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An empirical study on customers' behavior of passive and active resistance to innovation

Yu Wang[a], Min Han[a], Yuan Wang[b] and Sara Shafiee[c]

[a]School of International Business; Institute of Management Science and Engineering, Jinan University, Zhuhai, China; [b]School of Business Administration, South China University of Technology, Guangzhou, China; [c]Department of Mechanical Engineering, Technical University of Denmark, Copenhagen, Denmark

ABSTRACT

Previous studies reveal that the failure rate of innovation in enterprises is higher than expected. The reason for innovation failures is due to not only the customers' resistance towards innovation, subsequent changes and ignored factors that promote customer acceptance, but also the other disregarded factors that motivates the resistance towards innovation adaptation. The literature proved the customers' innovation resistance (CIR) consists of two categories. Passive innovation resistance (PIR) described as initial resistance behavior before evaluating the new product; and active innovation resistance (AIR) introduced as the resistant behavior after evaluating innovative products. However, few studies have investigated the simultaneous influence of both PIR and AIR, especially using the empirical methods. The main purposes of this study are (1) to construct a model that reflects on both PIR and AIR as two categories of CIR; (2) to provide empirical evidences to highlight the influences and correlation of PIR and AIR. The method used in this paper is partial least squares path modeling (PLS-PM) method to test our model and the hypotheses. The results from this research mainly indicate that (1) PIR is negatively influenced AIR; (2) PIR (including both cognitive and situational PIR) has negative effect on customers' innovation adoption intention (IAI) while (3) the correlation between AIR and IAI is opposite; (4) the degree of customers' IAI with high-perceived stimulation group and low-perceived stimulation group will reverse according to the changes of PIR and AIR. This paper is helpful for enterprises to improve their innovation success rate by analyzing users' resistance to innovation.

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1. Introduction

Enterprises need to improve their innovation capabilities, in order to gain competitive advantage in the increasingly fierce competition (Heidenreich & Kraemer, 2015). With the rapid development of technology, many companies have adopted new

CONTACT Yuan Wang wangyuan6@stu2019.jnu.edu.cn

innovative ways, different from previous independent innovation methods, to effectively improve the products/services from the perspective of customers. One of the most popular methods was to create an online co-creation community where users can post comments or innovative ideas on products/services and interact with each other (Wang et al., 2020); hence, enterprises could use the knowledge from co-creation communities to shape their innovation path. However, the fact is that all of the innovations will not be accepted and appreciated by customers when they are initially on the market. Customers may have resistant emotions or behaviors against innovative products/service, especially when it comes to radical innovation, which is one of the important reasons for the high failure rate of enterprise innovation.

Research on the positive behaviors and influencing factors of innovation adoption has been addressed by many scholars. However, since scholars and managers found out about the customer resistant behavior during the commercialization of innovation, Antioco & Kleijnen, 2010 suggested to pay more attention to the influencing factors on customer resistant behavior towards innovation. Resistance is customer's initial reaction when first confronted with innovations (Sääksjärvi & Morel, 2010; Stryja et al., 2017; Talke & Heidenreich, 2014). Innovation resistance theory was used to discover possible profitable innovations and consumer barriers (Stryja et al., 2017) and to explain or predict adoption-related behavior (Bartels & Reinders, 2011; Heidenreich & Kraemer, 2015). Scholars and managers have recognized the significance of customers' innovation resistance (CIR) behavior against new product/service and the adaptation of innovation to the attitude of customers (Antioco & Kleijnen, 2010; Long et al., 2012; Patsiotis et al., 2013; Rieple & Snijders, 2018). CIR reveals a phenomenon that customers refuse to accept innovation based on innovation resistance theory. Moreover, it's crucial to analyze CIR to reduce the failure of innovation and help manager creating or modifying marketing strategy (Stryja et al., 2017).

CIR is further divided into passive innovation resistance behavior (PIR) and active innovation resistance behavior (AIR), since there are some differences in CIR founded by scholars (Heidenreich & Handrich, 2015; Heidenreich & Kraemer, 2015; Heidenreich & Spieth, 2013; Rieple & Snijders, 2018; Talke & Heidenreich, 2014). PIR is the common initial tendency behavior of customers before evaluating or using new products/services (Heidenreich & Kraemer, 2015), while AIR is a resistant behavior of customers after evaluating innovative products (Talke & Heidenreich, 2014). In simple terms, PIR and AIR represent two stages of resistance behavior caused by different types of factors, before or after evaluating the products. Only several research studied adoption-related behavior based on resistance method (Bartels & Reinders, 2011; Hirunyawipada & Paswan, 2006). Few relevant research has distinguished different kinds of CIR (Mani & Chouk, 2017; Stryja et al., 2017), or separately studied one of the CIR (Heidenreich & Handrich, 2015; Heidenreich & Kraemer, 2015, 2016). Hence, there is still lack of research on the internal influence mechanism of CIR on the PIR and AIR relationship to discover the CIR internal impact on customers' innovation adoption intention. Moreover, there is rarely relevant research providing especially empirical evidences on PIR and AIR relations. Hence, in this research, we analyze the empirical data on CIR mechanism to better understand (1) how PIR and AIR affects customers' willingness to accept innovative products; and (2) whether

there is an intrinsic relationship between PIR and AIR. In addition, both cognitive PIR and situational PRI are included in this paper. If customers' emotions are tenser while facing new changes, it means that their cognitive PIR (CPIR) is higher, and it is more difficult to convince them on innovative products acceptance. Besides, all elements that apparel CIPR inhibit the adoption of new products. CPIR negatively affects its openness to innovation and adoption probabilities (Nov & Ye, 2008). Situational PIR (SPIR) reflects the degree to which an individual's preference for the current status quo inhibits considering and eventually adopting innovations due to the changes entailed.

In the process of facing or assessing innovative products, customers will be affected and simulated by a variety of internal and external factors. Perceived stimulation (PS) is defined as the amount of stimulation from all sources that an individual perceives at a certain point of time (Steenkamp et al., 1996). The difference between individuals' experience are closely related to PS, which are derived from PIR. The previous research proved that the stimulation caused by an innovation product might induce higher customers' PIR (Heidenreich & Kraemer, 2015; Talke & Heidenreich, 2014). However, there is no research on whether AIR has the same impact. Thus, moderating the effect of PS on PIR and AIR requires further empirical evidence.

For enterprises producing digital products, an important problem is that the innovation of new products may not be recognized by users. The user group will resist the innovation of this product by selecting other products. At the same time, because the product attribute of enterprise innovation does not utilize the use of users, users will also passively choose to resist innovation out of their own needs. Some important examples are that after functional innovation of products such as Tiktok, users will evaluate their innovation behavior. However, the resistance and acceptance of users to these innovative behaviors have not been studied accordingly. This research can help enterprises solve an important problem: What is the internal mechanism of users' resistance to product innovation? How does it affect the intention of accepting enterprise product innovation?

