Socio-Economic Determinants of Advanced Level subject Choice in Zimbabwe

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Abstract
The study was undertaken to establish the socioeconomic determinants of A' level subject choice in Zimbabwe in an effort to understand why there is the low uptake of sciences in Zimbabwean high schools. Using data from over 2300 randomly selected Advanced level students from all provinces and across each of the three main subject specializations, under the Logit and Granger causality methods, we established that students who are more exposed to science environment prior to enrolling by having relatives with a science-related profession or attending a carrier guidance, are more likely to take up sciences. Boys are more likely to take sciences so are those who would have performed well in sciences relative to non-sciences at ordinary level. Children whose tuition is paid by biological parents are more likely to take up sciences at A' level, so are children from smaller families. Students with either or all of their parents deceased are less likely to take sciences. The results show that those enrolling at boarding schools are more likely to take up sciences than their day school counterparts. Rural students are less likely to take up sciences so are students learning at school with poor prior science pass rate. We recommend collaborative effort from governments, NGOs, industry and tertiary education institutions to improve student's interest in science. This can be accomplished by undertaking well-timed carrier guidance workshops. More so, the government should improve the quality of schools to improve their ability to teach sciences. This involves improving the quality of both laboratories and teaching staff. Like any investment, uptake of sciences is seen to be heavily dependent on the perceived rate of return, and hence the government should improve employment opportunities for science graduates by resuscitating industry and provide funding for research and development so that students can be inspired by observing successful people from science backgrounds.

KEYWORDS: *STEM, Subject choice, Science-based growth*

JEL: I25, H75, I21

1. Introduction and background

The recent past has been seen focus shift in most developing countries towards a more entrepreneur oriented teaching. Most governments have adopted the Science, Technology, Engineering, and Mathematics (STEM) as a major driver in developmental policies. STEM is expected to create entrepreneurs who develop ideas and prototypes that suit the environment in which they live (White, 2014). Such ideas and prototypes would then be commercialized and thus create employment and improve livelihoods.

In Africa however, several challenges have been met in an attempt to adopt STEM-based economic growth. One major challenge is infrastructural deficiencies and poor funding. STEM requires heavy funding as science and engineering require state of the art laboratories from junior levels. It is equally important that there be competent teachers to guide students otherwise students may end up having STEM-related qualification but fail to bring up any ideas or prototypes usable in the communities that they live. Moreover, since innovation is research driven, funding is also important for research and development. If governments are serious about the STEM, then they should also channel significant resources towards scientific research.

Another major challenge that is faced is subject 'phobia' and general low uptake of sciences. In Zimbabwe, only 18% of students studying A' level have science specializations in 2014 as opposed to commercials 47% and 33% for arts (GoZ, 2015). This statistic is indeed worrisome for the proponents of the STEM because it provides evidence of science uptake dilemma. It cannot be overemphasized that STEM-based economic growth would require people with scientific literacy and hence low uptake of sciences at high schools would obviously mean specialization choice that is generally nonscience and hence low enrolment in tertiary institutions.

Efforts to improve human resource expertise in science disciplines would therefore meaningfully start at understanding the sources of low uptake of sciences at the high school level. The study was thus conducted to find out why there is a general low science uptake in Zimbabwean high schools. It will be important as it informs policymakers about the likely sources of science exclusion and efforts to increase science personnel would start by understanding why students shun sciences.

2. Data and Methods

To determine factors affecting science uptake in high schools we used a quantitative approach that minimizes subjectivity bias. A quantitative approach allows an individual, family and environmental factors to freely interact in a scientific setup and hence reduces bias. We presume that an individual student's decision to take-up sciences at A' level is influenced by some underlying individual, family, and school-related factors peculiar to him.

2.1 Theoretical model

We begin by assuming that up taking science subjects at advanced level function is stochastic and is of the form:

$$y_i = x_i\beta + \varepsilon_i \qquad (1)$$

where y_i is a binary outcome; (Bindu and Chigusiwa, 2013)?

