University Students' Preferences for Labour Conditions at a Mining Site: Evidence from Two Australian Universities

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Abstract: The mining industry makes up a large portion of the gross domestic product (GDP) in Australia, although securing human resources remains a problem in that field. The aim of this paper is to identify Australian university mining students' preferences, considering it as potential employees' preferences, for labour conditions at mining sites by means of a discrete choice experiment to promote efficient improvements in labour conditions in the mining industry. The data of 93 respondents analysed in this paper was collected by survey carried out in two universities in Australia. The result of the study showed that students have preferences on several factors such as wage, fatality rate, working position, commuting style, and company. Students having specific sociodemographic characters were found to show specific preferences on labour conditions. The results of this study indicate the potential average of appropriate monetary compensation for each factor.

Keywords: mining labour; working condition; conjoint analysis

1. Introduction

In recent years, Australia has taken on a major role in the mining industry as a supplier. According to one institutional report, Australia is the largest producer of iron and the second largest producer of lead in the world as of 2017 [1,2]. Furthermore, Australia has the largest amount of reserves of several metals, including iron, zinc, and lead, which are the so-called "common metals" regularly used for industrial purposes in the world [1–3]. In addition, the Australian mining industry has assumed a key role in the domestic economy by making up a large part of the gross domestic product (GDP). The government reported that the mining industry accounts for 10.2% of Australia's GDP and that makes the mining industry one of the most important in Australia [4].

Despite both the domestic and international importance of the mining industry, a shortage of skilled labour is reported in Australia. Mining companies that have operations in key mining states, namely, Western Australia and Queensland, have had to increase benefits and offer financial incentives

for current staff, such as pay rates, due to the shortage of skilled labour compared to other states in Australia (59.5% vs. 38.0%) [5]. Specifically, skilled labour shortages are concentrated in remote areas, which is where mining sites are generally located in Australia [6]. Hence, mining companies need to understand the factors and priorities that affect how mining students select jobs as potential mining workers. Based on such understanding, mining companies can achieve effective employment procedures that can lead to a reduction in employee turnover and an increase in job satisfaction. However, to the best of our knowledge, no previous study has assessed the factors affecting mining students' preferences for labour conditions in Australia.

To address this gap, this study identifies the factors that affect mining students' preferences for labour conditions by using a discrete choice experiment and contributes to the promotion of effective employment procedures in Australia. Finally, marginal willingness to accept (MWTA) for each attribute of labour conditions can be estimated from the results of the conjoint analysis. The result of MWTA showed monetary values of levels of each attribute, and those could imply potential compensations of each level of the attributes.

Previous Studies

Generally, job selection is based on the amount of income, job location, and other individual factors (e.g., family size, sex and age). However, there are some other important factors that affect job selection related to mining. Indeed, a study has been completed on the job preferences of a new mining labour force in order to attract them to a remote working location [7]. The study was carried out using a discrete choice experiment and an online format, and the respondents were selected from an internet panel of Brisbane residents. The respondents were asked to provide answers in two types of selection task scenarios: the first was commuting and the other was relocation. The attributes of the commuting scenario were employment (length of contract and promotion opportunities), block shifts and days off, distance from Brisbane, and commuter bonus. In the relocation scenario, the attributes were employment, housing type, town service, family package (education and housing subsidies), and relocation bonus. The results of the research indicate that the salary size was the most important factor in relocation. However, this study shows that other factors also affect the decision making in the relocation scenario. In particular, a medium-term contract was preferred for commuting and a long-term contract was preferred for relocation. The respondents of the research were selected from Brisbane residents as a potential mining workforce in a remote area. Other studies have analyzed student preferences in job selection on the assumption that university students are one of the most important potential labour forces for each industry. Specifically, workers in industries such as mining must have specific work skills. In such an industry, companies need to employ enough students who have learned the specific skills required at university. Therefore, a better understanding of the factors that affect university students' decisions to specialize in mining is therefore necessary for the business management of mining companies and the industry.

Labour conditions in terms of mining, it has been examined that labour and ambient conditions are strongly related with psychological burden such as strain and stress which lead to health problems and low productivity. A study on psychological and physical hazards, and its implications for employees' safety experience in Ghanaian mining industry insist that the experience of injuries, accidents and near misses are associated with mining conditions. Also, witnessed accidents in mining sites were associated with ambient conditions in the mines such as excessive noise, heat stress, dusty conditions and poor visibility. In this paper, as a conclusion it is reported that high job demand and low control of over workload are associated with negative safety reported outcome [8]. Another research focusing on workers' stress associated with productivity in Australian mining industry, the results of the surveys in the research insist that employees residing in the mining town showed comparatively higher productivity cost to employee with FIFO/DIDO, also employees with permanent day shift showed higher productivity cost than employees with rotating shift. Moreover, it is examined that the higher stress level of employees leads to higher productivity cost. In the same paper, differences between