The existing research has generally studied the impact of PIR on users' innovation adoption intention Talke and Heidenreich (2014), and the existing research has also studied the relationship between AIR and IAI. At the same time, existing research has also conducted sufficient research on important parts of PIR (cognitive PIR and situational PIR) (Heidenreich & Kraemer, 2016). However, it is regrettable that the research on the impact of PIR and AIR on IAI has not been carried out yet. Therefore, this paper hopes to make up for the deficiencies of existing research, and explore how PIR and AIR work together to explore the impact mechanism of IAI.

In this study, we excavate the internal influence mechanism of CIR (both PIR and AIR) on IAI and the moderating effect of PS. This study empirically improves the understanding of the influence of CIR on innovation in order to reduce the negative effects of PIR and AIR on new products using the co-creation communities in China as cases. The main contributions of this paper are as follow. First, the paper constructs the model based on related literature to understand the internal influence mechanism of CIR on IAI and demonstrate the hypothesis of the research. Second, brainstorming method and pilot study were used to generate the final survey

questionnaire in multiple iterations. Using survey based method, we gather empirical evidences to highlight the influences and correlation of PIR and AIR. Finally, we analyze the data using SPSS and Smart PLS to test the hypothesis of the model.

The rest of this paper is organized as follows. First, based on prior studies on customer resistance innovation, a theoretical framework reflecting the internal mechanism of CIR, including both AIR and PIR, is developed. Second, we give details on our scale, data and measurements before we reach our results. Finally, we present the implications of empirical results and outline some future research direction.

2. Related literature background

2.1. Customer innovation resistance

Based on resistance theory, CIR is detected as one of the reasons that customers refuse to accept or evaluate an innovative product. Previous literature on innovation failure relevant to OR include (1) resolving CIR towards new products based on innovation resistance (Kleijnen et al., 2009; Mani & Chouk, 2017; Stryja et al., 2017); and (2) conceptualizing innovative resistance (Heidenreich & Kraemer, 2015; Heidenreich & Spieth, 2013). Some researchers interpreted innovation resistance as a resistance behavior caused by product characteristics barriers after customer evaluation of new products (Heidenreich & Spieth, 2013; Kleijnen et al., 2009). While, others proved that customers themselves aroused innovative resistance behaviors (Heidenreich & Handrich, 2015; Heidenreich & Kraemer, 2015, 2016). According to existing research, CIR can be further divided into two categories, namely passive innovation resistance (PIR) and active innovation resistance (AIR) (Koch et al., 2021; Koo et al., 2017).

2.2. Passive innovation resistance (PIR) and active innovation resistance (AIR)

PIR is the common initial tendency behavior of customers before evaluating or using new products/services, while AIR is a resistant behavior of customers after evaluating innovative products (Heidenreich & Handrich, 2015; Yu et al., 2022). PIR refers to the consumer's unconscious resistance to changes caused by innovation before the awareness of product evaluation (Heidenreich & Kraemer, 2015; Heidenreich & Spieth, 2013), which can be seen as the initial response of customers to innovation without considering their product-specific factors and innovative attributes. It is difficult to change the high resistance of customers at the cognitive level, as this resistance is instinctive (Heidenreich et al., 2022; Oreg, 2003). Innovation can possibly change customer behavior and undermine its inherent balance of desires, leading customers to unconsciously create spontaneous initial barriers to innovation (P. Laukkanen et al., 2008). For those customers who are very satisfied with the existing products, facing innovative products can affect current satisfaction and they are even less willing to take the risks of change and hence, they prefer to maintain the status quo and reduce the losses that innovation may bring (Phelps et al., 2014).

AIR is completely different from PIR, which means that customers will form negative attitude towards innovative product based on perceived innovation attributes

(Kleijnen et al., 2009; Kuisma et al., 2007; P. Laukkanen et al., 2008; T. Laukkanen et al., 2009; Talke & Heidenreich, 2014). Customers evaluate innovative products and compare with their expected levels, which may lead to some mismatches in innovative attributes. When customers perceive dysfunction and psychological barriers below their minimum tolerance, they will have a bad evaluation of new products, further forming an AIR (Talke & Heidenreich, 2014). In general, AIR is formed when the evaluation of product innovation attributes is more likely to be rejected by customers, leading to the failure of innovation in the process of commercialization. Scholars have empirically verified the impact of specific product barriers on negative assessments (Heidenreich et al., 2022; Kleijnen et al., 2009).

By reviewing relevant literature, we defined the concepts of PIR and AIR. Previous studies have distinguished between their different structures (Talke & Heidenreich, 2014). PIR is the main cause of passive rejection because PIR is likely to occur before the user has actually used and evaluated the product (Nabih et al., 1997). This tendency and attitude of refusal evolved into positive resistance to innovation in the subsequent stage of persuasion, resulting in the emergence of AIR (Nabih et al., 1997). While PIR represents the sole driver of passive rejections at early stages of the adoption process, it also exerts an impact on active innovation resistance and thus on subsequent stages as it likely affects the mental effort devoted to new product evaluation (Talke & Heidenreich, 2014): Higher PIR prompts more negative responses, both cognitive and emotional, to the innovation. This in turn fosters functional and psychological barriers during new product evaluation, which then may lead to active innovation resistance and finally result in active rejection of the innovation. Hence, PIR as predisposition determines the whole course of the adoption process, whereas active innovation resistance and active rejections represent outcomes during the decision process which may be caused by PIR. According to a previous exploratory factor analysis, PIR is a two-dimensional variable that runs through the user's process of using the product (Talwar et al., 2020). Heidenreich & Kraemer (2016) ran an exploratory factor analysis and verified that PIR actually consists of a two-dimensional factor structure at the first-order level (i.e., cognitive and situational PIR), rather than the past common inclination to resist changes and status quo satisfaction.

2.3. Perceived stimulation (PS)

Perceived stimulation (PS) is defined as the amount of stimulation from all sources that an individual perceives at a certain point of time, which may be caused by any situation, event, agent or object (Steenkamp et al., 1996). Changes of an individual's experience are closely related to his/her PS, which are derived from a customer's PIR. Heidenreich and Handrich (2015) and Heidenreich and Kraemer (2015) showed that the stimulation induced by an innovative product might evoke higher customer's PIR.

