

**A Change of Heart?  
A Bivariate Probit Model of International Students' Change  
of Return Intention**

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**Abstract**

Using a bivariate probit model on a sample of 623 international students studying at tertiary-level courses in New Zealand universities, this paper identifies the factors that affect the change in the students' intention of whether or not to return to their home countries after completing their studies.

*Key words:* international students; intention change; return intention; bivariate probit

*JEL classification:* C25; J61; O15

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**1. Introduction**

New Zealand has recently become an emerging global player as a world class provider of tertiary education. In 2000–2001, there were only 8,210 international students in New Zealand, but this number increased to 33,047 in 2007 (UNESCO, 2003, 2009). In the Asia-Pacific region, New Zealand is currently ranked third after Australia and Japan as the most popular destination country for international education. According to New Zealand Department of Immigration, the main sending countries of international students are China, South Korea, Japan, and India.

Table 1 shows the breakdown by university and level of study in 2008. At approximately 66%, bachelor degree level students comprised the largest proportion of tertiary-level international students in New Zealand. The remaining one-third of the international students were enrolled in postgraduate level courses.

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A student goes for study abroad with a certain initial return intention, that is, whether or not to return home after completing study abroad. Once abroad and having been immersed with the foreign environment, a student may then have a different return intention from the initial one. A change of return intention may translate into a brain drain or a brain gain. For example, students who initially intend to return home but later undergo a change of intention may pose a brain drain threat to the home country and may signal a brain gain to the host country. It is thus imperative to understand what factors affect the change of intention so that the home and host countries can tailor their policies accordingly. There are only a handful of qualitative studies examining the change of return intention, so this paper is an empirically quantitative effort to fill the literature gap.

**Table 1. International Students Enrolled in 2008 by Level and University**

University	Degree Level				Total
	Bac	Hons/PG	Mas	PhD	
Auckland	2,157	654	314	418	3,543
Waikato	981	209	137	163	1,490
Massey	2,303	555	240	278	3,376
VUW	1,590	118	338	264	2,310
Canterbury	1,066	357	151	282	1,856
Lincoln	546	156	113	155	970
Otago	1,695	183	146	360	2,384
AUT	2,100	480	252	43	2,875
Total	12,438	2,712	1,691	1,963	18,804

Source: Ministry of Education's "Education Counts" webpage. Bac = Bachelor, Hons/PG = Honours/Postgraduate Diploma/Certificate, Mas = Masters.

Jayme-Card (1982) looked at the intention change of graduate students from the Philippines studying in the US, focusing on demographic and socio-psychological factors. Using indices and score methods, Jayme-Card looked at why students failed to return home although they had earlier intended to do so. She concluded that social experiences while in the US, youth, openness to the American culture, longer stay duration in the US, and the freedom to remain in the US were the primary determinants of intention change, whereas factors such as perceptions of relative economic and career opportunities were only of secondary importance.

A more recent focus group study (Hazen and Alberts, 2006) on the intention change of 185 international students studying in the US looked at the intended length of stay, i.e., whether to lengthen or shorten the stay. It concluded that most students changed their minds during their stay in the US, with the majority deciding to lengthen their stay. Economic and professional reasons such as differences in job markets and economic opportunities were the main factors of staying on in the US, while personal and societal reasons such as family ties and feelings of alienation were the main factors for returning home.

Szelenyi (2006) examined qualitatively the intention change of 26 international graduate students studying at a US university using in-depth interviews to compare

students' initial and post-graduation intentions. Szelenyi identified access of first-hand information regarding the host country, social ties such friendships formed in the US and faculty support, and the students' professional aspirations as the main determinants of intention change. Her findings also suggested that the less developed the home country, the more of its elites choose to emigrate.

Finn's (2007) study examined the stay-on rates of doctoral-level international students in the US after graduation. Using tax records, he examined the intentions to stay on in the US and the subsequent actual stay of those doctoral graduates. Two-thirds of the doctoral graduates who stayed on in the US earned their doctorates in science and engineering disciplines. Those who stayed on were typically from China and India.

The preceding studies, largely descriptive, looked at the intention change of international students studying in the US. However, there are yet to be any micro-level econometric studies specifically on the intention change of tertiary-level international students studying in New Zealand. Using a bivariate probit model as a formal estimation framework, this paper addresses the following research questions.