genders also found that female employees were more likely report wanting assistance for stress management than male employees, although females and males show similar average of impairment cost [9].ther research about psychological strain in Hungarian mining industry studied on 71 miners working in 794 shifts across 5 mining plants. The study targeted detailed factors such as presence of managers, temperature of mining site, illumination in mining site and so on, finding these might affect heart rate of miners, which indicates miners' strain. The results of the study indicate that those detailed factors also influence miners' strain, for example high temperature in mining sites gives miners more strain and brighter illumination gives miners less strain [10]. Regarding work environment related with wellbeing of employees, a study by Donatella Di Marco estimated that wellbeing of employees is decreased in discriminatory environment [11]. Furthermore, regarding wellbeing of work, it can be influenced by external factors such as Global Financial Crisis [12]. In the research, despite the fact that the impact of the GFC on the Australian economy was comparatively less than other countries such as U.S, or Europe countries, the GFC had a negative impact on the wellbeing of young people aged 19 and 22 regarding their life and works. Due to making the combination among assumed labour conditions in the survey practically imaginable for students, those detailed labour conditions mentioned above were not applied to the survey of this research.

Previous studies of job preferences in various regions and industrial sectors have utilized data on academic students who were enrolled in specific academic fields, including accounting students in Malaysia [13], agricultural students in Germany [14], and nursing students in Kenya, South Africa, Thailand, and the UK [15,16]. In a previous study by Omar (2015) [13] on accounting students' preferences for job conditions, the working environment was the most important factor, in addition to the starting salary and the employer reputation. Another study by Meyerding (2018) [14] of agricultural students' job preferences in Germany found that income and future prospects were more valued than other attributes, such as image, income, future, work-life-balance, prestige, place, and working hours. The results of another study by Blaauw (2010) [15] of nursing students' preferences in three countries (Kenya, South Africa, and Thailand) indicate that the receptiveness to various human resource strategies differs between countries. The results show that job preferences among nursing students differed among countries and that strategies tailored to local conditions are needed more than global strategies. Summarizing the above, previous studies of students' job preferences indicate that results differ by regions and industrial sectors, and other factors relating to the labour conditions and their personal situations.

However, the previous studies on academic students' job preferences did not analyze the effect of a work task category at a mining site. A mining job includes several kinds of work task categories, such as mine planning, drilling, blasting, etc. These tasks present different risks to employees. For example, compared with mine planning, drilling and blasting work tasks have a higher risk of death in a mining accident. In addition, the unpopularity of drilling and blasting does not depend solely on the risk of an accident. Generally, drilling and blasting are not easy to work due to physical labour and working environment in mining site. In consideration of such risks and reasons for being unpopular, drilling and blasting workers generally require higher salaries than mine planning workers. In short, mining companies need to adjust salaries or compensations based on the different risks and situations of each work task, otherwise they will face difficulties to secure enough employees to manage the mining site.

Based on this background, we analyze the factors that influence job selection in mining by using a discrete choice experiment. First, this study estimates the MWTA of the main factors in job selection form the estimation result of conditional logit model. Second, this study examines how much each individual characteristic affects job selection by logit estimation results. These results contribute to the discussion of how to achieve a stable labour supply in the mining industry in Australia.

2. Materials and Methods

2.1. Estimation Method

2.1.1. Conditional Logit Model

In this analysis, a random utility model is assumed. When subject n selects profile i, the subject's utility is given by $U_{n,i} = V_{n,i} + \varepsilon_{n,i}$, where $V_{n,i}$ is the observable component of $U_{n,i}$ and $\varepsilon_{n,i}$ is the unobservable component of $U_{n,i}$. The set of profiles that a subject n can select on the basis of $C = \{1, 2, \ldots, j\}$. The probability that a subject n chooses profile $i \in C$ is $P_{n,i}$. When subject n chooses profile i, $U_{n,i} > U_{n,i}(i \neq j)$ must be satisfied. Thus, the following equation is obtained:

$$
\begin{aligned}
\mathrm{P}_{n,i} &= \Pr\left[U_{n,i} > U_{n,j}, \forall j \in C, j \neq i\right] \\
&= \Pr\left[V_{n,i} - V_{n,j} > \varepsilon_{n,j} - \varepsilon_{n,i}, \forall j \in C, j \neq i\right]
\end{aligned}
\tag{1}
$$

Following McFadden (1973) [17], it is assumed that $\varepsilon_{n,i}$ and $\varepsilon_{n,j}$ are independent with a univariate type I extreme value distribution. Then, the probability that a subject n chooses profile i is

$$
\mathrm{P}_{n,i} = \frac{e^{\mu V_{n,i}}}{\sum_{j \in C} e^{\mu V_{n,i}}}
\tag{2}
$$

where μ is a scale parameter. In this paper, μ is normalized to 1. This model is known as a conditional logit model. Hence, the log-likelihood function is obtained:

$$
\ln L = \sum_{n=0}^{n} \sum_{i \in C} \delta_n^i \ln P_{n,i}
\tag{3}
$$

where N is the number of subjects, and δ_n^i is the dummy variable, such that $\delta_n^i = 1$ if subject n choses profile i and 0 otherwise. By maximizing the log-likelihood function, the parameters can be estimated.