Heidenreich and Kraemer (2015) highlighted that PS is one of the crucial factors to behavioral theory research in order to better understand the impact of PIR. Hence, the higher is the probability that an individual is exposed to new changes in life, the higher is his/her level of PS. The existing research on PS mainly studies two aspects as: (1) the actual stimulation level (ASL) of an individual expresses the amount of stimulation experienced by an individual from all sources at a specific time point;

and (2) the optimal stimulation level (OSL), which reflects the person's preferred level of stimulation under any feasible circumstances and over time (Steenkamp et al., 1996). The two levels of PS, namely both ASL and OSL, are not always equal. When changes occur, individuals will always seek a balance between the two to achieve optimal levels of stimulation.

3. Hypotheses development

3.1. The relationship between PIR and AIR

Prior studies have divided CIR into PIR and AIR to consider the comprehensive relationship between CIR and innovation adoption behavior. (Heidenreich & Spieth, 2013) have shown that PIR and AIR have a significant negative impact on customer's innovation adoption behavior, or it is not conducive to customer acceptance of a new product. AIR is triggered by customers' conscious evaluation of innovative products, which means that AIR will occur due to the functional or psychological barriers during the evaluation of innovative products (Molesworth & Suortti, 2002; Wiedmann et al., 2011). However, there are few studies on PIR compared with AIR (Talke & Heidenreich, 2014). Although PIR has several research and management implications, only few scholars focus on PIR (Rieple & Snijders, 2018). Thus, scholars began to call for more PIR studies, especially focusing on empirical results.

In the process of accepting an innovative product, PIR occurs before the AIR. Only (Talke & Heidenreich, 2014) have shown that PIR may further influence customers' initiative to resist innovation by affecting customer's efforts to adopt innovative products. Besides, the higher the customer's PIR, the less eager they are to get in touch with innovative products. Moreover, the customer with higher PIR will have higher requirements for the innovative products as they are already satisfied with the current products. Therefore, the possibility that customers will be functionally and psychologically dissatisfied with innovative products will increase, which will directly lead to the creation of AIR. Obviously, when customers are not satisfied with the evaluation of innovative products, customers will have less willingness to buy innovative products. If customers' emotions are tenser while facing new changes, it means that their cognitive PIR (CPIR) is higher, and it is more difficult to convince them on innovative products acceptance. Besides, all elements that apparel CIPR inhibit the adoption of new products. CPIR negatively affects its openness to innovation and adoption probabilities (Nov & Ye, 2008). Situational PIR (SPIR) reflects the degree to which an individual's preference for the current status quo inhibits considering and eventually adopting innovations due to the changes entailed.

In summary, the hypotheses are as below:

H_{1a}: Cognitive PIR is negatively related to IAI.
H_{1b}: Situational PIR is negatively related to IAI.
H_{2a}: Cognitive PIR has positive impact on AIR.
H_{2b}: Situational PIR has positive impact on AIR.
H_3: AIR has positive impact on IAI, and mediate the relationship between PIR and IAI.

3.2. Moderating effects of perceived stimulation

Oreg (2003) and (Talke & Heidenreich, 2014) and other scholars have shown that (1) PIR is negatively related to customer demand for stimulation, (2) the stronger is the PIR, the lower is the OSL, and (3) the higher is the PIR and PS, the greater is the gap between ASL and OSL. The higher is the probability that an individual is exposed to new changes in life, the higher is his/her level of PS. The two types of PS, i.e. ASL and OSL, of an individual are not always equal, which means that individuals are satisfied with the status quo. When changes occur, individuals will always seek a balance between the two to achieve optimal levels of stimulation.

When the ASL is higher than the OSL, the individual will take action to offset the gap between the two types of stimulation, which will further reduce the customer's willingness to adopt. Similar to PIR, each customer's perceived functional and psychological barriers regarding innovation are related to each individual's perceived level of stimulation. The more the obstacles perceived by customers and the higher is the level of PS, the stronger is the customer's AIR, and the more unfavorable if for the customer to accept innovation. When customers perceive a stronger external stimulation, the resistance degree of customers towards changes will be stronger, because they feel that their existing balance is likely to be broken. When the level of stimulation perceived by customers increases, in order to maintain the existing balance and the current satisfaction level, the resistance elements of customers will be intensified, and the innovative products will be more detailed and comprehensively evaluated by customers, and then customers' AIR may be increased. Based on this, the following hypotheses are proposed:

H_{4a}: The negative effect of PIR on IAI is negatively moderated by PS.
H_{4b}: The negative effect of AIR on IAI increases with higher levels of PS.

The theoretical model and predicted relationship of this paper are shown as Figure 1. The overall theoretical model is divided into two levels, hierarchical level and structural

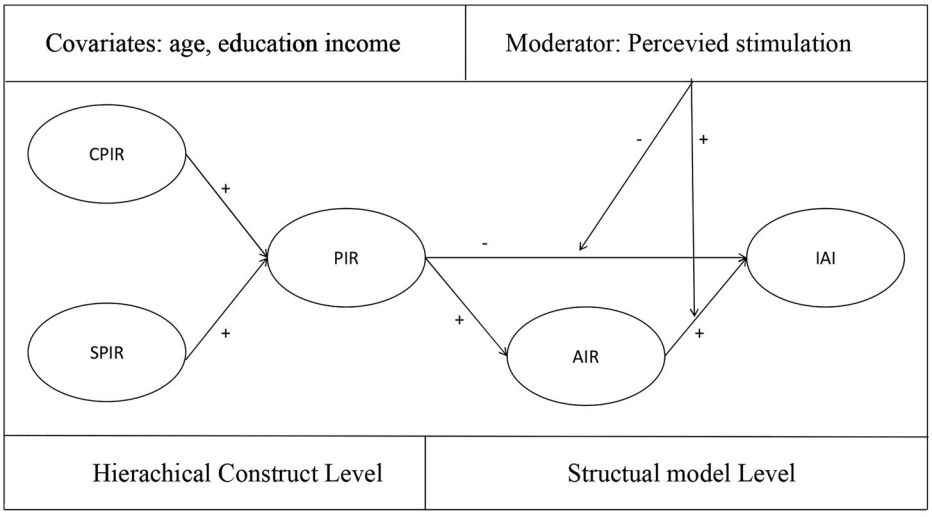

Figure 1. Theoretical model and research hypothesis.
Source: raw data analysis.

model level. In hierarchical level, PIR consists of two dimensions, CPIR and SPIR, and the stronger the CPIR and SPIR, the stronger the PIR. PIR is negatively related to customer's IAI. AIR has positive impact on IAI, and mediates the relationship between PIR and IAI. PS negatively moderates the effect of PIR on IAI and positively moderates the effect of AIR on IAI.