Logit models used for modeling binary outcomes are often expressed in terms of a latent variable specification. They assume that there is some continuous variable y^* that determines up taking science subjects. This latent variable is modeled by a linear regression function of individual, environmental, cultural and socioeconomic characteristics of the student and the school characteristics represented by vector x:

$$y_i^* = x_i\beta + \varepsilon_i \qquad (2)$$

This latent variable is not observable. What is observed is the binary variable y, that is, a student taking up science at A' level or not. The binary variable is defined by

$$y_i = \begin{cases} 1 \; if \quad y_i^* > 0 \quad and \\ 0 \quad otherwise \end{cases} \qquad (3)$$

The probability that y = 1 given **x** vector of variables is thus given by:

$$P(y_i = 1 | \mathbf{x_i}) = P(y_i^* > 0 | \mathbf{x_i}) \qquad (4)$$

Substituting equation (2) into equation (4) gives:

$$P(y_i = 1 | \mathbf{x}_i) = P(\mathbf{x}_i\boldsymbol{\beta} + \varepsilon_i > 0 | \mathbf{x}_i)$$

$$= \mathrm{F}(\mathbf{x}_i\boldsymbol{\beta}) \qquad (5)$$

By assuming that ε follows a logistic distribution, F becomes a cumulative distribution function for the logit model. To see the partial effects of each explanatory variable on the dependent variable y, marginal effects are computed by taking the partial derivatives of equation (5) with respect to each explanatory variable x (Gujarati, 2003).

By considering our study's objectives, theory and data we specified the following subject choice model;

$$P(SUBCH = 1/X) = F(\eta_i, \lambda_i, \gamma_i) \qquad (6)$$

Where η_i is a vector of student's innate and preference characteristics, λ_i is a vector of student's family characteristics and γ_i being a vector of school characteristics. Hence equation 6 say that the subject choice of a student will primarily depend on his innate abilities and preferences as of the time he finishes the ordinary level as these cannot be assumed constant across time. In addition, it will also depend on his family background and characteristics. Even though we observe a strong correlation between individual and family characteristics, it is important to single out the contribution of family background from individual choice. Family characteristics, in this case, mirror the ability of the student to meet financial commitments both directly through tuition payment and indirectly through opportunity costs of elongated schooling. γ_i shows school factors that affect choice. The school that one attends ordinary and advanced levels can brighten or dampen science interest. It is not unreasonable to think of science uptake as dependant on availability of science infrastructure at the enrolling school. Therefore if students know that they will enroll at a school that doesn't have the capacity to teach sciences their interest in science will be dampened competently. Expanding equation 6 would give equation 7.

P (SUBCH = 1|X) = F (***SSC, GEN, AGE, OQAUL,*** **OSCI**, ***ARES, ORES***, *CONTI*, **PAYDIF**, **SPO**, DECP, FAMS, FAMP, **AGEO, OGEO**, **AMAN, OMAN**, ASCOR, OSCOR, **ATYP, OTYP**,) (7)

Where SUBCH is A' level subject choice, SSC is an index of environmental factors affecting students social capital, GEN and AGE represent students gender and age respectively. OQUAL is quality of ordinary level science passes relative to non-sciences, OSCI measures whether a student did adequate science subjects at an ordinary level to enable him to uptake A' level sciences, ARES and ORES are advanced and ordinary level residence status. CONTI is whether a student continued for A' level at a school he did his ordinary levels. PAYDIF, SPO, and DECP measure incidences of school-related costs difficulties, whether one's school-related cost is borne by biological parents and whether one or both of the biological parents are deceased respectively. FAMS and FAMP are the family size and position respectively. AGEO, OGEO, AMAN, OMAN, ATYP, OTYP are advanced and ordinary level school geographical location, management, and type respectively. OSCOR and ASCOR are ordinary and advanced school science orientation respectively.

The equation (equation 7) says that the probability of a student up taking science at A' level given observed characteristics X is given by a function F. By assuming that the stochastic term follows a cumulative logistic distribution, F becomes a cumulative distribution function for the logit model. Hence, equation (7) is a logit model. The maximum likelihood estimation technique is used to estimate the marginal effects of the independent variables in equation (7) since OLS would break down in a situation where the dependent variable is dichotomous (Gujarati, 2004).

2.2 Justification of variables

Dependent variable

Our dependent variable is subject choice SUBCH. As highlighted earlier, this is a dummy variable which takes a value of 1 if the student does choose a science combination at an advanced level and value of zero if he does not take a science combination. Because of subject proliferation and the existence of a myriad of combinations that students take at the ordinary level we defined a subject combination as science if the student takes up at least two of the following science subjects. (Mathematics, Physics, Chemistry, Biology and Computer sciences). Whilst we understand that we have excluded a number of subjects that are generally categorized as sciences, e.g., geography agriculture and technical graphics, enrolment figures for Zimbabwe doesn't show reduced numbers in these fields.

