

## Research Article

# Application of the Expanded Theory of Planned Behavior in Intercity Travel Behavior

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Congestion in intercity corridors of metropolitan area has been increasing steadily. To alleviate congestion, many major investment projects, such as the high speed railway projects, were proposed by agency. To evaluate the adequacy and efficiency of these projects, the intercity travel behavior should be analyzed in metropolitan area. The paper constructed a Multiple Indicators and Multiple Causes (MIMIC) model according to an expanded theory of planned behavior (TPB) to study the travel behavior of choosing from the choice set of the traditional train, the high speed railway and the coach by demographic and psychological factors. Through empirical data collection and analysis, we found that demographic factors of travelers indeed positively engender the latent variables in MIMIC, and descriptive norm and habit had direct or indirect significant effect on travel behavior and intention. On the basis of the effect of psychological constructors of the expanded TPB on the intercity travel behavior and differentiation of traveler's demographic characteristics, the agency can make reasonable policies and proper information for the intercity transportation. The results will support the basic theory of optimizing the transportation system in metropolitan area. Implications for researchers and suggestions for future research are also addressed in this study.

## 1. Introduction

Congestion in intercity corridors of metropolitan area has been increasing steadily, which has raised serious concerns for its adverse impacts on regional economic development, national productivity and competitiveness, and environmental quality [1]. To alleviate congestion, many major investment projects, such as the Electric Multiple Unit (EMU) and the high speed railway (HSR) projects, were proposed by agency. To evaluate the adequacy and efficiency of these projects, public agencies need analyses of the intercity travel demand in metropolitan area due to the limited allocated financial resources. Meanwhile, intercity traveler carriers welcome reliable forecasts of intercity demand so that they can be more responsive to their patronage and to remain competitive. Therefore, intercity travel behavior research in metropolitan area is needed to estimate and evaluate expected policy impacts. Transportation agencies often focus on influencing travel behavior by changing the physical system. The possibility of actively influencing traveler preferences through

the psychological factors opens a whole new set of options that have been largely overlooked in the past [2]. Combining both perspectives enables agencies to position transportation policy within the broad context of sustainable metropolitan management.

This study compares psychological predictors of the intention and behavior to use three intercity travel modes in metropolitan area of Yangtze River Delta in China: the traditional train, the HSR, and the coach, and examines the effect that habit operates as moderator of intention-behavior relationship. In previous studies, various theoretical perspectives have been employed to understand factors important for choosing travel modes. The most widely applied model of cognitive determinants of choosing travel modes is the theory of planned behavior (TPB), which suggests that behavior is most closely determined by an intention to act [3]. Intentions are based on a combination of attitude toward the behavior, subjective norm (SN), and perceived behavioral control (PBC). Intention has a direct effect on behavior, and, under some circumstances, the same applies to perceived behavioral

control. The theory recognizes the importance of background factors, such as personality, emotions, education, age, gender, and past experience; although if they affect behavior, it would be via beliefs.

The TPBs sufficiency assumption is invalid; in other words, intention may be determined not only by attitude, subjective norm, and perceived behavioral control but also by more additional variables [4]. In this study, the original TPBs predictive validity was tested in the behavior of using the three intercity travel modes in Yangtze River Delta area. Furthermore, descriptive norm and habit as additional predictors of intention and behavior in TPB were examined, because the two variables have been provided enough evidences to satisfy Ajzen's criteria of adding predictors in other behavior domains [4–7]. The paper is organized as follows. The next section discusses the two additional variables expanding the TPB. Section 3 proposed hypothesis with respect to relationship among variables of the expanded TPB. Section 4 describes the data collection process and data used in the research. Section 5 presents the MIMIC model and the estimation results are given. The paper ends with a customary section of conclusions.

## 2. Descriptive Norm and Habit

According to Cialdini et al., a distinction should be made between subjective norms and descriptive norms (DN) [8]. The former refers to beliefs about what are and what are not approved ways of conduct, what one ought to do, while descriptive norms are what are typical and normal behaviors. With regard to mode choice, studies have found that descriptive norm is a significant predictor of using the car and the bus whereas subjective norm significantly predicted the intention to use these modes [9, 10], although Thøgersen found that only subjective norm was a significant predictor of using public transport [11]. Several explanations have been given as to why descriptive norms are sometimes more important than subjective norms. One methodological explanation is that since descriptive norms often display lower means and larger variability compared to subjective norms, the risk of reduced variability is greater for subjective norms [12]. Other explanations are that the distinction is real and not only a methodological artifact.

The habit approach is consistent with the TPB in that it suggests that, faced with a new or unfamiliar choice situation, a traveler will deliberate and form an intention to choose the most attractive goal-directed option, which will inform subsequent behavior [13]. The more frequently a behavior has been performed in a stable context, the more it is said to habituate and come under the direct control of external stimulus cues at the expense of intentions [14]. Habits are most clearly revealed where habitual and intentional tendencies diverge, because in such situations behavioral outcomes will correspond with habits but not intentions. The conflicted relationship between habit and intention in the extant transport literature potentially overlooks that, in the absence of modifications of the decisional environment, habits are

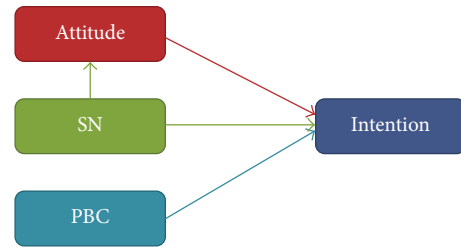


FIGURE 1: Impact of subjective norm on attitude.

likely to correspond with intentions, having developed from frequently enacted intentions.