2.1.2. Marginal Willingness to Accept (MWTA)

$V_{n,i}$ is the observable component of the utility of individual n when choosing the ith option. The utility component is assumed to have the following linear form:

$$
V_{n,i} = a_i d_i + \beta p_i
\tag{4}
$$

where d_i is the attribute vector and p_i is the price of option i, and a_i and β are the parameters. Assuming that $V_{n,i}$ is equal to the observable component of the utility associated with the status quo option, the following equation is obtained for the marginal willingness to accept (MWTA) for option i and the status quo:

$$
\mathrm{MWTA} = -\frac{a_i}{\beta_i}
\tag{5}
$$

where MWTA is the willingness to accept each option.

2.1.3. Logit Model

The MWTA for each option can be identified from the estimation results of the conditional logit model. However, the conditional logit estimation cannot show the effects of other individual characteristics and attributes of job selection. Therefore, a logistic regression approach is also utilized in this analysis. The logistic regression can handle both continuous and categorical explanatory variables. When subject n chooses profile i, it implies that: $U_{n1} > U_{n0}$, where U_{n1} and U_{n0} are the utilities that n associates with the option or not. The utility U_{nj} that alternative j ($j = 1$: selected as a preferred labour condition; $j = 0$: not selected as a preferred labour condition) gives individual n is composed of two

parts: a systematic term, which depends on variable vector X (wage, fatality rate, etc.), and a random term ϵ_{nj}:

$$U_{nj} = \overline{U}_{nj} + \varepsilon_{nj} \tag{6}$$

The utility U_{nj} is not observable. Decision Y_n is observed, which is worth 1 if individual n selects the option as a preferred labour condition and 0 if the individual does not select the option as preferred labour condition. If a rational individual chooses the alternative that gives the individual the greatest utility, the result would be given as:

$$\Pr[Y_n = 1] = \Pr\left[U_{n1} > U_{n0}\right] \tag{7}$$

$$\Pr[Y_n = 0] = \Pr\left[U_{n0} > U_{n1}\right] \tag{8}$$

It has been demonstrated by McFadden (1974) [17] that in this case the probability that student n selects alternative 1 is:

$$\Pr[Y_n = 1] = \frac{e^{X_n^0 \beta}}{1 + e^{X_n^0 \beta}} \tag{9}$$

2.2. Data Setting of Choice-based Conjoint Analysis

2.2.1. Data Collection

Data collection was conducted by a paper-based questionnaire survey on 26 October 2017. The purpose of this survey was to clarify what types of labour conditions at a mining site were preferred by students who were enrolled in fields related to mining using a choice-based conjoint (CBC) experiment. Respondents were students who were enrolled in fields related to mining engineering at Curtin University and at the University of Adelaide in Australia. The process and contents of survey were reviewed and approved by both Curtin University and the University of Adelaide. This survey did not include questions which ask for personally identifiable information in the survey. The survey was conducted in classes related to mining engineering at each university. The total number of students who were enrolled in the classes was 176. Of that total, 112 were students at Curtin University and 64 were students at The University of Adelaide. The number of female students was 27, and the number of male students 149. The response rate was estimated to be 52.8%. The number of students who participated in the survey was 95, including males and females aged 19–44 years. The number of valid responses was 93, including 45 students at Curtin University and 48 students at The university of Adelaide. Of the valid responses, 74 were by male students and 19 were by female students. The distribution of the respondents is shown in Table 1. The questionnaire consisted of a CBC experiment of labour conditions at a mining site and questions regarding individual characteristics, such as university, sex, age, and family, and questions related to risk preferences. Details of the choice experiment are presented in the next section.

Table 1. Subject details.

University ╲ Sex	Male Students	Female Students	Total
Curtin	36	9	45
Adelaide	38	10	48
Total	74	19	93

2.2.2. Choice-based Conjoint Experimental Modeling

This survey was carried out with an experimental choice-based conjoint model. The choice-based conjoint analysis can evaluate preferences more naturalistically by observing choice decisions comparing with traditional conjoint analysis [18,19]. This is compared with the revealed preference approach,

which deals with data observed from peoples' behaviors, the stated preference approach, which CBC is classified as dealing with data from people's hypothetical behaviors, specifically their choice behaviors in hypothetical situations [20]. In the case of choice behaviors for work in the mining industry, it is generally position-based due to required skills or experience for work rather than depending on their preferences on labour conditions, therefore the revealed preference approach would not be appropriate to investigate the preference of respondents from existing data. In that sense, CBC can elicit underlying preference of respondents by observing their choices among hypothetical options.