4. Research method

4.1. Data collection

We used an online questionnaire to investigate our theoretical model and hypotheses. The questionnaires were e-mailed to respondents, along with a description of the study's purpose and follow-up notification. There are already several Chinese companies that have established their online innovation communities to find diversified innovation method and they have quite many customers using their innovative communities. The online community we choose to test is a mobile phone brand in China, which has an online community to promote communication between users and products as well as between users. It has about 23 million users. The customer can use the online innovation community to evaluate corporate products and interact with other community members. On the other hand, companies can leverage their interactive knowledge in the innovation community. In order to make the survey results more universal, before respondents fill out the questionnaire, they must first answer a question whether they are a member of an innovative community. If they don't belong to any innovative community, then we eliminated them from the results. The questionnaire was divided into two parts, including basic information (from Q1 to Q4, see details in Acknowledgment 2) and a measurement scale for the variables associated with the study (from Q5 to Q20, see details in Acknowledgment 2). Since respondents are Chinese, and the scales are constructed in English, we first translate these scales into Chinese and in a very simple language and then back to English to ensure our survey items are not ambiguous and fully express the original thoughts. Thereafter, the questionnaire was sent to a small sample of online innovation community users who have joined the community for more than a month and have used or learned about innovative products.

4.2. Questionnaire pre-test and administration

Before the questionnaire was officially launched, we used the college students to pretest the questionnaire. We conducted a pretest on 80 undergraduate students from Jinan University, China. The pilot survey was focused on the expression and structure of the questionnaire with a Likert-scaled format (1-5). Accordingly, we used the recovered data from the pilot study for improving the questionnaire and further analysis to make sure that the questions were reasonable and reliable. The main objective of this pre-test was to verify the appropriateness and to clarity the questionnaire for a mailing survey. Hence, we assessed the challenges faced by the respondent in understanding the questions, and eventual ambiguities in our questions. Feedbacks from respondents required changes to approximately 20% of the questionnaire. Following

the pilot pre-test survey, small amendments were made to the questionnaire, which included changes in wordings to improve clarity. According to the data analysis, we figured out that the responses of the respondents using the 5-point Likert scale were concentrated. Hence, in order to make the data dispersion, the 7-point Likert-scale method was used and therefore, we revised the final questionnaire.

4.3. Respondents

All respondents must join the innovation community for more than one month, and have used or learned about innovative products so far. The participants who do not meet the criteria has been deleted from the study. As shown in Table 1, the entire online survey period lasted for two weeks, and a total of 214 complete and usable responses (the response rate of 70.1%) were collected. 46.7% respondents were male, whereas 53.3% were female. The age range of the respondents was 19-25 years old (35.5%), followed by above 35 years old (33.2%), 26-35 years old (26.2%) and less than 18 years old (5.1%). The descriptive analysis shows that most respondents (64.5%) were undergraduate students, and 32.7% respondents are graduated with a master degree or PhD. The occupations of the respondents were mainly corporate employees (35.0%), and the proportion of other subjects such as students, government employees, and freelancers was around 15%. The population structure obtained in the first part of our questionnaire is similar to the user structure of the online innovation community.

4.4. Questionnaire

The study was designed to explore—quantitatively—the importance and the characterization of the main factors. Based on early research related to PIR (Stryja et al., 2017), this paper defines PIR as the common initial tendency behavior of customers before evaluating or using new products/services. Heidenreich and Kraemer (2016) ran an exploratory factor analysis and verified that PIR actually consists of a two-dimensional factor structure at the first-order level (i.e., CPIR and SPIR), rather than the past common inclination to resist changes and status quo satisfaction. Hence, according to the previous projects, PIR is measured by CPIR and SPIR, which consists of four-item, seven-point scale; and two-item, seven-point scale respectively (see Acknowledgment 2 for details). In AIR category, we seek the answers to do the further analysis if there is an overall judgment of the customers of the innovative

Table 1. Resonances' demographic statistics (N = 214).

Features		Percentage	Features		Percentage
Occupation	Students	16.7%	Age	0-18	5.1%
				19-25	35.3%
	Government workers	15.9%		26-35	26.2%
				35∼	33.2%
	Company employees	35.0%		Total	100%
			Degree of Education	High school or junior college	2.8%
	Freelancers	14.7%		Undergraduate	64.5%
	Other	17.7%		Master degree and above	32.7%
	Total	100%		Total	100%

Source: raw data analysis.

Table 2. Multi-collinearity test (VIF).

	PIR	AIR	IAI	PS
PIR	1			
AIR	1.000***	1		
IAI	2.378***	1.699***	1	
PS	1.074***	1.074***	2.408***	1

***$p < 0.001$, **$p < 0.01$, *$p < 0.05$.
Source: raw data analysis.

products and also the level of this judgment. According to Talke and Heidenreich (2014), AIR category consist of three questions to mainly explore whether consumers have AIR in terms of product characteristics for innovative products, which makes the AIR scale consist of three-item, seven-point Likert scales (see Acknowledgment 2 for details). In IAI category, the questions aim in the likelihood of purchasing the innovative product. The existing research on PS mainly studies two aspects as: (1) the actual stimulation level (ASL) of an individual; and (2) the optimal stimulation level (OSL)(Steenkamp et al., 1996). Heidenreich and Kraemer (2015) built the PS scale of four-item, and we used four questions to measure PS. Finally, a four-item, seven-point Likert scales was determined for IAI measurement. In order to make the final questionnaire consistent with the Chinese scenario and the thinking pattern of Chinese consumers, we have adopted a brainstorming approach to specify the main constructs (Table 2) on the basis of these studies. Hence, all the factors has been mentioned in the literature addressing CIR, PIR (CPIR and SPIR), AIR and also PS are used to develop the questionnaire as discussed in the following paragraphs.

Based on the study of Heidenreich and Spieth (2013), AIR was measured using a three-item, seven-point scale. The intention to adopt innovations is measured using four bipolar semantic difference scales with seven-point scale, namely very unlikely/very likely, imaginable/unimaginable, and impossible/possible (Kulviwat et al., 2007). As for the measurement of PS, this paper follows the study of Heidenreich and Kraemer (2015). The Cronbach coefficients of the three flow measurement variables were 0.901, 0.933 and 0.831, respectively.

4.5. Data analysis

We used partial least squares path modeling (PLS-PM) method to test our model and the hypotheses (Esposito Vinzi & Russolillo, 2013), which needed Smart PLS 3.0. In order to conduct simple descriptive statistics, SPSS 22.0 was also applied during the analysis.

The data analysis process was as the following. First, we applied Smart PLS using a centroid weighting scheme and non-parametric bootstrapping to estimate and predict parameters of the model (Hair et al., 2014; Tenenhaus et al., 2005). PIR was defined as a high-order latent variable. We used PLS and repeated indicator method to construct the corresponding model, which is suitable for hierarchical models with equal numbers of manifest variables for every first-order variable (Chin, 1998). Second, in order to test the moderating effect in the model, we follow previous studies using product-dependent methods, i.e. we construct an interaction term that includes each of the structural indicators (Wilson, 2010)? Subsequently, we used PLS to build the

model and estimate the direct and indirect effects. Third, bootstrapping was used to estimate external and internal model parameters and statistics.

