This platform is often used in survey research to reach potential participants and compensate them for their participation. This data has been shown to be as valid as traditional laboratory data (Buhrmester et al., 2011; Germine et al., 2012; Rice et al., 2017). This survey's post included a brief description of the study, number of required participants, compensation rate, and link to the survey instrument on Google Forms. The minimum sample size was determined using G\*Power (Faul et al., 2009). An a priori power analysis with an effect size of 0.15, alpha of 0.05, power of 0.95, and 15 predictors yielded a minimum sample size of 199. An initial review of the data resulted in removing two cases due to ineligibility and two cases for missing or incomplete responses. The remaining 634 cases were randomly divided into a test data set ( $N = 319$ ) for use in stage 1 and a validation data set ( $N = 315$ ) for use in stage 2, both of which met the

minimum sample size requirement. The stage 1 (test) and stage 2 (validation) data sets are summarized in Table 1.

**Table 1**  
*Summary of Stage 1 and Stage 2 Data*

|                       |   | Stage 1 | Stage 2 |
|-----------------------|---|---------|---------|
| Gender                | Male                                      | 150     | 149     |
|                       | Female                                    | 166     | 163     |
|                       | No response                               | 3       | 3       |
| Age                   | Min                                       | 18      | 18      |
|                       | Max                                       | 78      | 79      |
|                       | Mean                                      | 39.80   | 38.80   |
|                       | SD  | 12.40   | 12.10   |
| Ethnicity             | American Indian or Alaska Native          | 1.88%   | 1.27%   |
|                       | Asian                                     | 8.15%   | 8.57%   |
|                       | Black or African American                 | 14.40%  | 12.70%  |
|                       | Caucasian (non-Hispanic) or White         | 69.90%  | 67.90%  |
|                       | Hispanic or Latino                        | 5.64%   | 7.62%   |
|                       | Native Hawaiian or other Pacific Islander | 0.00%   | 0.64%   |
|                       | Other                                     | 0.31%   | 0.95%   |
| Education             | High School or equivalent                 | 20.40%  | 18.40%  |
|                       | Bachelor's Degree or equivalent           | 56.10%  | 60.30%  |
|                       | Graduate Degree or higher                 | 22.90%  | 21.30%  |
| Political Affiliation | Very liberal                              | 12.90%  | 13.70%  |
|                       | Liberal                                   | 29.50%  | 31.70%  |
|                       | Moderate                                  | 27.00%  | 24.80%  |
|                       | Conservative                              | 21.00%  | 23.20%  |
|                       | Very conservative                         | 8.46%   | 6.03%   |
|                       | No response                               | 1.25%   | 0.635%  |
| Religious Affiliation | Extremely nonreligious                    | 20.7-%  | 27.6-%  |
|                       | Quite nonreligious                        | 0.00%   | 0.00%   |
|                       | Somewhat nonreligious                     | 8.15%   | 4.76%   |
|                       | Neither religious nor nonreligious        | 8.78%   | 8.57%   |
|                       | Somewhat religious                        | 26.60%  | 26.00%  |
|                       | Quite religious                           | 15.40%  | 18.40%  |
|                       | Extremely religious                       | 19.10%  | 14.30%  |
|                       | No response                               | 1.25%   | 0.32%   |



## Materials and Stimuli

Once redirected to the survey on Google Forms from MTurk, participants were prompted to sign an electronic consent form indicating their eligibility and agreement to participate in the study. Participants who completed the consent form were able to view instructions and respond to the survey questions. The survey began with a series of questions intended to collect demographic information (gender, age, ethnicity, education level, political affiliation, and religiosity). Likert items were used to rate political affiliation from very liberal (-2) to very conservative (2) and religiosity from extremely nonreligious (-3) to extremely religious (3). In the next section, participants were asked about their social media experience, including time spent on social media, the number of social media platforms used, the number of space-related profiles followed on social media, the number of space-related posts seen on social media, and trust in information on social media on a scale from extremely distrust (-3) to extremely trust (3).

The following section was focused on participants' opinions about space ventures. Two seven-item Likert scales were used to rate familiarity with space ventures and the perceived value of space ventures from strongly disagree (-2) to strongly agree (2). These scales were adapted from Rice and Winter (2019) and Winter et al. (2020). Before data analysis, the modified scales underwent both factor analyses and reliability analyses. These revised scales are presented in Appendix B.