To assess students' preferences of the two universities for labour conditions at a mining site, eight patterns of questionnaires were designed and each of those contained eight choice sets. Each choice set consisted of 5 hypothetical options regarding labour conditions at a mining site. The options consisted of the six variables shown in Table 2. The wage attribute was set to estimate the value of each variable as MWTA and to reveal the effect of wage on job selection which was reported as a factor affecting job selection [7]. Prior research indicates that the working position and method attributes are related to differences in the working environment and injury rates [21]. Additionally, the fatality rate attribute was included as it has been shown that it is one of the problematic features of the labour environment at a mining site. A previous study by Windle (2013) [7] has shown that the working style attribute affects the job selection of new employees, and another report has mentioned that the working style in the mining industry is related to workers' mental health and life. It was speculated that the company attribute affects job selection, based on the results of a preliminary survey carried out at Curtin University. The variable and its definitions are attached as Appendix A.

Table 2. Attributes and levels in the conditional logit model.

Attributes	Levels
Wage (AUS Dollars)	70,000, 90,000, 110,000, 130,000, 150,000
Fatality rate (per 100,000 employees)	3/100,000, 5/100,000, 7/100,000
Working position	Mine planning, Blasting, Drilling, Geotechnical engineer
Style	Living near the site, Fly in Fly out
Method	Underground mining, Surface mining
Company	BHP, AngloGold Ashanti, Barrick, Rio Tinto, Paddington

Each option had four common features, specifically job tenure, fixed working hours of 8 hours per day from 8 am to 5 pm, typical insurance cover and being in Australia. The combination of the options in a choice set was set randomly for each 8 patterns of the questionnaires. Respondents were asked to select the most preferred option from the 5 hypothetical options in each choice set. In each choice set of the questionnaire, an answer of N/A, not applicable or not available, was not included as an option since it was observed that majority of the mining students have job in mining companies form the result of the preliminary survey carried out at Curtin University.

Specifically, respondents were asked to answer the following question: "Now we will ask your preferences for hypothetical labour condition in the mining site with different conditions. You will choose one out of five hypothetical job opportunities from A to E. Common features of the proposed job opportunities are 1) tenure jobs, 2) 8 hours per day from 8 am to 5 pm, 3) covering typical insurance such as life insurance, income protection, trauma insurance and total permanent disability insurance, 4) any hypothetical mining site in Australia. Job opportunities are characterized by six variables such as average annual wage after three years (AUS$), fatality rate in the mining site per 100,000, work position, working style, method, company." An example of a choice set used for the survey is shown as following Table 3.

Table 3. Example of a choice set in the survey.

Working Conditions	A	B	C	D	E
Annual average wage in the third year including bonus (AUS$)	70,000	100,000	150,000	90,000	110,000
Fatality rate per 100,000 employees within a year	3	5	7	3	5
Working position	Blasting	Mine planning	Blasting	Drilling	Mine planning
Style	Fly-in Fly-out	Living near site	Fly-in Fly-out	Fly-in Fly-out	Fly-in Fly-out
Method	Surface mining	Underground mining	Underground mining	Surface mining	Surface mining
Company	AngloGold Ashanti	Barrick	Rio Tinto	Paddington	BHP

3. Results

For analysis, conditional logit model and logit model were applied. The estimation results of the conditional logit model are presented in Table 4 and the results of the marginal effect of the conditional logit model are presented in Table 5. The results of the conditional logit model show that a total of 7 variables are statistically significant for determining preferable labour conditions from the students' perspective, namely, wage, fatality rate, working position dummies such as mine planning, blasting and drilling, living near site style dummy (*p*-value < 0.001), and BHP company dummy (*p*-value < 0.05). Each coefficient is estimated by referring to a set level as follows: geotechnical engineer for level of the working position, fly-in fly-out for the level of style, surface mining for the level of method, and Paddington for the level of the company. The result of marginal effect of the conditional logit model in Table 5 shows how the independent changes when the independent variables changes while covariates are assumed to be held constant. The order of preference of variable, referring to the levels, for students can be observed from the results of marginal effect of conditional logit model. Among the variables of working position, mine planning is most preferred by students, followed by blasting and drilling. Living near the site is more preferred than Fly-in Fly-out as working style, and BHP is more preferred than Paddington.

Table 4. Estimation results of the conditional logit model.

Attribute		Coefficient	Std. Err.
Wage		2.210×10^{-5}***	1.620×10^{-6}
Fatality rate		-0.0822***	0.026
Working position (Referencing Geotech engineer)	Mine planning	0.379***	0.115
	Blasting	-0.321***	0.124
	Drilling	-0.508***	0.131
Style (Referencing Fly-in Fly-out)	Living near site	-0.330***	0.086
Method (Referencing Surface mining)	Underground mining	-0.127	0.086
Company(Referencing Paddington)	BHP	0.300**	0.135
	AngloGold Ashanti	0.053	0.137
	Barrick	0.130	0.137
	Rio Tinto	0.176	0.136

There are 3720 total observations (93 respondents × 8 times questions × 5 options). χ2 (11) is 301.42. The asterisks *, **& *** indicate that the coefficients are significantly different from zero at the 10%, 5%, and 1% level, respectively. Log likelihood = −1659.4296.