In order to ensure the consistency and stability of the results of this study, we further carried out the reliability test. The Cronbach coefficients of the two dimensions of PIR are 0.866 and 0.836, respectively threshold 0.6 (Li-Qiang & Jun-Wen, 2014), and the total Cronbach coefficient of PIR is 0.886.

To control variables, scholars indicated that key sociodemographic characteristics, may also affect innovation evaluation (Meuter et al., 2005). Therefore, same as previous studies, we also control four variables to make our results more stable. The age of the respondents was measured in years. The gender of the respondents was defined as a dichotomous variable (i.e., 1 = male, 2 = female). The level of education of respondents was measured based on the Chinese education system and was divided into three categories according to the level of education from low to high.

Due to the same data source or scorer, the same measurement environment, the project context, and the characteristics of the project itself, the artificial covariation between the predictor and the criterion variable may result in deviations in the communication method. Since the data is a result of self-reporting and survey, there may be a common method bias (CMB). We have taken some measures to control and reduce CMB as much as possible. First, the independent and dependent variables are clearly distinguished at the program level (Podsakoff et al., 2003). Second, the problem setting is as simple and easy as possible during the questionnaire design process, and reduces the confusing expression between measurement items (Jarvis et al., 2003). Finally, prior to all further studies, exploratory factor analysis was performed using SPSS. Based on Harman's single factor test which is a common method to verify if there is a common method bias, there was no single factor in the test results, and the first factor accounted for less than 50% of the total variance (Podsakoff et al., 2003). It's indicated that result is less likely to be affected by the common method variance, so the data can be further analyzed.

5. Results

The hypotheses were tested in this section. The correlation between the variables is shown in the Table 3. PIR is significantly negatively correlated with AIR and IAI, and PIR is significantly positively correlated with PS. AIR is significantly positively correlated with IAI and PS. The negative correlation between IAI and PS is also significant.

In order to estimate the relevant characteristics of PIR with high-order latent variables, we proposed a null model that does not reflect any relationship (Tenenhaus et al., 2005; Wetzels et al., 2009). Since PIR is a second-order indicator of molar model, we construct a hierarchical model of reflection in PLS path modeling and test

Table 3. Correlation matrix.

	PIR	AIR	IAI	PS
PIR	1			
AIR	−0.264***	1		
IAI	−0.675***	0.497***	1	
PS	0.362***	0.299***	−0.683***	1

***$p < 0.001$, **$p < 0.01$, *$p < 0.05$.
Source: raw data analysis.

Table 4. Measurement validation of passive innovation resistance.

First-Order Measurement Model			
	Item	Weights	t-value
Cognitive passive resistance	Q5	0.812	23.657
AVE = 0.714; CR = 0.909	Q6	0.838	33.634
	Q7	0.862	39.377
	Q8	0.868	45.217
Situational passive resistance	Q9	0.927	78.099
AVE = 0.859; CR = 0.924	Q10	0.927	78.099
Second-Order Measurement			
Passive innovation resistance	Cognitive PIR	0.716	38.777
AVE = 0.637; CR = 0.913	Situational PIR	0.376	31.582

Source: raw data analysis.

Table 5. Global measurement model results of structural model 1.

First-order construct	Item	Weights	t-value
Active innovation resistance	Q11	0.913	37.225
AVE = 0.834	Q12	0.921	63.208
CR = 0.938	Q13	0.906	35.062
Innovation adoption intention	Q14	0.957	159.741
AVE = 0.881	Q15	0.923	61.946
CR = 0.957	Q16	0.937	67.618
Perceived stimulation	Q17	0.825	36.566
AVE = 0.666	Q18	0.886	64.705
CR = 0.888	Q19	0.829	33.855
	Q20	0.716	15.859

Source: raw data analysis.

Table 6. Discriminant validity (HTMT).

	PIR	AIR	IAI	PS
PIR				
AIR	0.295			
IAI	0.743	0.541		
PS	0.679	0.366	0.259	

Source: raw data analysis.

the indicator correlation, multi-collinearity, and discriminant validity. The associated t-statistic is derived from non-parametric bootstrapping method. As shown in Table 2, we further evaluated the multi-collinearity between variables to ensure the operability of the mold test (Grewal et al., 2004; Henseler et al., 2009). In the second-order molar structure of PIR, the maximum influence factor (VIF) is 2.408 less than threshold 5), which does not exhibit multi-collinearity.

As shown in Tables 4 and 5, in null model all CR are high, between 0.888 and 0.957 above the threshold of 0.7; all AVE values exceed the threshold of 0.50(Fornell & Larcker, 1981), the lowest value is 0.666. All indicator loads in the measurement model are above the threshold of 0.7, and external weights have t values in excess of 1.98(Chin & Wynne, 1999). Both CR (>0.9) and AVE (>0.6) in the higher-order model test are larger than the threshold, and the external model load is significant. T-value are given by using bootstrapping method. To validate discriminant validity we used the Heterotrait-monotrait (HTMT) criterion (Han et al., 2012), and all the indicators shown in Table 6 performed well and the basic statistics of constructs are summarized in Table 7. Conclusively, the results of the measurement model evaluation meet the criteria for further evaluation of the structural model.

Table 7. Basic statistics of constructs.

Constructs	No. of Items	Mean	S.D.	Cronbach Alpha	C.R.	AVE	Concept & Scales adapted from
CPIR	4	4.18	1.399	0.866	0.909	0.714	Heidenreich & Kraemer, 2015
SPIR	2	4.42	1.356	0.836	0.924	0.859	Heidenreich & Kraemer, 2015
PIR	6	4.26	1.272	0.886	0.913	0.637	Heidenreich & Kraemer, 2015
AIR	3	4.78	1.301	0.901	0.938	0.834	Talke & Heidenreich, 2014
IAI	3	4.11	1.512	0.933	0.957	0.881	Kulviwat et al., 2007
PS	4	3.16	0.916	0.831	0.888	0.666	Heidenreich & Kraemer, 2015

Source: raw data analysis.