- (i) Have students' return intentions changed?
- (ii) How have their intentions changed (i.e., towards or against returning home)?
- (iii) What factors determine any change of intention?
- (iv) What are the relevant policy implications, if any, from the findings?

The paper is organized as follows. The next section describes the data and variables, while Section 3 provides descriptive statistics of the data. Section 4 specifies the model, and Section 5 discusses results. The following two sections check for model specification and robustness. The final section concludes.

## 2. Data and Variables

The target population of this study is all full-time international students currently (at time of survey) studying at tertiary-level programmes in New Zealand's eight universities. Tertiary-level students refer to those studying for Bachelor, Honours/Post-graduate Diploma/Certificate, Masters, and PhD degrees. International short-term exchange students are excluded.

The sampling frames used here are the lists of currently enrolled full-time international students maintained by the international offices of the universities. These lists are more comprehensive than self-constructed sampling frames in some studies of student non-return (Gungor and Tansel, 2008; Zweig, 1997). A web-based survey was sent to all the international students listed in the sampling frames.

The survey questionnaire had three main sections: Section A to C. Section A contained questions on a student's (i) demographic, (ii) family-related, and (iii) education-related background. Section B contained questions such as (i) whether or not the student currently intends to return home, and (ii) whether or not the student has experienced any changes in their return intention. The questions asked in Section B made up the response variables of the study. Section C comprised

questions on how the student perceived the different aspects of the home country such as the economic, professional, social, and political aspects.

The international offices of the eight universities in New Zealand were contacted. Only the University Otago and the University of Canterbury allowed their international students to participate in the survey. The web-based survey was sent out to the students through the Otago and Canterbury's international offices. The survey period spanned March to May 2008. There were 512 respondents from Otago and 269 from Canterbury, representing response rates of 31.4% (512 from a total of 1,633 international students) and 24.1% (269 from 1,116) each. The total number of international students at the two universities differs from that in Table 1 as the total here is as of March 2008, while that in Table 1 is as of December 2008. The final usable sample size totals to 623 students after excluding duplicate responses and responses from students who are under service bond to return home.

Krejcie and Morgan (1970) and Cavana et al. (2000, p. 278) suggest that a target population size of 15,000 needs a sample size of 375 respondents, while a size of 20,000 needs only 377 respondents. New Zealand government sources show that in 2008 there were 18,804 tertiary-level international students in New Zealand's universities (Ministry of Education, 2008). A sample size of 623 can therefore be deemed adequate for the target population specified in this study. Furthermore, the current sample size of 623 is also considered adequate for maximum likelihood estimation, which preferably needs more than 500 observations (Long, 1997, p. 54).

Although the final sample size appears to be adequate in general, sample representativeness cannot be established in terms of, for example, the overall distribution of students in different disciplines of study or the distribution of doctoral/non-doctoral students. However, within the University of Otago sample, the sample proportion of non-doctoral students (i.e.,  $296/416 \approx 0.7115$ ) mirrors the population proportion (i.e.,  $1695/2384 \approx 0.7110$  from Table 1). Unfortunately, this cannot be said for the University of Canterbury sample.

The choice of the explanatory variables is drawn from the brain drain and student non-return/migration literature such as those discussed in the introduction section. Three sets of explanatory variables are used. They include (i) demographic and family-related, (ii) education-related, and (iii) perception-related variables. The set of demographic and family-related variables captures the effects of, for instance, age, gender, marital status, and family socioeconomic status. Apart from age, two other time-varying variables are included: years of stay duration in New Zealand and years of professional work experience. The rest of the explanatory variables used in the study are dummy variables.

The set of education-related variables captures the effects of how the level and discipline of study may affect the change in return intention. A proxy of geographical mobility is also included. Such mobility is proxied by a variable capturing whether or not a student has had some education abroad prior to their current studies in New Zealand. The perception-related variables pertain to how the students perceive the different aspects of their home countries. Work-related perceptions, such as perceptions of wage competitiveness, skill use opportunities,

and work environment (e.g., in terms of quality peers and adequate physical resources) are included. Social-related perceptions, such as perceptions of family ties, preferred lifestyle, and race equality, are also included. The perception of race equality (or discrimination) variable is included since there are students who come from ethnically divided countries such as Indonesia, Malaysia, Sri Lanka, and Fiji. These three sets of explanatory variables have, in one form or another, almost always been used in past literature on student non-return/migration. Table 2 lists variable descriptions and coding scheme.