Table 5. Estimation results of the marginal effect of the conditional logit model.

Attribute		dy/dx	Std. Err.
Wage		2.82×10^{-5}***	3.06×10^{-7}
Fatality rate		−0.010**	0.004
Working position (Referencing Geotech engineer)	Mine planning	0.040***	0.012
	Blasting	−0.042**	0.019
	Drilling	−0.07***	0.023
Style (Referencing Fly-in Fly-out)	Living near site	−0.042***	0.014
Method (Referencing Surface mining)	Underground mining	−0.016	0.011
Company(Referencing Paddington)	BHP	0.038**	0.016
	AngloGold Ashanti	0.007	0.018
	Barrick	0.017	0.018
	Rio Tinto	0.023	0.017

There are 3720 total observations (93 respondents × 8 times questions × 5 options). The asterisks *, **& *** indicate that the coefficients are significantly different from zero at the 10%, 5%, and 1% level, respectively.

Table 6 shows the estimation results of the MWTA based on the estimation results of the conditional logit model. The MWTA for each variable can be estimated based on Equation (5). The monetary value of the levels of different attributes can be estimated as MWTA. Each MWTA is calculated by the estimation results of conditional logit model, specifically by the ratio of the coefficient of each independent variable to the coefficient of the wage which are shown in Table 4. Based on the calculation results of the MWTA in Table 6, mine planning has the highest value for respondents among the levels of working position. Furthermore, the estimation results show that BHP has the highest value as a company for respondents. Among the estimation results of the levels of all attributes for MWTA, mine planning has the highest value, which means that mine planning needs the lowest compensation as regards the job conditions. Meanwhile, the drilling has the lowest value among the levels of all attributes for MWTA, which means drillings need the highest compensation as regards the job conditions.

Table 6. Estimation results of the marginal willingness to accept.

Attribute		Marginal Willingness to Accept: MWTA (1000 Australian Dollar)
Fatality rate		3.72
Working position (Referencing Geotech engineer)	Mine planning	−17.15
	Blasting	14.52
	Drilling	22.99
Style (Referencing Fly-in Fly-out)	Living near site	14.93
Method (Referencing Surface mining)	Underground mining	5.75
Company(Referencing Paddington)	BHP	−13.57
	AngloGold Ashanti	−2.41
	Barrick	−5.88
	Rio Tinto	−7.96

Additionally, the results of MWTA indicate respondents prefer to work in the fly-in fly-out style rather than to live near the mining site, which has been reported in a previous study [22]. It can be speculated that students are concerned about the costs of living and the availability of accommodation a mining town, as reported in a previous study [7].

The estimation results also indicate that mine planning, which generally does not require physical labour, is the most preferred working position for respondents, whereas working positions that require comparatively more physical labour, such as blasting and drilling, are less preferred than mine planning by respondents. The drilling, which typically needs work using heavy mechanical labour on site, has the lowest value in the levels of the working position.

Table 7 represents the estimated parameters of the logistic model for the main effects and the interactions between the main effects and variables of individual characteristics. The results regarding the main effects show that the variables of wage, fatality rate, mine planning, blasting, and drilling are significant (*p*-value < 0.1) in labour condition decisions. Meanwhile, the variables of living near the site, underground mine, BHP, AngloGold Ashanti, Barrick, and Rio Tinto have only a limited effect on labour condition decision making. The estimation results of the logit model without the interaction dummies show the same trend as the conditional logit model, which ensures the rigorousness of the signs of the independent variables.

Table 7. Estimation results of logit model including interactions.

Attributes and Interactions		Coefficient	Std. Err.
Wage		1.99×10^{-5}***	2.500×10^{-6}
Fatality rate		−0.071*	0.041
Working position (Referencing Geotech engineer)	Mine planning	0.430**	0.174
	Blasting	−0.353*	0.192
	Drilling	−0.664***	0.204
Style (Referencing Fly-in Fly-out)	Living near site	0.007	0.132
Method (Referencing Surface mining)	Underground mining	0.216	0.133
Company(Referencing Paddington)	BHP	−0.025	0.207
	AngloGold Ashanti	−0.220	0.212
	Barrick	0.08	0.204
	Rio Tinto	−0.028	0.205
Interactions			
Wage × Adelaide		6.510×10^{-6}**	3.29×10^{-6}
Wage × Female		−10.04	−9.07
Fatality rate × Adelaide		−0.046	0.053
Fatality rate × Female		0.022	0.065
Mine planning × Adelaide		−0.314	0.233
Mine planning × Female		0.535*	0.301
Blasting × Adelaide		−0.196	0.253
Blasting × Female		0.538*	0.321
Drilling × Adelaide		0.036	0.268
Drilling × Female		0.518	0.339
Living near site × Adelaide		−0.654***	0.177
Living near site × Female		-0.214	0.217
Underground mining × Adelaide		−0.423**	0.175
Underground mining × Female		−0.534**	0.217
BHP × Adelaide		0.663**	0.276