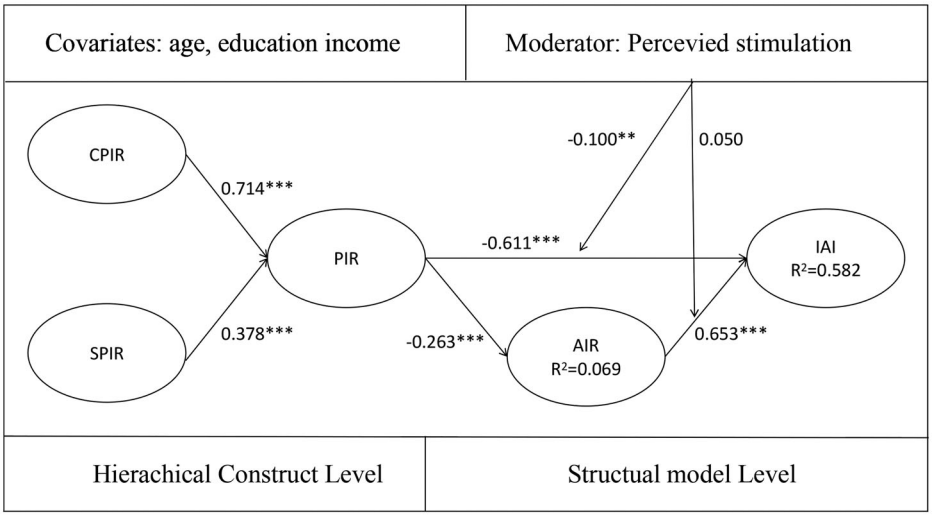

Figure 2. Structural Model Results across technological Products.
Source: raw data analysis.

From Figure 2, we can conclude that the reported results support and confirm the Hypothesis 1a and Hypothesis 1b. The results show that CPIR and AIR have a strong negative relationship with customers' IAI (β=-0.611, $p < 0.01$). However, H2a and H2b are not supported. There is a significant negative correlation between the two types of PIR and AIR (β=-0.263, $p < 0.01$). Consistent with Hypothesis 3, there is a significant positive correlation between AIR and innovation IAI (β=-0.2653, $p < 0.01$). Aligned with H4a, the PS significantly moderates the influence of PIR on innovation IAI (β=-0.100, $p < 0.05$). However, it is assumed that the effect of PS in H4b on the initiative innovation resistance and the willingness to adopt innovation is not significant ($\beta = 0.050$, $p > 0.05$).

We use SPSS to establish two regression equations respectively. Equation 1 contains IAI, PIR and PS. Equation 2 adds the interaction term of PS and PIR based on Equation 1. In the second equation, the amount of change in R2, the sig F change value is less than 0.05, and the sig. value of the cross-term coefficient is less than 0.05, demonstrating that the moderating effect is present and significant (as shown in Tables 8 and 9).

Furthermore, we tested the mediate model with a moderate effect based on Liang et al. (2012). As shown in Table 8, the regression coefficient of PIR in Equation 1 is significant (β =-.975, t =-13.687, p <.001), indicating that PIR negatively affects IAI. The regression coefficient of PIR in Equation 2 is significant ($\beta = -.690$, $t = -10.328$, p <.001), indicating that PIR positively affects AIR. The regression coefficient of AIR in Equation 3 is significant (β =.390, $t = 5.699$, p <.001), indicating that AIR plays a

Table 8. Model summary.[c]

Model	R	R^2	Adjusted R^2	Std. Error of the Estimate	Change Statistics					DW
					R^2 Change	F Change	df1	df2	Sig. F Change	
1	.705[a]	.497	.492	1.07723	.497	104.251	2	211	.000	
2	.719[b]	.517	.510	1.05789	.020	8.784	1	210	.003	2.066

[a]Predictors: (constant), PS, PIR.
[b]Predictors: (constant), PS, PIR, PIR*PS.
[c]Dependent variable: IAI.
Source: raw data analysis.

Table 9. Coefficients a.

Model		Unstandardized coefficients		Standardized coefficients		
		B	Std. Error	Beta	t	Sig.
1	Constant	6.770	.315		21.515	.000
	PIR	−.975	.071	−.820	−13.687	.000
	PS	.413	.099	.251	4.187	.000
2	Constant	4.795	.735		6.526	.000
	PIR	−.446	.192	.375	−2.325	.021
	PS	1.021	.227	.621	4.500	.000
	PIR*PS	−.154	.052	−.739	−2.964	.003

[a]Dependent variable: IAI.
Source: raw data analysis.

mediating role between PIR and AIR, and the mediating effect (mediation effect/total effect) is 0.28. In Equation 4, although the interaction term between AIR and PS has a positive predictive effect on IAI ($\beta = 0.056$), it is not significant ($t = 1.233$). PS is a regulatory variable for the relationship between PIR and IAI, and AIR is a mediator between PIR and IAI, but the regulation of PS on AIR and PS is not significant. Thus, the PS adjusts the first half of the mediation process "PIR→AIR→IAI".

Further analysis shows how PS adjusts the relationship between PIR, AIR and IAI, and performs a simple slope analysis. The PS is grouped according to the average standard deviation of 1 standard deviation. The average score is less than 1 standard deviation below the low PS group, and the average score plus 1 standard deviation is higher PS group, and the middle is PS. It can be seen from the regulation diagram of Figure 3 that with the increase of PIR, the IAI of the high, medium and low PS groups decreased, but the relative willingness level of the high PS group and the low PS group will be reversed. In other words, the original high PS group customers' adoption intention is higher than that of the low PS group customers. As the PIR increases, the overall user willingness will decrease, but the high PS group customers will be less willing to use the innovative product than the low PS group. Figure 4 shows that as AIR increases, the overall customers' innovation adoption intention increases. At low AIR levels, customers in the low PS group are more willing to use than in the high PS group; but at high AIR levels, customers in the low PS group are less willing to use than the high PS group (as shown in Table 10).

6. Discussions and conclusion

6.1. Major findings

The research results of this paper are summarized as follows. First, PIR will prompt customers to refuse to use or purchase innovative products at first time, which will

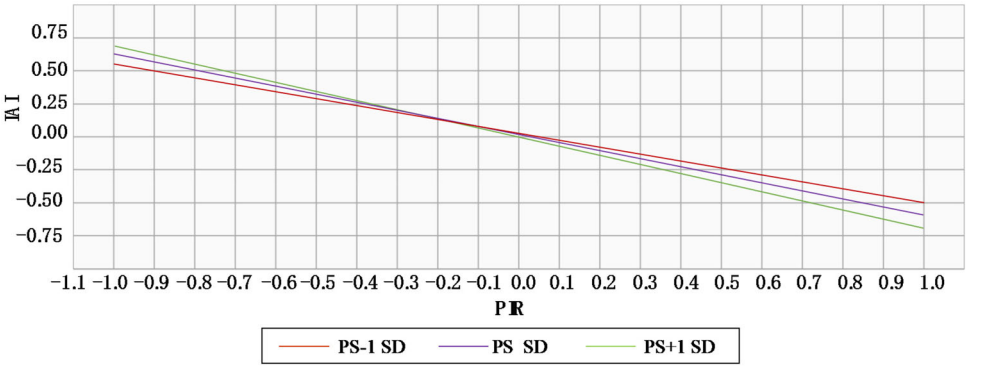

Figure 3. Moderating effect of PS*PIR.
Source: raw data analysis.