Exogenous variables

Our explanatory variables are categorized as an individual, family, and school-related characteristics.

Individual factors

The student *social capital* enables him to choose A' level subject combinations wisely (Kerka, 2000). In fact, to the extent to which there are information costs associated with A' level subject choice, students with low science-related social capital are likely to have higher transaction costs and hence are less likely to uptake sciences. We created an index variable SSC, comprising of six independent measures that would proxy the depth of social capital the student possess before deciding on the subject combination. Most of the questions had binary yes or no responses. A 'yes' response would score one point while a 'no' response would score zero. The respective student index would then be total points earned as a fraction of the total possible hence SSC would assume values between zero and one with the former signifying least possible and the latter maximum possible social capital. The questions included whether one had ever attended carrier guidance (Harvey, 1984), whether one has family members with a science-related profession (Taylor et al., (2004), whether he views sciences to be difficult in comparison with arts and commercials, whether the student has intrinsic preference or interest in pursuing a science-related carrier, whether he thinks sciences are more rewarding or esteemed compared to non-sciences and lastly whether one has a role model who has a science carrier. The expected sign of the coefficient of this variable is positive since more social capital reduces transaction costs associated with science choice and hence increases uptake of sciences.

Girls are less likely to take up sciences. This is because patriarchal nature of Zimbabwean society just likes most African countries. Even in the wake of feminist's gospel, women's role is largely supportive and hence are likely to take shorter and perceptionally easy routes to employment than their male counterparts ceteris paribus. We, therefore, created a dummy variable for gender, GEN, taking the value one for male and zero otherwise. The expected sign of the variable parameter is positive. Age *is* more likely to affect subject choice negatively. Enrolling late for A' level might signify earlier academic, health or financial challenges on the part of the student. Such challenges are likely to force the student to choose non-science combination because non-science specializations are perceived to be easier and providing a shorter route to employment. A negative relationship is expected between science uptake and age of the student.

Students are likely to take up sciences if they would have done them at O' level because this would form the basis for advanced level studies. We created a dummy variable OSCI that takes a value of one if the student would have done at least 3 of any recognized science subjects at ordinary level and taking the value of zero for students taking less than 3 of such subjects. We also posit that the quality of ordinary level passes also seems an important determinant of subject choice. Students who pass science subjects more in relation to non-sciences will be more likely to take up sciences at an advanced level. To factor in the aforementioned, we created an index number to proxy student science quality at ordinary level OQUAL. For the best three science passes (as explained earlier) we compare with best three non-science grades at O' level. A grade of A would score 5 points descending and E scoring 1 point. We then sum the non-science score and subtract it from science score. The score lies between 15 and -15. Positive figures would indicate more science ability at O' level whilst negatives show non-science strength. We expected positive relationship for the variable.

Another individual characteristic that is likely to affect subject choice is residence status both at ordinary and advanced level. Boarding students do commit more time to studying compared to day scholars who commit considerable time commuting and also doing household chores at home. In a situation where there is a general perception that sciences are more demanding than arts or commercials, boarding students are likely to have a higher probability of choosing sciences than day scholars. We thus included dichotomous variables ORES and ARES which takes the value of one for boarding students at O' and A' level respectively and zero otherwise. These variables are expected to have a positive relationship with science choice. Students who know that they will enroll for A' level as day scholars would shy away from sciences because they know that they will be doing their schooling part-time.

Family characteristics

As argued earlier, the role of family background in determining student subject choice at A' level cannot be overemphasized. Poor families might struggle not only to raise tuition for good schools which might have better science infrastructure but also have higher transaction costs associated with such enrolments and hence members of such families are forced into nonscience specializations. Moreover, the family labour supply model highlights that an individual labour supply decision is not strictly independent but depends heavily on decisions of other household members. To that effect, an individual might be forced to choose a shorter route to the labour force because of income deficiencies and poverty on the part of the family that he hails from. In situations where perceptions are rife that nonsciences provide shorter routes to the labour market on average members of poor families might be forced into nonscience specializations.