**Table 2. Variable Descriptions and Coding Scheme**

Variable	Description
<b>Set 1: Demographic and family-related variables</b>	
Age	Years of age
Years of stay in New Zealand	Years of stay duration/residence in New Zealand
Years of work experience	Years of work experience at home prior to current study
Single	1 if single or not married; 0 otherwise
Male	1 if male; 0 otherwise
Family supports migration plan	1 if family supports non-return/migration intention; 0 otherwise
Father tertiary-educated	1 if father has tertiary-level education; 0 otherwise
<b>Set 2: Education-related variables</b>	
PhD	1 if a PhD student; 0 otherwise
Have had education abroad	1 if studied abroad before prior to current study; 0 otherwise
Science discipline	1 if in the science discipline of study; 0 otherwise; base group
Health science discipline	1 if in the health science discipline of study; 0 otherwise
Humanities discipline	1 if in the humanities discipline of study; 0 otherwise
Commerce discipline	1 if in the commerce discipline of study; 0 otherwise
<b>Set 3: Home perception-related variables</b>	
Good work env. at home	1 if work environment is perceived good at home; 0 otherwise
Competitive wage at home	1 if wage competitiveness is perceived good at home; 0 otherwise
Good skill use opp. at home	1 if skill use opportunity is perceived good at home; 0 otherwise
Good lifestyle at home	1 if lifestyle is perceived good at home; 0 otherwise
Close ties at home	1 if family/social ties is perceived good at home; 0 otherwise
Race equality at home	1 if race equality is perceived good at home; 0 otherwise

### 3. Descriptive Statistics

The paper defines a change of intention as the difference between a student's initial and current return intention. As mentioned before, a student's initial intention is the intention before coming to New Zealand. Due to practicality purposes, students are only asked of their initial intentions at the time of the survey. A student's current intention is the intention during the time of the survey.

Table 3 shows the breakdowns of the explanatory variables by the dichotomous outcome variable, i.e., whether or not the intention has changed. From the total of

623 students in the sample, 159 (25%) observed a change in their intention, while the majority of the students observed no change of intention.

**Table 3. Descriptive Statistics**

Variable	Change of intention		Total
	Unchanged	Changed	
<b>Demographic and family-related variables</b>			
Age	24.5	24.7	–
Years of stay in New Zealand	2.6	3.1	–
Years of work experience	1.4	1.1	–
Single	418	142	560
	(74.6)	(25.4)	(89.9)
Male	232	66	298
	(77.9)	(22.1)	(47.8)
Family supports migration plan	216	86	302
	(71.5)	(28.5)	(48.5)
Father tertiary-educated	293	112	405
	(72.4)	(27.6)	(65.0)
<b>Education-related variables</b>			
Have had education abroad	205	75	280
	(73.2)	(26.8)	(44.9)
Health science discipline	72	39	111
	(64.9)	(35.1)	(17.8)
Humanities discipline	99	28	127
	(78.0)	(22.0)	(20.4)
Commerce discipline	112	38	150
	(74.7)	(25.3)	(24.1)
Science discipline	181	54	235
	(77.0)	(23.0)	(37.7)
PhD	106	48	154
	(68.8)	(31.2)	(24.7)
<b>Perception-related variables</b>			
Good work env. at home	117	25	142
	(82.4)	(17.6)	(22.8)
Competitive wage at home	180	51	231
	(77.9)	(22.1)	(37.1)
Good skill use opp. at home	138	33	171
	(80.7)	(19.3)	(27.4)
Good lifestyle at home	134	34	168
	(79.8)	(20.2)	(27.0)
Close ties at home	344	119	463
	(74.3)	(25.7)	(74.3)
Race equality at home	173	53	226
	(76.6)	(23.4)	(36.3)
Total	464	159	623
	(74.5)	(25.5)	(100.0)

Notes: Science is the base group for the disciplines of study. Percentages are in parentheses. Mean figures (in years) for age, stay duration in New Zealand, and work experience.

Students who observed a change of intention have, on average, stayed in New Zealand for slightly more than 3 years. On the other hand, those whose intentions remained the same have, on average, stayed in New Zealand for about 2.5 years. This simple statistic seems to support the intuition that the longer one stays in a host country, the more likely one is to observe a change of intention.

Compared with students from other disciplines, students from the health science discipline made up the largest proportion of those who changed their intention. About 35% of health science students observed a change of intention. About one third of the doctoral-level students observed a change of intention.