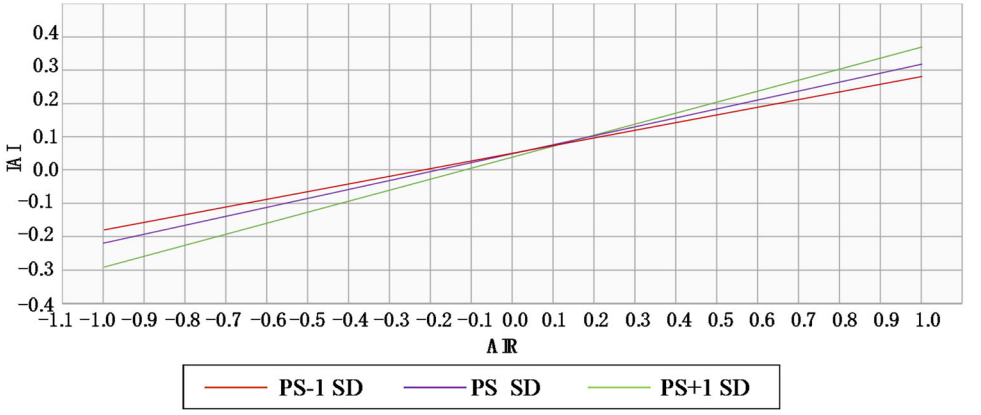

Figure 4. Moderating effect of PS*AIR.
Source: raw data analysis.

Table 10. The relationship between PIR and IAI: an mediate model test with moderating effects.

	Equation 1 (Dependent variable: IAI)		Equation 2 (Dependent variable: AIR)		Equation 3 (Dependent variable: IAI)		Equation 4 (Dependent variable: IAI)	
	β	t	β	t	β	t	β	t
PIR	−0.975	−13.687***	−0.690	−10.328***	−0.706	−8.656***	−0.698	−8.541***
PS	0.413	4.187***	1.004	10.847***	0.021	0.187	−0.250	−1.007
AIR					0.390	5.699***	0.189	1.064
AIR*PS							0.056	1.233
R^2	.497		.403		.558		.559	
F	104.251***		71.113***		90.696***		68.571***	

***$p < 0.001$, **$p < 0.01$, *$p < 0.05$.
Source: raw data analysis.

reduce the likelihood of AIR happening. The higher is the degree of PIR, customer will not evaluate the innovative product.

Second, PIR has negatively effect on IAI, and AIR mediates the negative effect between PIR and AIR, that supports the reported results from Hess (Phelps et al., 2014). However, the relationship between AIR and IAI is positive in this study which

is in conflict with the result from Heidenreich and Spieth in 2013 (Heidenreich & Spieth, 2013). Since PIR is an individual's involuntary resistance behavior to change, PIR will increase the customer rejection of products, i.e. the relationship between PIR and IAI is negative. Heidenreich and Spieth (2013) indicated that product-level barriers and psychological barriers cause AIR. Accordingly, if customers perceive more barriers, their willingness to adopt innovative products is lower, which means they are negatively correlated. As for the opposite result of the relationship between AIR and IAI, possible reasons are as follow. AIR occurs after the customer exhibits PIR behavior. This suggests that customers who demonstrate active innovation resistance has been experienced PIR first. In other words, they are relatively weak in resisting change and are more willing to try to access innovative products rather than reject new products in the first place. Therefore, when they evaluate the product, they will increase their willingness to try the new product even if they perceive some barriers.

Third, PS significantly moderates the negative relationship between PIR and IAI, but the positive moderating effect on AIR and IAI is not significant. The degree of customers' adoption intention with high-PS group and low-PS group will reverse according to the change of passive and active innovation resistance. In combination with previous literature on PS research, people with strong PIR have weaker demand for stimuli and novelty (Oreg, 2003; Talke & Heidenreich, 2014). PS is relatively weaker for customers with a high degree of resistance to change, because PIR is less affected by other factors like environmental or products properties and it is mainly influenced by customers themselves. When customers feel the stimulation, customers' behavior of resolutely resisting to innovative products may be reduced. However, the impact of such changes is less than the negative impact of PIR on IAI. AIR arises when customers perceived product features or psychological projections that do not meet their expectations. PS may enhance this perception and volatility. However, the positive moderating effect on AIR and IAI is not significant. This may be caused by the product characteristics of the customer during evaluation, which needs further testing and empirical investigations.

6.2. Research and practical contributions

The existing research has generally conducted a comprehensive and comprehensive analysis of users' resistance to innovation (Heidenreich et al., 2016). Some new research shows that users' active and passive resistance to innovation has an impact on sustainable innovation behavior (Casidy et al., 2021; Heidenreich et al., 2022; Killmer & Heidenreich, 2022). At the same time, the existing research has fully studied the cognitive PIR and situational PIR of users (Giraldo Ospina & Guevara Sanchez, 2022). Unfortunately, the existing research on how the user's PIR works through AIR, thus affecting the IAI mechanism is still flawed.

Our study contributes both to research and to industry. First, we construct a new model that reflects the internal mechanism (the correlation between PIR and AIR) of customers' resistance behavior, which is helpful to understand this phenomenon that customer refuses to accept or evaluate an innovative new product. Moreover, both the model and empirical results emphasize and highlight the importance of customer resistance behavior related to customers' adoptive behavior study.

Second, we also provide empirical evidence for the hypothesis related to PIR and AIR including the evaluation of the relationship from PIR to AIR, AIR to IAI, PIR to IAI, and the moderating effect of PS. The research provides survey based empirical evidences to prove the hypothesis regarding PIR and AIR that will give a new perspectives and insights for future marketing and management decisions while commercializing innovative products.

Third, we test the moderating effect of PS on customer PIR and AIR. We found that PS played a significant negative role on the relationship between PIR and IAI; PS played a positive role in moderating the relationship between AIR and IAI, but it was not significant and required further research.

For companies and managers, the new products will be successful if they have been successfully commercialized in the market, that is, to be selected by more customers, which is a serious challenge in practice (Meuter et al., 2005; Henard & Szymanski, 2001). Therefore, the contribution to industry and lesson learned for practitioners is summarized below.