## 3. Hypothesis

Even though several studies have examined psychological predictors of travel mode choice, the focus has often been on examining a single travel mode making a comparison between different travel modes unfeasible. Moreover, in the context of mode choice, few studies have treated subjective and descriptive norms as two separate constructs and examined the role of habit in intention-behavior relationship in the behavior domain of choosing intercity travel modes. Through testing the following hypotheses, we examine psychological predictors of the expanded TPB and relationships among them.

*3.1. The Relationship of Subjective Norms towards Attitudes.* Wu and Lin revealed that subjective norms can directly influence attitude [15]. Both have a significant relationship with each other. As the positive support received by individuals from other persons or organizations important to them becomes greater, their attitude also becomes more positive [16]. When the subjective norms of respondents are more positive, their attitudes also become more positive. Research of Yu into the behavior patterns of downloading MP3 shows that the subjective norm of users on downloading MP3 positively influences their attitude. In view of these, we present the first hypothesis as follows: there exists a significant relationship between subjective norm and participation attitude in intercity travel mode choice behavior, as shown in Figure 1.

*3.2. The Role of Descriptive Norms in Expanded TPB.* Ravis used meta-analysis to find a medium to strong average correlation between descriptive norms and intention and, more importantly, showed a significant improvement in the predictive validity of the TPB when descriptive norm was included as an additional predictor [7]. Therefore the second hypothesis is as follows: the descriptive norms have positive significant impact on intention to choose intercity travel mode. Accounting for the descriptive norms and subjective norms being parts of social norms in psychological theory, the descriptive norms' significant influences on attitudes towards intercity travel modes became the third hypothesis of the paper. As shown in Figure 2.

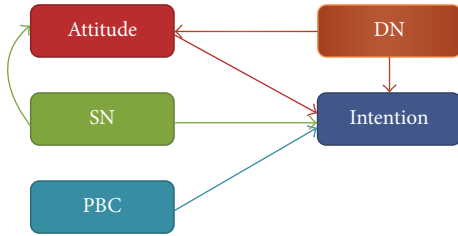


FIGURE 2: Impact of descriptive norm in TPB.

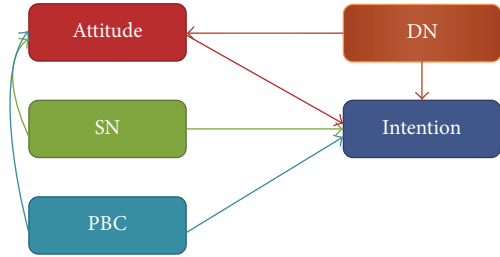


FIGURE 3: Impact of PBC on attitude.

3.3. *The Relationship of Perceived Behavioral Control towards Attitudes.* Ajzen’s original TPB did not include the relationship that PBC has influence on attitude. However, attitude can be an intervening variable of the subjective norm when influencing behavioral intention. Thus, in the causal model constructed by Yu specifying the behavioral tendencies of Taiwanese tourists in Kinmen [16], attitude was made an intervening variable. Results of this study show attitude as an intervening variable in the effect of perceived behavioral control towards behavior intention. Tsai also proved the impact of perceived behavioral control on attitude by analysis of canonical correlation [17]. From this, it can be said that perceived behavioral control has a positive effect on attitude. Taking these into account, the paper gives its forth hypothesis as follows: there exists a significant relationship between perceived control behavior and participation attitude. As shown in Figure 3.

3.4. *The Role of Habit in the Expand TPB.* Habit has a great impact on individuals’ choice behavior. Several empirical studies have found that habit included in TPB showed significant relationships with all the other original variables [6, 18, 19]. The fifth hypothesis proposed is that habit has significant impact on attitude, subjective norms, descriptive norms, perceived behavior control, and intention to choose intercity travel modes. According to Gardner’s research that habit will moderate the effect of intention on behavior [9]: where habit is weak, intention will predict behavior, but where habit is strong, intention will have a weak effect on behavior; Figure 4 illustrates the sixth hypothesis: habit has moderate effect between intention and behavior on intercity travel mode choice behavior.

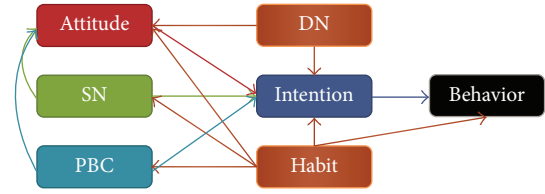


FIGURE 4: Impact of habit in TPB.

TABLE 1: Socioeconomic status variables.

Categories	Value	Frequency (%)	Variables
Gender	Male	58.41	Male
	Female	41.59	
Age	16~25	27.11	Young
	25~54	54.61	
	55+	18.28	Old
Employment	Working	58.34	Working
	Student	26.85	Student
	Other	14.81	
Income	Unites: RMB	—	Income
Education	(1) Primary; (2) junior; (3) senior; (4) technical secondary school; (5) college; (6) undergraduate; (7) master; (8) Ph.D.	—	Edu

#### 4. Data

The study was conducted in Zhenjiang in the east of China. Zhenjiang is one of the most important transport hubs in Yangtze River Delta area. In 2012, a survey was carried out by face-to-face interviews with the travelers in railway station and long distance bus station. A questionnaire was sent to a randomly selected sample of 3695 passengers in the station and the response rate was 93%. The number of completed questionnaires was 3436, of which 3248 individuals are included as the study sample after removing those who travel outside Yangtze River Delta area. Demographic characteristics concerning gender, age, education, occupation, income, and access to various travel modes were assessed in the questionnaire at first, as shown in Table 1.