Table 4 shows the cross-tabulation between the change of intention and current return intention. From Table 4, we might surmise that these two variables should be negatively correlated due to the disproportionately high counts in the upper right-hand cell ( $n = 314$ ). Indeed, the correlation coefficient between the two variables is  $-0.4548$ . We shall let these two variables be the outcome variables, to be jointly estimated using a bivariate probit model. Also note that, from Table 4 and from the way the change of intention is defined, we know which way the direction of change is. For example, if there is a change of intention and the current intention is to not return, then we know that the initial intention was to return. Therefore, the direction of change is from an initial intention to return to a current intention to not return.

**Table 4. Cross-Tabulation between Change of Intention and Current Return Intention**

	Current return intention		Total
	Not return	Return	
Unchanged intention	150	314	464
Changed intention	134	25	159
Total	284	339	623

#### 4. Bivariate Probit Model Specification

By the latent variable approach, the bivariate probit model is specified as follows:

$$\begin{aligned}
 Y_1^* &= \mathbf{X}\boldsymbol{\beta}_1 + \varepsilon_1 \\
 Y_2^* &= \mathbf{X}\boldsymbol{\beta}_2 + \varepsilon_2 \\
 E[\varepsilon_1 | \mathbf{X}] &= E[\varepsilon_2 | \mathbf{X}] = 0 \\
 \text{Var}[\varepsilon_1 | \mathbf{X}] &= \text{Var}[\varepsilon_2 | \mathbf{X}] = 1 \\
 \text{Cov}[\varepsilon_1, \varepsilon_2 | \mathbf{X}] &= \rho,
 \end{aligned} \tag{1}$$

where  $Y_1^*$  is the latent propensity to change one's intention,  $Y_2^*$  is the latent propensity to (currently) return,  $\mathbf{X}$  is the vector of explanatory variables,  $Y_1$  is 1 if there is a change of intention (i.e.,  $Y_1^* > 0$ ) and 0 otherwise, and  $Y_2$  is 1 if the current intention is to return (i.e.,  $Y_2^* > 0$ ) and 0 otherwise.

Note that the same vector of explanatory variables is used in both equations, as each equation is not required to have different explanatory variables (Greene, 2008, p. 822). The error term of each equation is allowed to be correlated; that is, any random disturbances affecting the latent propensity to change one's intention may also affect the latent propensity to (currently) return. The two error terms,  $\varepsilon_1$  and  $\varepsilon_2$ , are distributed as bivariate normal with zero mean, unit variance, and correlation  $\rho$ . The  $\rho$  is estimated to be  $-0.7258$ , which is significantly different from zero at the 1% level. This correlation suggests that the two outcome variables,  $Y_1$  and  $Y_2$ , are affected by similar unobserved factors and supports the use of a bivariate probit model to estimate the marginal effects on the joint probabilities of the two outcome variables.

## 5. Results Discussion

This section discusses some of the factors that affect the different joint probabilities of the change of intention and the current return intention. Marginal effects analysis has been typically omitted from studies using bivariate probit models because there are marginal effects on different joint probabilities to be considered (Greene, 1996). Departing from the norms of such studies, this paper examines the marginal effects on the four joint probabilities, as shown in Table 5.

The  $P_{00}$  column pertains to the joint probability of not observing a change of intention and currently not intending to return, which may also be expressed as  $\Pr(Y_1 = 0, Y_2 = 0)$ . The  $P_{01}$ ,  $P_{10}$ , and  $P_{11}$  columns are similarly interpreted. The marginal effects on  $P_{00}$  and  $P_{01}$  are generally larger than those on  $P_{10}$  and  $P_{11}$ , implying that the explanatory variables have stronger impact on the probability of not changing one's mind,  $\Pr(Y_1 = 0)$ , than the probability of changing one's mind,  $\Pr(Y_1 = 1)$ .

The longer a student stays in New Zealand for his studies, the more likely he is to experience a change of intention from initially intending to return to currently not intending to return home. This finding is consistent with the literature. The longer one stays in a host country the more likely one assimilates with the culture of the host country, diminishing one's intention to return home in the assimilation process.