Managers should not be too optimistic about the benefits of innovation, which means that they must be effectively conscious of customers' innovation resistance behavior. Meanwhile, customers' attitude toward innovation product should not be overrated either (Talke & Heidenreich, 2014; Gourville, 2006; Hess, 2009). This study can help managers to understand different types of innovation resistance behavior and its two classifications of CIR, PIR and also AIR, influence mechanism, and how to commercialize the innovative products based on the suggestions. In other words, Managers can better understand that it is difficult to overcome the process of commercialization of innovative products, due to the factors of PIR and customers themselves, and relative to AIR. When the level of innovation is higher, the managers need to be more cautious about the fact that customers may refuse to accept the proposed innovation at the beginning, so the marketing plan needs to be aligned with the targeted customer groups. Dividing innovation resistance behavior into PIR and AIR, and further dividing PIR into CPIR and SPIR, are the key variables in new product development and evaluation. When customers face the changes and external stimulation caused by new products, managers can adjust or reduce the passive or active resistance of customers and the risk of innovation failure by adjusting market strategies.

Moreover, in the early stage of new product development, managers need to focus on reducing the degree and depth of changes that the innovative product may bring to the customer and concentrate on the customers' satisfaction with the original product. Hence, by reducing the initial PIR of the customer, the possibility of getting connected to the customer to have the chance of evaluating the innovative product would increase. When the customer is in the product evaluation stage, managers need to focus on the product itself, minimize product barriers, and use marketing methods to communicate the characteristics of new products; Therefore, the managers will be capable of preventing AIR, and increase the success rate of innovation commercialization.

Finally, the managers should distinguish customers who have resistance by grouping the customers' PS on innovation products. Management or marketing strategies

should be tailored to different categories of customers; or to different product commercialization stages. In general, facing the customers with higher passive innovation resistance, managers should pay more attention to marketing strategies to reduce customers' resistance. Marketing strategies for innovative products should focus on customers with low PIR and low PS. When customers have moderate levels of PIR and PS, marketing strategies may not be formulated separately to enhance the customers' IAI. However, when the customer has high level of PIR and PS, managers should focus on improving the willingness of customers in the high-perceived stimulation group.

6.3. Limitations and future research

This present empirical study analyzed customer's passive and active innovation resistance behavior using surveys to gather and analyze data about resistance behavior, innovation adoption intention, and perceived stimulation. Although the findings provide initial insights to overcome PIR, this study has several limitations that must be taken into consideration.

First, due to the age limitation of the respondents, the results may be limited to the generality of the wider population. Second, since customer resistance or acceptance of innovative products changes over time. This research has been limited to China while further research in different geographical and cultural environment can be conducted and the results can be compared as well.

Future research can be further developed in the following two aspects. First, future research can use longitudinal research to conduct more in-depth and detailed research on passive and active barrier behaviors across different time periods. Second, further study is appreciated to predict the resistance based on different factors.

Disclosure statement

No potential conflict of interest was reported by the authors.

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ORCID

Yuan Wang http://orcid.org/0000-0003-1439-5288

Data availability statement

The data used to support the findings of this study are available from the corresponding author upon request.

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Appendix 1. Questionnaire

Part 1: Basic information

1. Your gender:
   A. male
   B. female
2. Your age:
   A. less than 18 years old
   B. 19–25 years old
   C. 26–35 years old
   D. 35 years old and above
3. What is your education level?
   A. high school or junior college
   B. undergraduate
   C. master degree and above
4. Your occupation:
   A. students
   B. government workers
   C. company employees
   D. freelancers
   E. other:

Part 2: Survey of related variables

Please hook up the following form according to the actual situation.								
Variables	Items	1	2	3	4	5	6	7
Cognitive passive resistance (Heidenreich & Kraemer, 2015)	Q5: I generally prefer to use technological products I am familiar with rather than to use a new technological product.	strongly disagree	disagree	relatively disagree	neither agree, nor disagree	relatively agree	agree	strongly agree
	Q6: I find it exciting to try out new technological products.	strongly disagree	disagree	relatively disagree	neither agree, nor disagree	relatively agree	agree	strongly agree
	Q7: I often feel a bit uncomfortable to try out new technological products, even though it may be beneficial to me.	strongly disagree	disagree	relatively disagree	neither agree, nor disagree	relatively agree	agree	strongly agree
	Q8: Once I've started using certain technological products, I don't prefer to switch	strongly disagree	disagree	relatively disagree	neither agree, nor disagree	relatively agree	agree	strongly agree
Situational passive resistance (Heidenreich & Kraemer, 2015)	Q9: In general, my personal need for innovation in the field of technological products has been by far not covered in the past.	strongly disagree	disagree	relatively disagree	neither agree, nor disagree	relatively agree	agree	strongly agree
	Q10: In the past, I was very satisfied with available technological products.	strongly disagree	disagree	relatively disagree	neither agree, nor disagree	relatively agree	agree	strongly agree
Active innovation resistance (Talke & Heidenreich, 2014)	Q11: I normally have a judgement of innovative product.	strongly disagree	disagree	relatively disagree	neither agree, nor disagree	relatively agree	agree	strongly agree
	Q12: What is your overall judgment of this product?	very bad	bad	relatively bad	neither bad, nor good	relatively good	good	very good
	Q13: What is your overall judgment of this product?	very unfavorable	unfavorable	relatively unfavorable	neither unfavorable, nor favorable	relatively favorable	favorable	very favorable

(*continued*)

Part 2: Continued.

Please hook up the following form according to the actual situation.

Variables	Items	1	2	3	4	5	6	7
Innovation Adoption Intention (Kulviwat et al., 2007)	Q14: I would like to purchase this product	very unlikely	unlikely	relatively unlikely	neither unlikely, nor likely	relatively likely	likely	very likely
	Q15: How likely would you purchase this product?	Strongly imaginable	imaginable	relatively imaginable	neither imaginable, nor unimaginable	relatively unimaginable	unimaginable	strongly unimaginable
	Q16: How likely would you purchase this product?	very impossible	impossible	relatively impossible	neither impossible, nor possible	relatively possible	possible	Very possible
Perceived stimulation (Heidenreich & Kraemer, 2015)	Q17: In the past, I was not occupied doing same things too often.	strongly disagree	disagree	relatively disagree	neither agree, nor disagree	relatively agree	agree	strongly agree
	Q18: In the past, I have not experienced far too seldom new things and changes.	strongly disagree	disagree	relatively disagree	neither agree, nor disagree	relatively agree	agree	strongly agree
	Q19: In the past, I was not making sufficient new experiences.	strongly disagree	disagree	relatively disagree	neither agree, nor disagree	relatively agree	agree	strongly agree
	Q20: In the past, I did not have stable accommodation, work, or income.	strongly disagree	disagree	relatively disagree	neither agree, nor disagree	relatively agree	agree	strongly agree