Table 7. *Cont.*

Attributes and Interactions	Coefficient	Std. Err.
BHP × Female	−0.134	0.337
AngloGold Ashanti × Adelaide	0.504*	0.28
AngloGold Ashanti × Female	0.051	0.337
Barrick × Adelaide	−0.069	0.279
Barrick × Female	0.182	0.338
Rio Tinto × Adelaide	0.446	0.278
Rio Tinto × Female	−0.229	0.346

There are a total of 3,720 observations (93 respondents × 8 times questions × 5 options). χ^2 (11) is 350.76. The asterisks *, **, *** indicate that the coefficients are significantly different from zero at the 10%, 5%, and 1% level, respectively. Log likelihood = −1666.0995.

Furthermore, the estimation results show that the interaction terms between individual characteristics of respondents and the main factors also affect job selection. In the interactions regarding working positions, interactions between mine planning and female, and blasting and female are significant (p-value < 0.1). The positive signs indicate that female respondents prefer mine planning and blasting rather than geotechnical engineering (which is set as the referring level) for labour conditions compared to male respondents.

In addition, the estimation results show that the interaction terms between The University of Adelaide and the main variables have significant relationships to job selection. The interaction term between wage and Adelaide is significant (p-value < 0.05). This means that students at The University of Adelaide prefer higher wages than students at Curtin University. This result indicates that there are differences in wage standards between the two areas. The interaction term between The University of Adelaide and living near site has a negative correlation (p-value < 0.001) to job selection. The interaction term between underground mining and female also shows a negative correlation. The negative signs indicate that students at The University of Adelaide tend to avoid selecting underground mine as a method compared to students at Curtin University and those female students tend to avoid selecting an underground mine as a method compared to male students. The interaction term between The University of Adelaide and company affiliation also shows a significant correlation with job selection. The interactions terms between BHP and The University of Adelaide and between AngloGold Ashanti and The University of Adelaide are also statistically significant. Regarding the differences between underground mining and surface mining, statistical data reports show that underground mining had a ratio of 0.1 fatal injuries per thousand employees from 2012–13 to 2016–17, whereas the ratio was 0.018 in the case of surface mining [21]. It is also known that women are more risk averse than men [23]. It can, therefore, be speculated that the trends were affected by the differences in the safety conditions of underground mining and surface mining and by gender characteristics of risk aversion.

4. Discussion

In this study, the factors that affect mining students' preferences for labour conditions at a mining site were assessed by CBC analysis. The data for the analysis was obtained from students who were enrolled in mining studies at Curtin University and The University of Adelaide in Australia by means of a paper-based questionnaire survey. Assuming a correlation between personal characteristics and factors related to labour conditions, the questionnaire also included questions regarding the individual characteristics of the respondents.

As was expected, the results of this study indicate that students prefer to work for higher wages and at lower fatality rates. However, of all the labour condition factor values in this study, mine planning showed the highest MWTA, although the experiment controlled for fatality rates. In addition, the level of drilling had the lowest value, which indicates that students expect the highest compensation for working as a driller among all the levels in this study. These results imply that companies need

to take the working conditions of drilling and blasting into consideration. One of the reasons that respondents tend not to select the drilling and blasting jobs is speculated as because of potential risks of non-fatal accidents or other dangers at the mining site. However, the estimation results of this study can be interpreted as that factors such as an aversion towards heavy physical labour and environment of mining site play a large role in not choosing such jobs, as the fatality rate is controlled as an attribute. Mining companies therefore need to consider not only the safety at the mining site but also the working environment of drilling and blasting if they want to more employ workers for such tasks. Moreover, the results of the conditional logit model indicate that students prefer not to live near the site, despite unfavorable effects on the mental health and lifestyle of the worker and the family associated with fly-in fly-out have been reported in Australia [24–27]. This result implies a possibility that psychological and physical risk by labour conditions might not be well understood or recognized by students. The occupational health in mining sector was examined as a factor which influences turnover rate [28]. To avoid that situation, objective and deeper understanding of the facts and health support to fill the gap between their understanding and experience on the site are conjectured to be effective.

Of course, the results of this study reveal that other relations among sociodemographic characteristics and factors influence job selection in mining. Specifically, the interaction between individual characteristics and the main variables show a significant correlation with job selection. These findings have not been mentioned in previous studies. The results suggest that employment contracts for mining workers can be optimized by adjusting the contracts for potential workers who have specific sociodemographic characteristics.