More men than women answered the questionnaire, the mean age was 26, and more than 56% had university or college education. In the questionnaire, the participants described the trip’s purpose, how long it was, and what travel mode was often used. Forty-two percent made a work trip, 21% a trip to visit relatives and friends, 5% to study, 3% to the doctor, 13% to leisure activities, 3% to service and shopping activities, 8% to go home, and 5% had other trip purposes. The most command travel mode was the HSR, chosen by 36.98% of the participants, while 32.11% used the coach, and 30.91% used the traditional train.

Following the description of the typical set of socioeconomic variables, the participants evaluated the use of the traditional train, HSR, and coach. The survey contains

29 psychometric indicators with respect to relevant TPB variables.

Attitudes towards the three intercity travel modes were accessed by a combination of behavioral beliefs and outcome evaluation. Initially, the respondents were solicited to rate the consequences of using the three intercity travel modes, 7 different behavioral beliefs on a five-point scale (1 = strongly disagree, 5 = strongly agree). The behavioral beliefs included fitness level, feeling of free and relax, expenditure for the ticket, risk of being in a traffic accident, quickly, convenient for transfer and buying the ticket. Subsequently, the importance of each of the consequences was evaluated on a five-point scale (1 = not at all important to me, 5 = very important to me) to give the outcome evaluations. Before combining the behavioral beliefs and outcome evaluations into measures of attitudes toward the three modes, positive consequences were recoded to make sure those higher values on all behavioral beliefs indicated a more positive belief. Each behavioral belief was multiplied by the respective outcome evaluations. The products were summarized and divided by the number of items resulting in a scale from 0.5 to 12.5 where a higher value signified a more positive attitude. Principle components analysis identified just one component accounting for 72% of the variance (eigenvalue of 2.75). Cronbach's alpha ( $\alpha$ ) was 0.75, indicating strong inner consistency.

The two types of social norms were measured by two indicators for both subjective norms and descriptive norms. For subjective norms the items "My best friends consider using the traditional train/using the HSR/using the coach to be . . ." and "My family/relatives consider using the traditional train/using the HSR/using the coach to be . . ." were assessed on a five-point scale ranging from completely unacceptable to completely acceptable. The items were recoded so that a high value indicated a stronger subjective norm.

Principle components analysis identified a single coherent component, accounting for 76% of the variance (eigenvalue of 1.52). Cronbach's alpha was lower than that for intention ( $\alpha = 0.68$ ) but still indicates reasonable internal consistency. Nunnally suggested that  $\alpha = 0.70$  represents strong inner consistency [20], but Cortina urges researchers to consider the number of items used—a moderate alpha with small number of items may well represent better internal consistency than a larger alpha with a larger number of items [21, 22]. Ajzen suggests that a requirement for high internal consistency for belief based measures is not necessary, given that it is the aggregate of differing beliefs that forms an attitude [14]. The principle components analysis showing that the aggregated variable forms a unitary component is an important justification for aggregation.

Descriptive norms were measured by the items "My closest friends will themselves use the traditional train/use the HSR/use the coach" and "My family/relative will themselves use the traditional train/use the HSR/use the coach" and rated a five-point scale from strongly disagree to strongly agree. After recoding the items, a high value indicated a strong descriptive norm. Again, principle components analysis revealed one component accounting for 72% of the variance (eigenvalue = 1.44). Cronbach's alpha indicated

moderate internal consistency, again in line with expectations for such a belief based aggregate,  $\alpha = 0.61$ .

Direct measures of perceived behavioral control were used, including three items for each mode: (i) "It's mainly up to me whether I choose the intercity travel mode or not"; (ii) "To use the travel mode on my ordinary trip is difficult"; (iii) "It will make me feel trouble to choose the travel mode". All the three items were evaluated on five-point scale ranging from strongly disagree to strongly agree. Subsequently, the items were recoded so that a higher value indicated a higher perceived behavioral control. These items formed one component in a principle components analysis accounting for 65% of the variance (eigenvalue = 1.95). Cronbach's alpha ( $\alpha$ ) was 0.73, indicating strong inner consistency.

Behavior intention was assessed separately for different travel mode by a mean of three items: (i) "It is likely that I will choose the intercity travel mode in the future"; (ii) "I would expect to use the intercity travel mode in the next time"; (iii) "Within the next coming one month I have the intention to use the travel mode". All items were evaluated on a five-point scale (1 = completely impossible, 5 = completely possible). After recoding the items, a higher value signified a stronger intention to use that particular intercity travel mode. Principle components analysis identified just one component accounting for 65% of the variance (eigenvalue of 1.94). Cronbach's alpha ( $\alpha$ ) was 0.72, indicating strong inner consistency.

In addition to assessing the predictors in the TPB, the questionnaire also inquired into the respondents' behavior by asking them to indicate how often (1 = always, 5 = never) and frequently (1 = very low, 5 = very high) they had used each intercity travel mode. Principle components analysis identified just one component accounting for 77% of the variance (eigenvalue of 1.53). Cronbach's alpha ( $\alpha$ ) was 0.69, indicating reasonably inner consistency.