The participants were then asked about their offline activity, including time spent reading or watching the news and discussing space ventures offline. In the final section of the survey, participants were presented a hypothetical scenario, *“Imagine a scenario in which you have the ability to vote on providing monetary support for the advancement of space ventures (such as astronomy, human space exploration, and satellites). Please indicate how strongly you agree or disagree with the following statements.”* Participants were then asked to rate their willingness to support privately run and government-run space ventures. Each of these dependent variables was measured using a seven-item Likert scale rated from strongly disagree (-2) to strongly agree (2) and randomly presented to prevent order effects. The willingness to support scales were adapted from Rice et al.'s (2020) willingness to fly scale. Prior to data analysis, the modified scales underwent both factor analyses and reliability analyses.

## Design and Purpose

The purpose of this quantitative non-experimental study was to create a valid model for predicting willingness to support private and government space ventures. This study consisted of two stages. A regression equation was generated for each dependent variable using backward stepwise regression in stage 1 and evaluated for model fit using stage 2 data. The results of stage 1 and stage 2 are discussed in the following section.

This study was approved by the research institution's Institutional Review Board. All researchers completed training on the proper treatment of human subjects via the Collaborative Institutional Training Initiative (CITI). The study was approved by the university's institutional review board before data collection.

## Results

### Initial Data Analysis and Scale Validation

A factor analysis was conducted on each modified scale before data analysis using the principal components method and varimax rotation. For the perceived value scale, the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy (MSA) of 0.881 is considered 'meritorious' (Hair et al., 2013), while Bartlett's test of sphericity was statistically significant ( $p < 0.001$ ), which indicate the data was appropriate for factor analysis. All items loaded onto one factor, and a

Cronbach's alpha value of 0.897 demonstrated high internal consistency. Thus, the average score of these five items was used in the data analysis. This outcome was similar for the familiarity scale. The scale had a KMO of .868, with a statistically significant ( $p < 0.001$ ) Bartlett's test of sphericity, all items loaded onto one factor, and a Cronbach's alpha value of 0.900 to use the average score of familiarity.

The willingness to support private and government ventures scales also showed similar values. The KMO for willingness to support private space ventures and willingness to support government space ventures showed 'meritorious' values of 0.945 and 0.938, respectively. Each had statistically significant ( $p < 0.001$ ) Bartlett's test of sphericity with all items loaded onto one factor. They both had Cronbach's alpha value of 0.950. Thus, the average scores for willingness to support private and government ventures were also used.

Education and ethnicity were both collapsed down to two values. Approximately 60% of participants reported having a Bachelor's or equivalent level of education. Therefore, participants were grouped as either having a Bachelor's degree or not for the data analysis. For ethnicity, over 60% of the participants for stage 1 and stage 2 were Caucasian (non-Hispanic) or white and coded as a baseline with 0. All other ethnicities were coded as 1.

### **Main Data Analysis**

The data analysis was conducted in two stages, the first to develop regression equations for each dependent variable and the second to test model fit. The objective was to determine which factors could be used to predict a participant's willingness to support the government and private space ventures. The data were randomly split to create the two datasets for use in stage 1 and stage 2.

#### **Stage 1 –Regression Equation Creation**

##### ***Willingness to Support Private Space Ventures***

Using data from 319 participants, a backward stepwise regression for willingness to support private space ventures was performed. The following regression equation was produced:

$$Y = 0.268 - 0.238X_1 + 0.069X_2 + 0.121X_3 + 0.610X_4$$

Where Y is the predicted willingness to support private space ventures and  $X_1$ ,  $X_2$ ,  $X_3$ , and  $X_4$  are gender, political affiliation, average familiarity, and average perceived value. These predictors indicate females are less willing to support private space ventures than males and were higher for those who had more conservative political affiliation. Also, as familiarity and perceived value increase, so does the willingness to support private space ventures. The statistical summary for this equation is provided in Table 2. The model accounted for 41.1% (40.9% adjusted) of the variance in the willingness to support private space ventures. The model was also significant,  $F(4, 306) = 54.7$ ,  $p < 0.001$ . Gender, political affiliation, average familiarity, and average value had standardized beta coefficients of -.124, .084, .127, and .519. The average value had the greatest effect size of .519.