The level of study (PhD) variable has the largest negative marginal effects on  $P_{01}$ , decreasing the joint probability by about 0.13. Conversely,  $P_{10}$  increases by about 0.12 for a doctoral student compared with a non-doctoral student. Note that the  $P_{10}$  implies an initial intention to return home. Doctoral students who come to New Zealand with an initial intention to return may subsequently change their mind due to their doctoral degrees opening up more prospects abroad. The finding here is consistent with those in Jayme-Card (1982) and Finn (2007), which found that the majority of Filipino graduate students and international doctoral students who initially intend to return have failed to do so.



Table 5. Marginal Effects on Different Joint Probabilities

Variable	Joint probabilities			
	$P_{00}$	$P_{01}$	$P_{10}$	$P_{11}$
<b>Demographic and family-related variables</b>				
Age	-0.0005 (0.0045)	-0.0012 (0.0065)	0.0012 (0.0057)	0.0005 (0.0033)
Years of stay in New Zealand	0.0001 (0.0076)	<b>-0.0281***</b> <b>(0.0108)</b>	<b>0.0242**</b> <b>(0.0102)</b>	0.0038 (0.0058)
Years of work experience	-0.0016 (0.0071)	0.0125 (0.0101)	-0.0102 (0.0090)	-0.0007 (0.0053)
Single	0.0182 (0.0461)	-0.0032 (0.0710)	-0.0034 (0.0634)	-0.0116 (0.0369)
Male	0.0453 (0.0278)	0.0343 (0.0391)	-0.0514 (0.0337)	-0.0282 (0.0190)
Family supports migration plan	<b>0.0760***</b> <b>(0.0281)</b>	<b>-0.1196***</b> <b>(0.0382)</b>	<b>0.0710**</b> <b>(0.0355)</b>	-0.0274 (0.0187)
Father tertiary- educated	<b>-0.0848***</b> <b>(0.0303)</b>	0.0158 (0.0409)	0.0321 (0.0350)	<b>0.0370*</b> <b>(0.0192)</b>
<b>Education-related variables</b>				
Have had abroad education	0.0337 (0.0312)	-0.0103 (0.0444)	-0.0063 (0.0391)	-0.0171 (0.0211)
Health science discipline	0.0149 (0.0381)	<b>-0.1275**</b> <b>(0.0536)</b>	<b>0.1126**</b> <b>(0.0516)</b>	0.0000 (0.0275)
Humanities discipline	0.0157 (0.0378)	0.0115 (0.0543)	-0.0165 (0.0480)	-0.0107 (0.0268)
Commerce discipline	0.0194 (0.0360)	-0.0640 (0.0511)	0.0493 (0.0470)	-0.0047 (0.0258)
PhD	0.0094 (0.0386)	<b>-0.1309**</b> <b>(0.0541)</b>	<b>0.1184**</b> <b>(0.0525)</b>	0.0031 (0.0283)
<b>Perception-related variables</b>				
Good work env. at home	-0.0256 (0.0322)	0.0783 (0.0492)	-0.0557 (0.0414)	0.0029 (0.0253)
Competitive wage at home	-0.0184 (0.0286)	0.0561 (0.0426)	-0.0403 (0.0372)	0.0026 (0.0216)
Good skill use opp. at home	<b>-0.0759***</b> <b>(0.0272)</b>	<b>0.1516***</b> <b>(0.0436)</b>	<b>-0.1005***</b> <b>(0.0366)</b>	0.0249 (0.0242)
Good lifestyle at home	<b>-0.1221***</b> <b>(0.0264)</b>	<b>0.1843***</b> <b>(0.0440)</b>	<b>-0.1321***</b> <b>(0.0352)</b>	<b>0.0699**</b> <b>(0.0281)</b>
Close family/social ties at home	<b>-0.1723***</b> <b>(0.0363)</b>	<b>0.1383***</b> <b>(0.0443)</b>	-0.0176 (0.0407)	<b>0.0517**</b> <b>(0.0202)</b>
Race equality at home	-0.0408 (0.0273)	<b>0.0846**</b> <b>(0.0412)</b>	-0.0567 (0.0357)	0.0129 (0.0216)

Notes: \*, \*\*, and \*\*\* denote significance 10%, 5%, and 1% levels.  $P_{00} = \Pr(Y_1 = 0, Y_2 = 0)$ ,  $P_{01} = \Pr(Y_1 = 0, Y_2 = 1)$ ,  $P_{10} = \Pr(Y_1 = 1, Y_2 = 0)$ ,  $P_{11} = \Pr(Y_1 = 1, Y_2 = 1)$ . Standard errors are in parentheses.