Habit was measured using a ten-item version of Verplanken and Orbell's Self-Report Habit Index (SRHI) [23]. Each item related to "Choosing the travel mode on the intercity trip" (e.g., "Choosing the traditional train on the inter-city trip is something I do automatically," "Choosing the traditional train on the inter-city trip is something I do without having to consciously remember") and was measured on a five-point scale (1 = strongly disagree, 5 = strongly agree;  $\alpha = 0.80$ ).

The indexes of reliability and validity for the predictors of the TPB were listed in Table 2.

## 5. Model and Estimation

In order to examine the interrelationships among the latent variables of TPB and between them and the socioeconomic status variables, a Multiple Indicators and Multiple Causes (MIMIC) model is estimated. In terms of the multivariate regression of the indicators on the causes, the model implies restrictions of two types: (i) the regression coefficient matrix has ranked one; (ii) the residual variance-covariance matrix satisfies a factor analysis model with one common factor.



TABLE 2: Measurements of reliability and validity.

Variables	Percentage of one component accounting for the variance	Eigenvalue	Cronbach's alpha ( $\alpha$ )
Attitude	72%	2.75	0.75
SN	76%	1.52	0.68
DN	72%	1.44	0.61
PBC	65%	1.95	0.73
Intention	65%	1.94	0.72
Behavior	77%	1.53	0.69
Habit	71%	2.73	0.80

The MIMIC model is a special form of structural equation modeling (SEM) in fact. The specification of the model is as follows:

$$\boldsymbol{\eta} = \boldsymbol{\Gamma}\mathbf{x} + \boldsymbol{\zeta} \quad (1)$$

$$\mathbf{y} = \boldsymbol{\Lambda}\boldsymbol{\eta} + \boldsymbol{\varepsilon}, \quad (2)$$

where (1) is structural equation and (2) is measurement equation. The latent variable vector  $\boldsymbol{\eta}$  is linearly determined, subject to disturbances  $\boldsymbol{\zeta}$ , by vector of observable exogenous causes  $\mathbf{x}$ . The latent variable and disturbance  $\boldsymbol{\varepsilon}$  determine the vector of observable endogenous indicators  $\mathbf{y}$  linearly.  $\boldsymbol{\Gamma}$  and  $\boldsymbol{\Lambda}$  are matrices of unknown parameters to be estimated. The operational implications of the model appear when we solve for the reduced-form relation connecting the observables:

$$\mathbf{y} = \boldsymbol{\Lambda}(\boldsymbol{\Gamma}\mathbf{x} + \boldsymbol{\zeta}) + \boldsymbol{\varepsilon} = \boldsymbol{\Pi}\mathbf{x} + \mathbf{v}, \quad (3)$$

where the reduced-form coefficient matrix is

$$\boldsymbol{\Pi} = \boldsymbol{\Lambda}\boldsymbol{\Gamma} \quad (4)$$

and the reduced-form disturbance vector is

$$\mathbf{v} = \boldsymbol{\Lambda}\boldsymbol{\zeta} + \boldsymbol{\varepsilon}. \quad (5)$$

Estimation of a structural equation latent variable model minimizes the difference between the sample covariance matrix,  $\mathbf{S}$ , and the covariance matrix  $\boldsymbol{\Sigma}$ . The elements of  $\boldsymbol{\Sigma}$  are hypothesized to be a function of the parameter vector  $\boldsymbol{\theta}$  so that  $\boldsymbol{\Sigma} = \boldsymbol{\Sigma}(\boldsymbol{\theta})$ . The parameters are estimated so that the discrepancy between  $\mathbf{S}$  and the implied covariance matrix  $\boldsymbol{\Sigma}(\hat{\boldsymbol{\theta}})$  is minimal. The discrepancy function,  $F = F(\mathbf{S}, \boldsymbol{\Sigma}(\boldsymbol{\theta}))$ , measures the discrepancy between  $\mathbf{S}$  and  $\boldsymbol{\Sigma}(\boldsymbol{\theta})$  evaluated at  $\hat{\boldsymbol{\theta}}$ .  $F_{\min}$  is the minimum value of the discrepancy function and equals zero only if  $\mathbf{S} = \boldsymbol{\Sigma}(\hat{\boldsymbol{\theta}})$ . An indication of model fit is, therefore, given by the closeness of the  $F_{\min}$  to zero, supposing that the disturbances are all mutually independent. For convenience, the expectation of all variables is zero:

$$E(\boldsymbol{\zeta}\boldsymbol{\zeta}') = 0, \quad E(\boldsymbol{\zeta}^2) = \sigma^2, \quad E(\boldsymbol{\varepsilon}\boldsymbol{\varepsilon}') = \Theta, \quad (6)$$

where  $\Theta$  is the diagonal matrix with  $\theta$ , the vector of standard deviations of the  $\boldsymbol{\varepsilon}$ 's, displayed on its diagonal. The covariance matrix can be computed by

$$\sum(\hat{\boldsymbol{\theta}}) = E(\mathbf{v}\mathbf{v}') = \sigma^2\boldsymbol{\Lambda}\boldsymbol{\Lambda}' + \Theta. \quad (7)$$

TABLE 3: Goodness-of-fit statistics for MIMIC model.