##### ***Willingness to Support Government Space Ventures***

Using data from the same 319 participants, the backward stepwise regression for willingness to support government space ventures was performed. The following regression equation was produced:

$$Y = 0.203 - 0.162X_1 + 0.743X_2$$

Where Y is the predicted willingness to support government space ventures, and  $X_1$  and  $X_2$  are education and average perceived value. People with a bachelor's degree showed more support of government space ventures than those with only a high school degree or equivalent or a graduate degree. Also, as the average perceived value increased, so did willingness to support private space

ventures. The statistical summary for this equation is provided in Table 3. The model accounted for 45.8% (45.4% adjusted) of the variance in the willingness to support government space ventures. The model was also significant,  $F(2, 308) = 130, p < 0.001$ . Education and average perceived value had standardized beta coefficients of  $-0.088$  and  $.660$ , with average perceived value having the greatest effect size. The statistics summary for both equations is provided in Table 4.

**Table 2**

*Regression Summary of the Variables for Willingness to Support Private Space Ventures from Stage 1 (N = 319)*

|                         | <i>B</i> | <i>SE</i> | Beta   | <i>t</i> | Sig.   | VIF  |
|-------------------------|----------|-----------|--------|----------|--------|------|
| Constant                | 0.268    | 0.074     | -      | 3.59     | <0.001 | -    |
| Gender                  | -0.238   | 0.087     | -0.124 | -2.72    | 0.007  | 1.10 |
| Political Affiliation   | 0.069    | 0.036     | 0.084  | 1.92     | 0.056  | 1.01 |
| Average Familiarity     | 0.121    | 0.053     | 0.127  | 2.30     | 0.022  | 1.61 |
| Average Perceived Value | 0.610    | 0.063     | 0.519  | 9.62     | <0.001 | 1.53 |

**Table 3**

*Regression Summary of the Variables for Willingness to Support Government Space Ventures from Stage 1 (N = 319)*

| Variable                | <i>B</i> | <i>SE</i> | Beta   | <i>t</i> | Sig.  | VIF  |
|-------------------------|----------|-----------|--------|----------|-------|------|
| Constant                | 0.203    | 0.063     | -      | 3.23     | 0.001 | -    |
| Education               | -0.162   | 0.078     | -0.088 | -2.08    | 0.039 | 1.02 |
| Average Perceived Value | 0.743    | 0.048     | 0.660  | 15.61    | 0.000 | 1.02 |

**Table 4**

*Summary of Stage 1 Models (N = 319)*

| Dependent Variable | $R^2$ | Adjusted $R^2$ | df     | <i>F</i> | Sig.   |
|--------------------|-------|----------------|--------|----------|--------|
| Private            | 0.417 | 0.409          | 4, 306 | 54.7     | <0.001 |
| Government         | 0.458 | 0.454          | 2, 308 | 130      | <0.001 |

## Stage 2 – Model Fit Evaluation

A separate sample of 315 participants was used for stage 2 to assess model fit for the equations developed in stage 1. Predicted values for willingness to support private and government space ventures were created using the data from the 315 participants and the equations from stage 1. Both model fits were analyzed from three separate approaches, *t*-tests and correlations between the predicted and actual willingness to support private and government space ventures, and by cross-validation of  $R^2$ .

The *t*-test examined the fit between the predicted values calculated using the stage 1 equations and the actual values of willingness to support private and government space ventures reported in stage 2 data. The independent samples *t*-tests found no significant difference between the predicted values ( $M = 0.65, SD = 0.58$ ) and reported values ( $M = 0.67, SD = 0.89$ ) for Private, as  $t(623) = -0.361, p < 0.718$ . Likewise, there was no significant difference between the predicted values ( $M = 0.75, SD = 0.56$ ) and reported values ( $M = 0.70, SD = 0.87$ ) for Government, as  $t(628) = 0.826, p = 0.409$ . The lack of a significant difference in the means provides evidence that the

equations in stage 1 are valid models to predict willingness to support private and government space ventures.

The Pearson's correlation was conducted between the predicted willingness to support private, and government space ventures and the actual values reported in the stage 2 data. For willingness to support private space ventures, a significant relationship exists,  $r(310) = 0.641, p < 0.001$ . For willingness to support government space ventures, a significant relationship also exists,  $r(315) = 0.651, p < 0.001$ . The cross-validity coefficient shows additional evidence of model fit for both equations as there is a strong and positive correlation between the predicted and actual scores.