The factors affecting the intention change of doctoral students may differ from those affecting non-doctoral students. We estimate two separate bivariate probit models, one for each of the doctoral and non-doctoral subgroups. Indeed, different factors do have different impact on the subgroups. We find that (results not reported) the stay duration and work experience have significant impact on the intention change of the doctoral subgroup. For the non-doctoral subgroup, stay duration, perceptions of skill use opportunities and family ties are the significant factors. This illustrates a limitation of estimating just one model that includes all levels of study.

Similar interpretations of  $P_{01}$  and  $P_{10}$  apply for a student studying in a health science discipline. The joint probability of not observing a change of intention and currently intending to return,  $P_{01}$ , decreases by about 0.13 for a health science student compared with a science student. In contrast, the joint probability of observing a change of intention and currently not intending to return,  $P_{10}$ , increases by about 0.11 for a health science student compared with a science student. Thus selecting a health science discipline is associated with changing one's mind against returning. This is perhaps due to the health science discipline being a relatively capital-dependent discipline. Following Chen and Su (1995), a capital-dependent discipline is defined as one that depends on the stock of capital, both physical and human, in the host country. Students studying in relatively capital-dependent disciplines are found to be less likely to return home after completing their studies abroad (Chen and Su, 1995).

Generally, the perception-related variables have larger marginal effects on  $P_{00}$  and  $P_{01}$  than on  $P_{10}$  and  $P_{11}$ , i.e., the marginal effects are larger on the probability of not observing a change of intention (the first zero subscript of  $P_{00}$  and  $P_{01}$ ). A good perception of the lifestyle in one's home country has the largest positive marginal effect on the joint probabilities of having no change of intention and currently intending to return home,  $P_{01}$ , where  $P_{01}$  increases by about 0.18 for a student with such a perception. Note that the joint probability  $P_{01}$  implies that the initial intention was to return.

A student who perceives good opportunities to use his acquired skills and race equality at home would be more likely to remain unchanged with his intention of returning home, corresponding to an increase of about 0.15 and 0.08 on  $P_{01}$ . The marginal effects of the perception-related variables make sense, where students with good perceptions of the different aspects of their home countries are more likely to initially intend to return and are less likely to deviate from their initial intention. The next two sections check the model for its goodness-of-fit with the data and the robustness of its key conclusions.

## **6. Model Specification Check**

This section discusses some of the specification tests for the bivariate probit model. The model is first tested for overall model specification using a chi-squared test, which is a test of the joint significance of all the explanatory variables. The chi-

squared statistic of 145.43 is significant at the 1% level, indicating that at least one explanatory variable has explanatory power on the joint outcome variables.

If the two binary outcome variables are correlated, the coefficient estimators yielded by joint estimation will be at least asymptotically more efficient than those obtained by single equation estimation (Zellner and Lee, 1965). Here, the two outcome variables, the change of intention and the current intention, yield a correlation coefficient of  $-0.4548$ . This correlation coefficient is significant at the 1% level, supporting joint estimation.

The significant correlation between the error terms of the two outcome variables suggests that unobserved factors affecting the change of intention may also affect the current return intention. Here, the two error terms produce a correlation coefficient of  $\rho = -0.7258$ , which is significant at the 1% level with a likelihood ratio chi-square statistic of 121.93. The significant correlation suggests that the two outcome variables should indeed be estimated jointly.

The bivariate probit model is also scrutinized for possible presence of heteroskedasticity by comparing the models with the usual unadjusted and with robust standard errors. Since the z-statistic and p-values (not reported) remain largely the same whether or not robust standard errors are used, we conclude no significant presence of heteroskedasticity.

Now, students who observed a change of intention can be categorized into those who changed from intending to return home initially to not intending to ( $n = 134$ ), and vice versa ( $n = 25$ ). One may be concerned that the bivariate probit model, by lumping these students into a single group (those who observed a change of intention), is unable to capture the effects of the explanatory variables which may differ by their initial intentions. We estimated two separate binary logit models, one for those who initially intend to return and one for those who do not. The results are shown in Table 6.

Table 6 suggests that different factors have different impacts on the change of intention of each subgroup. For example, doctoral students whose initial intentions are to return are more likely to observe a change of intention against returning. Students who perceive a good lifestyle at home are less likely to deviate from their initial intentions. However, a coefficient equality test reveals that the difference between the two sets of coefficients is statistically insignificant (p-value 0.339). There is no need to estimate the two subgroups separately. The bivariate probit model is a better-fitting model than separate binary logit models in this case.