	Traditional train	High speed railway	Coach
$\chi^2$	772.865	787.114	834.648
df	235	235	235
$\chi^2/df$	3.289	3.349	3.552
RMSEA	0.048	0.044	0.049
CFI	0.890	0.903	0.880
TLI	0.858	0.875	0.845
SRMR	0.043	0.046	0.044

The multiple indicator part of the MIMIC model is a confirmatory factor analytical model specified. The multiple cause part of the model is given by

$$\begin{aligned} \eta_{li} = & \gamma_{11}\text{male}_i + \gamma_{12}\text{young}_i + \gamma_{13}\text{old}_i \\ & + \gamma_{14}\text{working}_i + \gamma_{15}\text{student}_i + \gamma_{16}\text{income}_i \\ & + \gamma_{17}\text{edu}_i + \zeta_i \end{aligned} \quad (8)$$

$l = \text{Attitude, SN, DN, PBC, Intention, Habit.}$

Figure 5 illustrates the structure of the MIMIC model. Structural equation and measurement equation are alleviated to SE and ME in Figure 5.

As illustrated in Figure 5, the MIMIC model includes demographic characteristics of travelers, the latent variables that construct the expanded TPB, and endogenous observed indicators. Specifically this model hypothesizes that the socioeconomic variables influence all latent variables of TPB, which are also explained by indicators from questionnaires for respondents. Figure 6 specifies the hypothesized relationships among the latent factors, where ellipses represent unobservable variables and rectangles observable indicators. Dashed arrows represent measurement equations while solid arrows represent the structural equations. The latent variable model describes the relationships between the latent variables and their indicators and causes.

The MIMIC model simultaneously estimates the measurement equations relating each factor to its indicators, and the structural equations specify the relationships among latent factors and between them and socioeconomic status variables. The estimation of the MIMIC model was conducted in STATA 12. Table 3 summarizes the overall goodness-of-fit statistics.

Most interpreters of the root mean squared error of approximation (RMSEA) test label the fit close if the lower bound of the 90% CI is below 0.05 and label the fit poor if the upper bound is above 0.10. CFI and TLI are two indices such that a value close to 1 indicates a good fit. CFI stands for comparative fit index. TLI stands for Tucker-Lewis index and is also known as the nonnormed fit index. A perfect fit corresponds to a standardized root mean squared residual (SRMR) of 0. A good fit is a small value, considered by some to be limited to 0.08. Though CFI is 0.880 slightly below 0.9, RMSEA and SRMR are below 0.05 and in particular the full 90% confidence interval 0.027~0.030 falls below 0.05 so the overall data fit is acceptable; that is, the model cannot reject

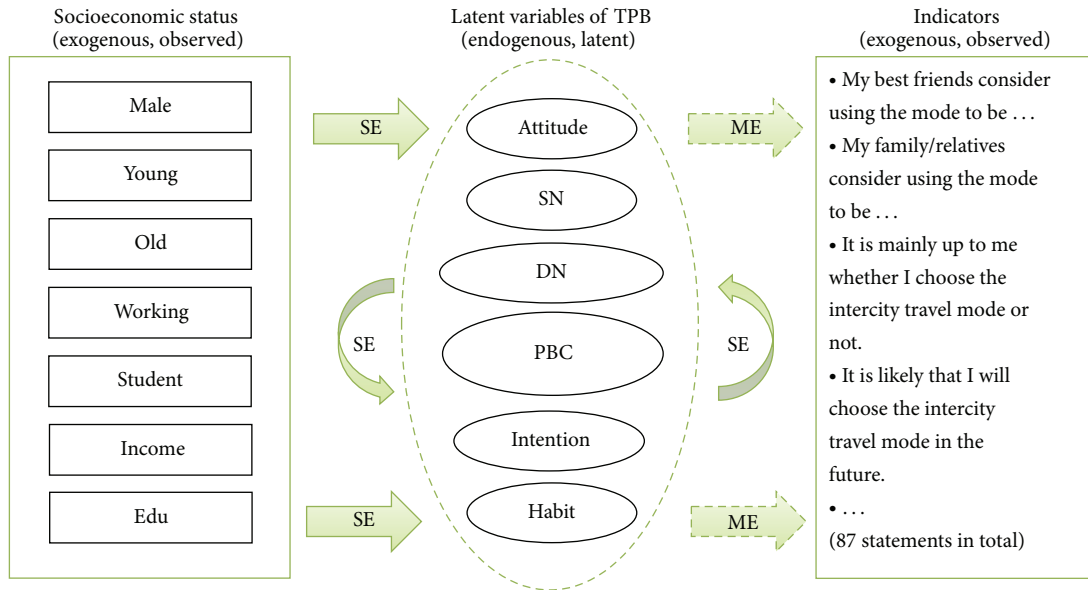


FIGURE 5: Multiple Indicators and Multiple Causes (MIMIC) model.