Lastly, the cross-validated  $R^2$  was the final assessment used to demonstrate model fit for both equations. The equation used to calculate the cross-validated  $R^2$  manually:

$$R'^2 = 1 - (1 - R^2) \left[ \frac{(n + k)}{(n - k)} \right]$$

The  $R^2$  comes from the stage 1 models,  $n$  is the stage 1 sample size, and  $k$  is the degrees of freedom. The calculation produced an  $R'^2$  of 0.402 for willingness to support private space ventures and 0.451 for willingness to support government space ventures which were sufficiently close to the stage 1 model  $R^2$  indicating a good model fit. A summary of the model fit statics is included in Table 5.

**Table 5**

*Stage 2 Model Fit using Actual Versus Predicted Willingness to Support Private and Government Space Ventures*

|                | t-Test |     |       | Correlation |        | Original $R^2$ | Cross Validated $R^2$ |
|----------------|--------|-----|-------|-------------|--------|----------------|-----------------------|
|                | $t$    | df  | Sig.  | $r$         | Sig.   |                |                       |
| WTS Private    | -0.361 | 623 | 0.718 | 0.641       | <0.001 | 0.409          | 0.402                 |
| WTS Government | 0.826  | 628 | 0.409 | 0.651       | <0.001 | 0.455          | 0.451                 |

*Note:* WTS = Willingness to Support

### Discussion

Willingness to support private space ventures appears to be most influenced by gender, political affiliation, familiarity, and perceived value. Women in this study were less supportive of private space ventures, consistent with the conclusions of previous works by Cook et al. (2011) and Nadeau (2013). This finding could be due to disproportionate interest in space ventures in general, in following news about private space companies or their leadership, or due to a lack of female representation in space exploration as proposed by Cobb (2019). Conservative participants expressed support for private space ventures only slightly more than liberal participants, consistent with the trends discussed by Cobb (2011). The support from these groups could be very close because both are interested in the benefits of space ventures; that is, support for space ventures is apolitical or bipartisan, as posited by Nadeau (2013) and Burbach (2019). One possible explanation for the small difference in support is liberal interest in science and technology in general versus conservative support of private space ventures because of their potential benefits to the US economy. The inclusion of familiarity in the prediction equation is consistent with the mere exposure theory, where increased familiarity leads to liking or preference (Zajonc, 2001). In this study, similar to De Vries et al. (2017), participants responded as if they were potential investors and may have exhibited a similar familiarity bias in their evaluation.

As the perceived value of space ventures increases, so does the willingness to support. This predictor is a significant predictor of willingness to support both private and government space ventures. Bainbridge's (2015) theory that conceptualization of space ventures is linked to opinions about current events may explain the appearance of perceived value in the regression equations. Private space companies are taking advantage of the opportunity to develop new and reusable vehicles, which may be appealing to the public and appealing to the companies themselves. Currently, SpaceX is demonstrating the benefits of reusable launch vehicles, which the public can learn about on social media or through the news. Governmental organizations can appeal to more potential supporters by emphasizing the benefits to individuals and communities from the space ventures in their social media posts. For example, NASA currently uses Instagram ® to share information about the science conducted aboard the ISS, sometimes including how these experiments benefit life on Earth. These posts could be shared on additional platforms to appeal to an even broader audience.

The prediction equation for willingness to support government space ventures also indicates education is a significant predictor. Participants with high school-level education or equivalent and those with a graduate degree or higher were less willing to support government space ventures than those with a bachelor's degree or equivalent. There may be a lack of awareness of what these space ventures are among people with a high school-level or equivalent education. As Cobb (2011) suggested, higher support levels may be due to a better understanding of or appreciation for space ventures. People with a graduate degree or high education might be prioritizing other initiatives over space ventures.

### **Practical Applications**

The findings of this study may be of interest to private and governmental organizations pursuing space ventures. As more organizations pursue space ventures and the future landscape of these ventures evolves, organizations may desire a stronger influence over policy or more monetary support for their endeavors. In both of these cases, the American public can play an important role. A public that is willing to support space ventures can vote in favor of different bills that benefit these organizations.

To increase support for space ventures among Americans, private and government organizations engaged in space ventures must first identify and understand the factors most influential to support. These factors are identified in this study. Private companies may be interested in increasing familiarity with their products and mission statements among Americans and appeal to women and liberals. At the same time, NASA might consider increasing outreach to high school and graduate students. All organizations can benefit by emphasizing the value space ventures bring to American life through education or outreach initiatives.

### **Limitations**

The sampling frame is a significant limitation in this study. Participants were reached through MTurk, which all Americans do not use. These individuals might be more familiar or comfortable with technology, resulting in greater willingness to support space ventures than Americans who do not use MTurk or complete similar online survey platforms. It is assumed that most Americans are comfortable with technology at the time of this study and the sample population's responses are generalizable to the American people. Additionally, this study is cross-sectional, and answers could change in the future as current events or space ventures change.