Finally, the limitations of this study should be noted. The results could possibly be biased by the context in which the survey took place. In the case of this study, a paper-based questionnaire survey was answered in a class at each university. It cannot be assumed that the students who were absent from class have similar characteristics in terms of job preferences, and this could lead to biased results. The result of this study does not imply the common preferences of all mining students on labour conditions in Australia. Although a statistical significance was observed in this study, limited applicability of the results to all Australian mining students because of limited number of respondents and the differences of preferences by universities should be noted. In this research, although we examined preferences of students on labour conditions in mining sites, it does not imply that meeting those preferences surely or directly gives students increased or satisfying wellbeing for their works.

It is recommended that future studies include more respondents to generalize the results. To apply the results of this study to broader trends in mining worker preferences, a comprehensive study that examines the preferences of experienced mining workers could contribute to more effective employment practices in the mining industry.

Appendix A

Table A1. List of variables.

Variables	Definitions	Contents
Wage	The average annual wage after three years (AUS$)	Numerical value
Fatality rate	Fatality rate at the mining site per 100,000 employees	Numerical value
Mine planning	A working position at a mining site	If it is chosen as a preferred working position = 1 If it is not chosen as a preferred working position = 0
Blasting	A working position at a mining site	If it is chosen as a preferred working position = 1 If it is not chosen as a preferred working position = 0
Drilling	A working position at a mining site	If it is chosen as a preferred working position = 1 If it is not chosen as a preferred working position = 0
Geotechnical engineer	A working position at a mining site	If it is chosen as a preferred working position = 1 If it is not chosen as a preferred working position = 0
Living near site	Living near the mining site where the respondent is assumed to be working	If it is chosen as a preferred working style = 1 If it is not chosen as a preferred working style = 0
Fly-in fly-out	Commuting by air to the mining site where the respondent is assumed to be working	If it is chosen as a preferred working style = 1 If it is not chosen as a preferred working style = 0
Underground mining	A mining method that excavates valuable materials by drilling underground	If it is chosen as a preferred method = 1 If it is not chosen as a preferred method =0
Surface mining	A mining method that excavates valuable materials near the surface of the earth	If it is not chosen as a preferred method =0 If it is chosen as a preferred method = 1
BHP	An existing mining company	If it is not chosen as a preferred company = 0 If it is chosen as a preferred company to work for = 1
AngloGold Ashanti	An existing mining company	If it is not chosen as a preferred company = 0 If it is chosen as a preferred company to work for = 1
Barrick	An existing mining company	If it is not chosen as a preferred company = 0 If it is chosen as preferred company to work for = 1
Rio Tinto	An existing mining company	If it is not chosen as a preferred company = 0 If it is chosen as preferred company to work for = 1
Paddington	An existing mining company	If it is not chosen as a preferred company = 0 If it is chosen as a preferred company to work for = 1

References

1. U.S. Geological Survey. IRON ORE. 2017. Available online: https://s3-us-west-2.amazonaws.com/prd-wret/assets/palladium/production/mineral-pubs/iron-ore/mcs-2017-feore.pdf (accessed on 23 September 2018).
2. U.S. Geological Survey. LEAD. 2017. Available online: https://s3-us-west-2.amazonaws.com/prd-wret/assets/palladium/production/mineral-pubs/lead/mcs-2017-lead.pdf (accessed on 23 September 2018).
3. U.S. Geological Survey. ZINC. 2017. Available online: https://prd-wret.s3-us-west-2.amazonaws.com/assets/palladium/production/atoms/files/mcs-2017-zinc.pdf (accessed on 23 September 2018).
4. Australian Government, Department of Mines, Industry Regulation and Safety. Labour Market Research and Analysis Branch. Industry Outlook Mining. *Poult. Sci.* **2014**, *69*, 2103–2106.
5. Bankwest. Skills Shortage Report. 2012. Available online: https://www.bankwest.com.au/about-us/media-centre/news?redirurl=/media-centre/financial-indicator-series/bankwest-skill-shortage-report-2012-1292487426050 (accessed on 10 June 2018).
6. McKenzie, F.H. Attracting and retaining skilled and professional staff in remote locations of Australia. *Rangel. J.* **2011**, *33*, 353–363. [CrossRef]
7. Windle, J.; Rolfe, J. Using discrete choice experiments to assess the preferences of new mining workforce to commute or relocate to the Surat Basin in Australia. *Resour. Policy* **2013**, *38*, 169–180. [CrossRef]

8. Amponsah-Tawiah, K.; Jain, A.; Leka, S.; Hollis, D.; Cox, T. Examining psychosocial and physical hazards in the Ghanaian mining industry and their implications for employees' safety experience. *J. Saf. Res.* **2013**, *45*, 75–84. [CrossRef] [PubMed]