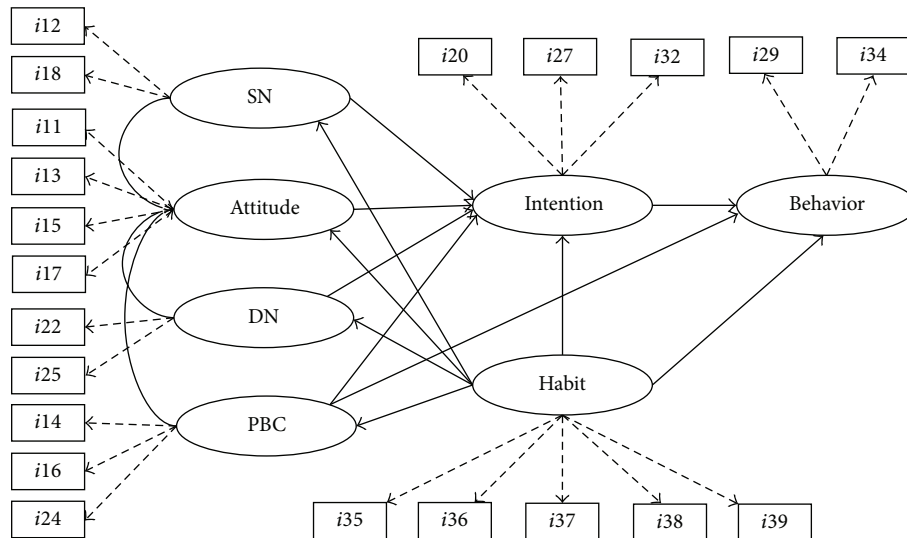


FIGURE 6: Detailed path analysis diagram.

the hypothesis of the relationships among the latent factors and between them and demographic variables specified in Figures 5 and 6.

## 6. Results

Based on the results from the MIMIC model, we can examine the relationships between the demographic characteristics variables and the latent variables in TPB and within them.

### 6.1. Relationships between the Demographic Variables and the Latent Factors.

The relationships between the demographic

variables and the latent factors are summarized as the regression coefficients shown in Table 4. The number in parenthesis is  $t$  statistics.

As shown in Table 4, young and education have significant impact on some of the latent variables in MIMIC models using all the three intercity travel modes. However, career and income play a significant role in the model using coach.

In the MIMIC model of the traditional train, male and old are significantly associated with liking to habit. Education has a significant negative impact on habit. People with less years of education are more accustomed to use traditional train as intercity travel mode. Being working or income is not associated with the latent variables of TPB. People of male and being students have significant influence on PBC, which

TABLE 4: Impact of demographical variables on the latent factors.

	Male	Young	Old	Working	Student	Income	Edu
Traditional train							
SN	0.022 (0.56)	-0.074 (-1.41)	-0.040 (-0.73)	-0.060 (-1.11)	-0.010 (-0.13)	-0.019 (-0.97)	0.018 (1.36)
DN	0.005 (0.15)	<b>-0.141** (-3.26)</b>	0.018 (0.40)	-0.007 (-0.15)	<b>0.150* (2.25)</b>	0.027 (1.64)	0.014 (1.32)
Attitude	-0.017 (-0.48)	-0.042 (-0.72)	-0.019 (-0.41)	0.078 (1.67)	0.066 (0.86)	-0.009 (-0.53)	-0.005 (-0.39)
PBC	<b>0.094* (2.45)</b>	-0.063 (-1.25)	-0.048 (-0.93)	0.041 (0.79)	<b>0.164* (2.11)</b>	0.017 (0.89)	0.024 (1.84)
Habit	<b>0.103* (2.53)</b>	0.031 (0.57)	<b>0.164** (2.96)</b>	-0.078 (-1.43)	-1.30 (-1.60)	0.013 (0.65)	<b>-0.056** (-4.12)</b>
High speed railway							
SN	0.023 (1.03)	-0.024 (-0.66)	0.024 (0.73)	0.009 (0.28)	0.015 (0.32)	<b>-0.022* (-2.16)</b>	<b>0.024** (2.67)</b>
DN	-0.027 (-1.01)	-0.011 (-0.33)	0.008 (0.21)	0.032 (0.79)	-0.034 (-0.64)	-0.022 (-1.79)	0.014 (1.36)
Attitude	-0.20 (-1.28)	<b>-0.094** (-2.91)</b>	<b>0.068* (2.00)</b>	-0.06 (-0.26)	<b>0.068* (2.04)</b>	-0.08 (-0.99)	0.001 (0.17)
PBC	0.005 (0.16)	0.033 (0.87)	-0.025 (-0.57)	0.086 (1.89)	<b>0.142* (2.34)</b>	0.018 (1.29)	0.018 (1.63)
Habit	<b>-0.082* (-2.39)</b>	-0.034 (-0.78)	-0.032 (-0.62)	-0.042 (-0.80)	0.039 (0.56)	<b>0.040* (2.53)</b>	<b>0.036** (2.81)</b>
Coach							
SN	-0.039 (-1.10)	0.037 (0.77)	-0.008 (-0.15)	-0.089 (-1.57)	-0.035 (-0.50)	0.001 (0.06)	0.022 (1.69)
DN	0.016 (0.48)	<b>-0.107* (-2.30)</b>	0.033 (0.63)	-0.038 (-0.69)	-0.051 (-0.73)	-0.011 (-0.63)	0.007 (0.55)
Attitude	0.012 (0.32)	-0.048 (-0.89)	-1.04 (-1.70)	0.060 (0.94)	-0.006 (-0.08)	0.002 (0.10)	<b>-0.033* (-2.26)</b>
PBC	-0.002 (-0.05)	0.025 (0.50)	-0.022 (-0.38)	<b>-0.147* (-2.47)</b>	-0.087 (-1.16)	0.015 (0.79)	0.003 (0.27)
Habit	<b>0.099* (2.36)</b>	-0.028 (-0.49)	0.023 (0.36)	0.017 (0.26)	-0.150 (-1.75)	<b>-0.053* (-2.48)</b>	-0.004 (-0.28)

\*  $P < 0.05$ ; \*\*  $P < 0.01$ .

implies that man and students may have more patience than female and workers for the bad schedules of traditional train. Being young and students are significantly associated with descriptive norms, while students think that their family or relatives should prefer the traditional train.