### **Conclusions**

This study identified gender, political affiliation, familiarity, and perceived value as significant predictors of willingness to support private space ventures. Education and perceived

value are significant predictors of willingness to support government space ventures. Previous studies have looked at some, but not all, of these predictors. Additionally, surveys such as those performed by Pew Research Center provide some information about the different contributors to the willingness to support space ventures. Still, they do not in a method that allows the audience to compare the impact of each contributor. This study contributes novel regression equations, which can be used to compare each predictor's influence to willingness to support private or government space ventures.

Of particular note is perceived value, the most significant factor in both equations. There is an opportunity for future studies to investigate further perceived value and what creates that perceived value. With this knowledge, organizations can strategize how to highlight their space ventures' value to gain supporters who might be on the periphery. Private companies have a unique opportunity to influence Americans' willingness to support their space ventures through a four-pronged approach approaching women and people with more liberal political views and increasing the public's awareness of their ventures in addition to perceived value.

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## Appendix A

### Willingness to Support Space Ventures Scale (adapted from Rice et al., 2020)

1. I would have no problem supporting space ventures in this situation.  
Strongly disagree   Disagree   Neither Disagree Nor Agree   Agree   Strongly Agree
2. I feel confident supporting space ventures in this situation.  
Strongly disagree   Disagree   Neither Disagree Nor Agree   Agree   Strongly Agree
3. I have no fear of supporting space ventures in this situation.  
Strongly disagree   Disagree   Neither Disagree Nor Agree   Agree   Strongly Agree
4. I would be comfortable supporting space ventures in this situation.  
Strongly disagree   Disagree   Neither Disagree Nor Agree   Agree   Strongly Agree
5. I would be willing to support space ventures in this situation.  
Strongly disagree   Disagree   Neither Disagree Nor Agree   Agree   Strongly Agree
6. I would feel safe supporting space ventures in this situation.  
Strongly disagree   Disagree   Neither Disagree Nor Agree   Agree   Strongly Agree
7. I would be happy to support space ventures in this situation.  
Strongly disagree   Disagree   Neither Disagree Nor Agree   Agree   Strongly Agree

## Appendix B

### Modified Familiarity and Value Scales

*Familiarity of Space Ventures Scale (adapted from Rice & Winter, 2019 and Winter et al. (2020)*

Please indicate how strongly you agree or disagree with the following statements.

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|  |                   |          |                            |       |                |
|--|-------------------|----------|----------------------------|-------|----------------|
| 1. I am familiar with space ventures.                          | Strongly disagree | Disagree | Neither Disagree Nor Agree | Agree | Strongly Agree |
| 2. I know more about space ventures than the average person.   | Strongly disagree | Disagree | Neither Disagree Nor Agree | Agree | Strongly Agree |
| 3. I have a lot of knowledge about space ventures.             | Strongly disagree | Disagree | Neither Disagree Nor Agree | Agree | Strongly Agree |
| 4. I have read a lot about space ventures.                     | Strongly disagree | Disagree | Neither Disagree Nor Agree | Agree | Strongly Agree |
| 5. Space ventures have been of interest to me for a while now. | Strongly disagree | Disagree | Neither Disagree Nor Agree | Agree | Strongly Agree |

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*Perceived Value of Space Ventures Scale (adapted from Rice & Winter, 2019 and Winter et al. (2020)*

Please indicate how strongly you agree or disagree with the following statements.

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|  |                   |          |                            |       |                |
|--|-------------------|----------|----------------------------|-------|----------------|
| 1. If space ventures were available, I think they would be beneficial for me to support. | Strongly disagree | Disagree | Neither Disagree Nor Agree | Agree | Strongly Agree |
| 2. I think space ventures are useful.  | Strongly disagree | Disagree | Neither Disagree Nor Agree | Agree | Strongly Agree |
| 3. There would be value in using space ventures.   | Strongly disagree | Disagree | Neither Disagree Nor Agree | Agree | Strongly Agree |
| 4. Space ventures would be beneficial to me.   | Strongly disagree | Disagree | Neither Disagree Nor Agree | Agree | Strongly Agree |
| 5. Space ventures would be something valuable for me to support.                         | Strongly disagree | Disagree | Neither Disagree Nor Agree | Agree | Strongly Agree |

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