9. Street, T.D.; Lacey, S.J.; Somoray, K. Employee stress, reduced productivity, and interest in a workplace health program: A case study from the Australian mining industry. *Int. J. Environ. Res. Public Health* **2019**, *16*, 94. [CrossRef]

10. Varga, J.; Nagy, I.; Szirtes, L.; Pórszász, J. Physiological strain in the Hungarian mining industry: The impact of physical and psychological factors. *Int. J. Occup. Med. Environ. Health* **2016**, *29*, 597–611. [CrossRef]

11. Di Marco, D.; Arenas, A.; Giorgi, G.; Arcangeli, G.; Mucci, N. Be friendly, stay well: The effects of job resources on well-being in a discriminatory work environment. *Front. Psychol.* **2018**, *9*, 413. [CrossRef]

12. Parker, P.D.; Jerrim, J.; Anders, J. What effect did the global financial crisis have upon youth wellbeing? Evidence from four Australian cohorts. *Dev. Psychol.* **2016**, *52*, 640–651. [CrossRef]

13. Omar, M.K.; Zakaria, A.; Ismail, S.; Sin, J.S.L.; Selvakumar, V. Job Selection Preferences of Accounting Students in Malaysian Private Universities. *Procedia Econ. Finance* **2015**, *31*, 91–100. [CrossRef]

14. Meyerding, S.G.H. Job preferences of agricultural students in Germany—A choice-based conjoint analysis for both genders. *Int. Food Agribus. Manag. Rev.* **2018**, *21*, 219–236. [CrossRef]

15. Blaauw, D.; Erasmus, E.; Pagaiya, N.; Tangcharoensathien, V.; Mullei, K.; Mudhune, S.; Goodman, C.; English, M.; Lagarde, M. Policy interventions that attract nurses to rural areas: A multicountry discrete choice experiment. *Bull. World Health Organ.* **2010**, *88*, 350–356. [CrossRef] [PubMed]

16. Cleland, J.A.; Johnston, P.W.; Anthony, M.; Khan, N.; Scott, N.W. A survey of factors influencing career preference in new-entrant and exiting medical students from four UK medical schools. *BMC Med. Educ.* **2014**, *14*, 151. [CrossRef] [PubMed]

17. McFadden, D. *Conditional Logit Analysis of Qualitative Choice Behavior*; Academic Press: New York, NY, USA, 1974; pp. 105–142.

18. Green, P.E.; Krieger, A.M.; Wind, Y. Thirty Years of Conjoint Analysis: Reflections and Prospects. *Interfaces* **2001**, *31*, 56–73. [CrossRef]

19. Green, P.E.; Srinivasan, V. Conjoint Analysis in Consumer Research: Issues and Outlook. *J. Consum. Res.* **1978**, *5*, 103–123. [CrossRef]

20. Louviere, J.; Williams, M.; Adamowicz, M.W.W. Combining Revealed and Stated Preference Methods for Valuing Envrimental Amenities. *J. Environ. Econ. Manag.* **1992**, *26*, 271–292.

21. Government of Western Australia, Department of Mines, Industry Regulation and Safety. *Safety Performance in the Western Australian Mineral Industry, Accident and Injury Statistics 2016–2017*; Department of Mines, Industry Regulation and Safety: Western Australia, Australia, 2018; p. 46.

22. Rolfe, J.; Miles, B. Lessons from the social and economic impacts of the mining boom in the Bowen Basin 2004-2006. *Australas. J. Reg. Stud.* **2007**, *13*, 134–153.

23. Croson, R.; Gneezy, U. Gender Differences in Preferences. *J. Econ. Lit.* **2009**, *47*, 448–474. [CrossRef]

24. Lifeline, W.A. *FIFO/DIDO Mental Health Research Report 2013*; Lifeline WA: Western Australia, Australia, 2013; p. 108.

25. Cooke, D.C.; Kendall, G.; Li, J.; Dockery, M. Association between pregnant women's experience of stress and partners' fl y-in- fl y-out work. *Women Birth* **2018**, *32*, e450–e458. [CrossRef]

26. Rebar, A.L.; Alfrey, K.L.; Gardner, B.; Vandelanotte, C. Health behaviours of Australian fly-in, fly-out workers and partners during on-shift and off-shift days: An ecological momentary assessment study. *BMJ Open* **2018**, *8*. [CrossRef]

27. Gardner, B.; Alfrey, K.L.; Vandelanotte, C.; Rebar, A.L. Mental health and well-being concerns of fly-in fly-out workers and their partners in Australia: A qualitative study. *BMJ Open* **2018**, *8*. [CrossRef]

28. Amponsah-Tawiah, K.; Ntow, M.A.O.; Mensah, J. Occupational Health and Safety Management and Turnover Intention in the Ghanaian Mining Sector. *Saf. Health Work* **2016**, *7*, 12–17. [CrossRef] [PubMed]