In the MIMIC model of the high speed railway, gender, income, and education of all the travelers' demographical characteristics have significant influence on habit. This result seems logical considering the fact that female to a great extent than men are accustomed to use high speed railway as intercity travel mode. Being student has positive impact on perceived behavioral control of high speed railway, which may imply that students are open to new intercity travel mode. The pairwise correlation coefficients between income and being young display that the two explanted exogenous observed variables have statistical significant correlation at the individual 1% level. Although income has not direct significant influence on attitude of high speed railway, we can see from the relationship of being young and attitude that higher incomes are coupled with stronger preferences for habit, potentially reflecting the fact that the opportunity cost of time losses is higher at higher incomes.

In the MIMIC model of coach, respondents with male and lower incomes are used to travel with coach as intercity mode. Considering the indicators used to construct perceived behavioral control of coach shows that respondents with having work do not think that they can be fitted with the schedule of coach. In addition, negative significant impact of education on attitude of coach shows that respondents with lower education have stronger preferences for coach. Finally, considering the indicators used to construct descriptive norms it seems natural that respondents with being young

would expand their negative feelings with relation to coach to the important person for them.

Overall, the demographical characteristics of intercity travelers have different impact on the endogenous latent variables of TPB. Gender has significant influence on habit of all the three intercity travel modes, which shows that male is used to using traditional train and coach and female has stronger preferences for high speed railway. The negative significant impact of being young on descriptive norms of traditional train and coach shows that the younger is not satisfied with the perceptions of the two intercity travel modes, while the older respondents implicate that they are accustomed to using traditional train. Being student reflects the strong ability to adapt perceived behavior control of traditional train and high speed railway, while the workers express their to some extent distrust with respect to the ability of on time and convenience of coach. The respondents with higher incomes are habituated to high speed railway; the corresponding fact is that respondents with lower incomes are used to coach. The respondents' level of education shows negative impact on the latent factors of traditional train and coach; however, it has positive influence on habit and subjective norms of high speed railway, which signify that the respondents with high level of education ask for higher requirement of travel environment, timeline, and convenience.

*6.2. Relationships among the Latent Factors.* The significant interrelationships among the latent factors are summarized in Figures 7, 8, and 9, which shows the standardized coefficients ( $z$ -statistics in parenthesis) between latent factors in the path diagram. \* indicates  $P < 0.05$ ; \*\* indicate  $P < 0.01$ .

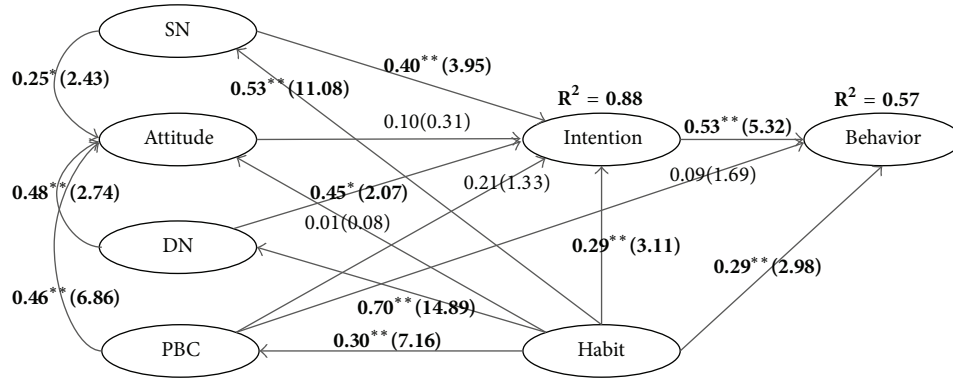


FIGURE 7: Standardized coefficients between the latent factors using traditional train.

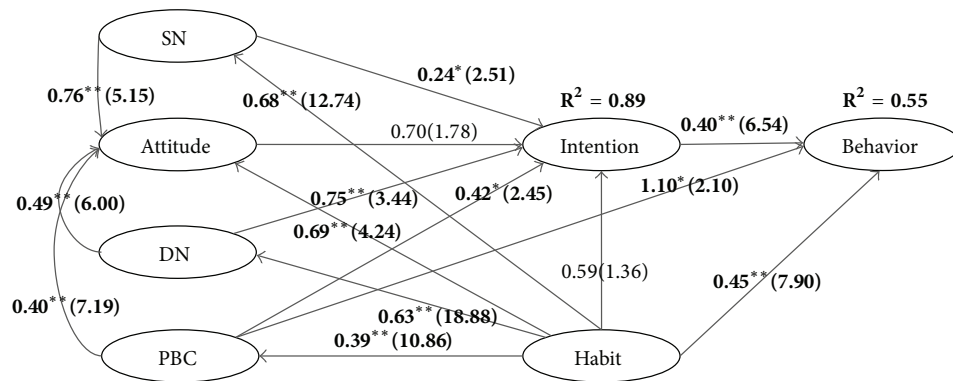


FIGURE 8: Standardized coefficients between the latent factors using HSR.