## 7. Model Robustness Check

The results from the bivariate probit model (M1) are compared with three other model specifications to examine the robustness of M1's key conclusions. Table 7 provides coefficient estimates and significance levels of the four different specifications. M2 specifies two separate probit models, i.e., not allowing the two error terms to be correlated. In M2, there are only some slight changes in the

significance levels, while none of the coefficient signs are different from those of M1.

**Table 6. Binary Logit Coefficient Estimates for Subgroups of Initial Intention**

Variable	Initial return intention	
	Return	Not return
Age	-0.1095	0.0398
Years of stay in New Zealand	0.1508	<b>0.1441**</b>
Years of work experience	0.0600	-0.0791
Single	-0.4652	0.0849
Male	-0.4270	-0.3868
PhD	<b>1.1694**</b>	0.2477
Have had education abroad	-0.2252	-0.0369
Health science discipline	0.6031	0.5387
Humanities discipline	0.4561	-0.2059
Commerce discipline	0.6983	-0.0407
Family supports migration plan	0.5440	0.0819
Father tertiary-educated	0.2381	0.3752
Good work env. at home	-0.5958	-0.2588
Competitive wage at home	-0.3507	-0.1426
Good skill use opp. at home	-0.5125	-0.0941
Good lifestyle at home	<b>-0.7226*</b>	0.0576
Close ties at home	-0.5985	<b>0.6911**</b>
Race equality at home	-0.3560	-0.1740

Notes: The outcome variable is a change of intention. \* and \*\* denote significance at the 10% and 5% levels.

M3 is a restricted version of M1 which excludes variables that are insignificant in M1. The key conclusions of M1 remain largely unchanged in M3, with the exception of the perception on skill use opportunities being significant in the  $Y_1$  equation.

M4 specifies a linear seemingly unrelated regression (SUR) model. Specifying a SUR in place of M1 is analogous to specifying a linear probability model in lieu of a binary regression model. There are no changes of coefficient signs and no noticeable changes in the significance levels of the key variables in M4.

Since there are concerns that the nationality of the students might have an effect on the change of intention, we also include one dummy variable for students who come from a developed country (53% of the sample) and one for Asian students (56%). We include these dummies separately into the model to avoid potential collinearity issues, although the correlation coefficient of the two dummies is only 0.5647. Results (not reported) suggest that nationality is not significant at the 5% level. The effect may have been captured by the perception-related variables. The results here differ from those in Szelenyi (2006), which found that students from a less developed home country are more likely to change their intention against returning home.