We can see from the three figures above that the MIMIC models with the expanded theory of planned behavior account for 77%~89% of the variance of intention to use the three intercity travel modes, which is consistent with Bamberg's previous finds [24]. In Bamberg's research the models with introduction of habit account for 77% and 80% of the variances in intention to choose the bus and car. The amounts of expanded variances in behavior of choice between intercity modes are 55%~61%, which of Bamberg are 51% and 66%. Although there are distinctions between the two researches, such as travel modes and latent factors, the amounts of expanded variances in behavior and intention to choose between modes to some extent imply that the expanded theory of planned behavior can be fitted with the intercity mode choice.

In the three MIMIC models, subjective norms, descriptive norms, and perceived behavioral control have significant impact on attitude at the individual 0.1% level, which support the first, third, and forth hypothesis. The positive significant impact of habit on attitude in the mode of using high speed railway supports the fifth hypothesis in part. Descriptive norms have positive significant influence on intention to using the three intercity modes, which supports the second hypothesis. Except for the model of traditional train, descriptive norms have direct and indirect influence on choice behavior, as shown in Table 5. The number in parenthesis is *t* statistics. Hierarchical regression analyses are performed

TABLE 5: Direct and indirect impact of DN on intention and behavior.

	Traditional train	High speed railway	Coach
Direct impact on intention	0.45* (2.07)	0.75** (3.44)	0.28** (3.49)
Indirect impact on behavior	0.44 (1.86)	0.33* (1.97)	0.19** (3.87)

\*  $P < 0.05$ ; \*\*  $P < 0.01$ .

and find that the explained variance increases significantly 4%~8% in all the models after the inclusion of descriptive norms, which verify that the influences of social norms on travelers are mutual feedback.

The relationship between habit and subjective norms, descriptive norms, perceived behavioral control, and behavior suggests that what take the travelers make decision among intercity mode is habit, which drives all the other latent factors. The standardized coefficients among habit, subjective norms, and descriptive norms are 53%~70% at the individual 0.1% level, which supports the fifth hypothesis in part. Habit has no significant impact on intention to using high speed railway, whereas it has that on intention to using traditional train and coach, which can be interpreted that high speed railway has not become the habitual mode for intercity



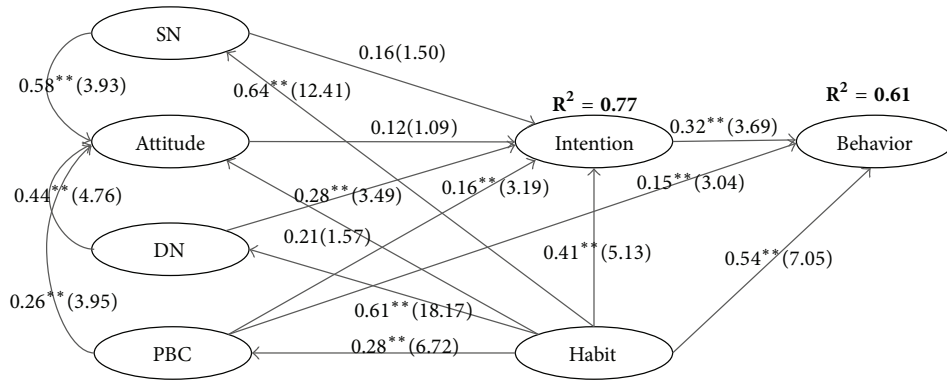


FIGURE 9: Standardized coefficients between the latent factors using coach.

TABLE 6: Habit as moderate between intention and behavior.

	Traditional train	High speed railway	Coach
Inclusion of habit	0.53** (5.32)	0.40** (6.54)	0.32** (3.69)
Exclusion of habit	0.73** (19.51)	0.68** (17.54)	0.73** (19.28)

\* $P < 0.05$ ; \*\* $P < 0.01$ .

travelers. Table 6 shows the standardized coefficients between intention and behavior to the exclusion of habit. The number in parenthesis is  $t$  statistics.

As illustrated in Table 6, the standardized coefficients between intention and behavior that arise in the MIMIC modes excluded the latent factor of habit. It is suggested that habit plays a moderate role between intention and behavior. When habit was weak, intention had a stronger effect on behavior of choice in intercity modes, but when habit was strong there was relative weak relationship between intention and behavior, supporting the sixth hypothesis.

### 7. Conclusions

The paper introduces the theory of planned behavior into the research of intercity travel mode choice and includes descriptive norms and habit as new latent factors into the theory. The choice and intention of the three intercity travel modes in Yangtze River Delta can be explained by the original predictors of TPB. Moreover, descriptive norm and habit may increase significant explained variance in intention. Particularly, introduction of habit in hierarchical regression analyses results in the biggest incremental explained variance in intention. Habit not only has a significant effect on intention but also operates as moderator of intention on behavior of mode choice. The paper also constructs the MIMIC models to research the relationship between demographic characteristics and the latent factors of the expanded TPB. The results show that socioeconomic statuses of travelers have different significant impact on the latent factors. In addition, the analyses among the latent factors in the expanded TPB verify that the theory's suitability of intercity travel mode choice and increase the understanding of the role of descriptive norms and habit in TPB. Based

on the understanding and the different demographic statistical characteristics, transportation planners could design a socially desirable sustainable transportation system in line with people's preferences.

### Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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