Table 7. Model Robustness Check

Variable	M1	M2	M3	M4
<b><math>Y_1</math> : Change of intention</b>				
Age	0.0047	0.0043		0.0010
Years of stay in New Zealand	<b>0.0773**</b>	<b>0.0835***</b>	<b>0.0823***</b>	<b>0.0265***</b>
Years of work experience	-0.0302	-0.0257		-0.0072
Single	-0.0411	-0.0563		-0.0165
Male	<b>-0.2333**</b>	<b>-0.2421**</b>	<b>-0.2168*</b>	<b>-0.0714**</b>
PhD	<b>0.3178**</b>	<b>0.3069*</b>	<b>0.2884**</b>	<b>0.0995**</b>
Have had education abroad	-0.0654	-0.0695		-0.0249
Health science discipline	<b>0.2953*</b>	<b>0.3101*</b>	<b>0.3131**</b>	<b>0.1031**</b>
Humanities discipline	-0.0763	-0.0341		-0.0071
Commerce discipline	0.1201	0.1341		0.0417
Family supports migration plan	0.1175	0.1122	0.1042	0.0351
Father tertiary-educated	<b>0.2002*</b>	0.1976	<b>0.1978*</b>	0.0575
Good work env. at home	-0.1510	-0.1735		-0.0502
Competitive wage at home	-0.1067	-0.1078		-0.0315
Good skill use opp. at home	-0.2208	-0.2186	<b>-0.2641**</b>	-0.0596
Good lifestyle at home	-0.1794	-0.1857	-0.2007	-0.0522
Close ties at home	0.0961	0.1455	0.1125	0.0509
Race equality at home	-0.1244	-0.1339	-0.1231	-0.0432
<b><math>Y_2</math> : Current return intention</b>				
Age	-0.0019	0.0063		0.0021
Years of stay in New Zealand	<b>-0.0619**</b>	<b>-0.0606*</b>	<b>-0.0818***</b>	<b>-0.0193*</b>
Years of work experience	0.0299	0.0261		0.0081
Single	-0.0378	-0.0022		-0.0007
Male	0.0155	0.0165	0.0196	0.0059
PhD	<b>-0.3217**</b>	<b>-0.3591**</b>	<b>-0.2335*</b>	<b>-0.1211**</b>
Have had education abroad	-0.0694	-0.0550		-0.0199
Health science discipline	<b>-0.3209**</b>	<b>-0.3278**</b>	<b>-0.3133**</b>	<b>-0.1123**</b>
Humanities discipline	0.0021	-0.0144		-0.0066
Commerce discipline	-0.1730	-0.2068		-0.0673
Family supports migration plan	<b>-0.3706***</b>	<b>-0.3958***</b>	<b>-0.3571***</b>	<b>-0.1333***</b>
Father tertiary-educated	0.1332	0.1312	0.1370	0.0431
Good work env. at home	0.2122	0.2236		0.0654
Competitive wage at home	0.1519	0.1496		0.0495
Good skill use opp. at home	<b>0.4862***</b>	<b>0.4818***</b>	<b>0.5490***</b>	<b>0.1577***</b>
Good lifestyle at home	<b>0.7536***</b>	<b>0.7523***</b>	<b>0.7698***</b>	<b>0.2440***</b>
Close ties at home	<b>0.4819***</b>	<b>0.5242***</b>	<b>0.4813***</b>	<b>0.1781***</b>
Race equality at home	<b>0.2564**</b>	<b>0.2667**</b>	<b>0.2340*</b>	<b>0.0845**</b>

Notes: \*, \*\*, and \*\*\* denote significance at the 10%, 5%, and 1% level. M1 is the bivariate probit model, M2 is two separate probit models, M3 is the restricted version of M1, and M4 is the linear SUR model.

The preceding and the present sections suggest that the bivariate probit model fits the data and is robust to different estimation models and subsets of variables. Therefore, the results from this model can be accepted with more confidence.

## **8. Conclusions**

This paper's main contribution is to add to the literature by examining the change of intention, rather than just the more typical issue of whether or not students intend to return home. Specifically, this paper looks into the determinants of intention change by jointly estimating the intention change along with the current return intention.

The results indicate that when the students have good perceptions of the different aspects of the home country, an initial intention to return home is less likely to change. One key factor is how students perceive the opportunities applying their skills at home. Hence, for home countries, one way of attracting return is to ensure such opportunities through sustained economic growth.

Doctoral-level students and students from the health science discipline are more likely to either remain steadfast with their intention to not return home, or to experience a change of intention from a return to a non-return intention. This finding may have serious policy implications to the home countries, since doctoral-level students are the least affordable to lose. In the case of poorer developing countries, losing their health science students may retard any efforts in reviving the countries' health-related sectors. Countries such as China, Mexico, and South Korea have devised brain gain strategies to actively attract the return of high-skilled citizens, especially those involved in science and technology areas and/or those with doctoral qualifications.

In terms of stay duration, we find that the longer the students stayed in New Zealand, the more likely they are to change their intention against returning home. This may pose a threat or an opportunity to New Zealand, the host country, depending on how one looks at it. If the students opt to stay on in New Zealand, this may create a supply glut in the labor market and may result in unemployment of New Zealanders. At the same time, these students can boost New Zealand's population, which in turn can add vitality to its economy. Therefore, the New Zealand government, or any host country for that matter, needs to strike a healthy balance in its immigration and labor policies.

We also find that students who perceive race equality in the home countries are more likely to hold on to their intention to return home. In light of this, countries such as Indonesia, Malaysia, Sri Lanka, and Fiji should work on their policies regarding races, ethnic groups, and religions. Mutual understanding and tolerance should be practiced and prejudice of any kind should be discarded.

Due to time constraints, this study does not construct a panel dataset, in which the same individual students would be followed over time. Compared to a panel dataset, the use of a cross-sectional dataset is unable to capture variation over time. Therefore, this study is unable to provide evidence of whether a change of intention is followed by consistent actual migration behavior. Findings from this study should be interpreted bearing these caveats in mind. Suggested future research is to

construct a longitudinal study and follow the individual students to compare their return intention with actual migration behavior.

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