Students who had all or either of their parents deceased are likely to be under pressure to leave school to earn some income and assume responsibilities at home. Even in situations where the living parent seems quite managing, such students normally have a feeling that the living parent is overburdened than what could have been the case had the deceased been still around. It is not unreasonable to think that the aforementioned feelings might be significant to force the students into nonscience specialization at A' level. We included a switch variable PAREDEC which takes a value of one if the student has one or all of his parents deceased and zero otherwise. A negative relationship is expected with science uptake.

We also created a binary variable SPO which takes the value of one if the student school related cost is borne by their biological parents and zero otherwise. Students who get sponsorships from elsewhere and not parents are likely to shy away from subject combinations which are more costly both in the short term and long term. In particular, they are more likely to choose shorter and cheaper routes to employment as the psychological effect associated with burdening already struggling extended family sponsors would force would be science students to reconsider their choices. The expected sign of this coefficient is negative.

Additionally, the size of the family from which one comes directly affects subject choice. Ordinarily, members of larger families face more financial challenges other things being equal. Such challenges will obviously affect their subject choices in ways that are fundamentally different from those from smaller families. We included a discrete variable FAMSIZ. Moreover, the position upon which the student is born will further affect the family's overall expected schooling cost. In particular, children born later in the family enjoy relatively more financial freedom than their predecessors because of reduced financial obligation as older siblings would have moved out of their parents' custody. In some circumstances, older siblings might assume educational cost responsibility of their younger siblings. Moreover, income stability is always a positive function of age hence children born later in the family are usually born of richer parents than their predecessors. We created a variable FAMPOS which we standardized by dividing by family size to cater for the family size heterogeneity. The relationship of this variable and uptake is likely to be ambiguous.

School characteristics

Interest in a science discipline is heavily affected by the availability of science-related infrastructure. In fact, students are not likely to take up sciences if the school in which they are enrolled does not have the capacity to teach science subjects competently. It is in this respect that school characteristics play an important role in discouraging or encouraging uptake of sciences. Because the particular variables embedded in school characteristics are numerous and difficult to measure singularly, we proxy such characteristics by the number of science subjects they offer. We, therefore, created dummy variables OSCOR and ASCOR which take the value of one if the school upon which one did ordinary and is doing advanced level respectively offers at least five science subjects at ordinary level and three subjects at an advanced level as explain before and zero otherwise. The expected sign of both coefficients is positive as the characteristic promote science uptake.

We also wanted to find out whether there are differences in uptake by school type, school location, and school management. It is not unreasonable to think that students enrolling for the ordinary level at rural schools are less likely to take up sciences than their urban counterparts other things being controlled for. Similar argument goes for students that attend day schools, and government schools against their boarding, and private schools counterparts. Dummy variables OGEO, OTYP, OMAN, were created taking the value of zero for those who did O' level at rural, day and government schools respectively and one otherwise. For all these variables a positive relationship is expected. Even after ordinary level, infrastructural deficiencies at advanced level might inform choice. In a setup where there are heterogeneous characteristics at A' level, the same variables discussed above might affect uptake. We, therefore, created variables AGEO, ATYP, AMAN which takes the value of zero if the student is doing his A' level at rural, day, government school and 1 otherwise.

2.3 Data sources

Because data on individual, family and school characteristics are not readily available we collected primary data. Since the research population includes all advanced level students in Zimbabwe, the spatial distribution of the population poses a huge budgetary concern. We, however, feel that by using a mix of stratified and purposive sampling we would significantly reduce cost without proportionately sacrificing sample representativeness. We had proposed to target at least 6000 respondents across all of the 10 administrative provinces in Zimbabwe, where each province would provide at least 10 schools and each school providing at least 60 participants across all the three A' level subject specializations. In each province, we ensured that all the school heterogeneity characteristics are included (For example boarding/ day, government/ missionary/ private, urban/ rural). On implementation, however, only 3 780 participants were obtained representing 63% of our targeted sample. This was largely because of low student numbers from some predominantly rural provinces were schools would have at times only 15 upper six students doing predominantly non-sciences. In such situations, the 600 students per province target were exceedingly high because of low numbers of A' level students. Provinces like Matabeleland North, Mashonaland East, and Mashonaland Central being the major culprits. Of the 3780 responses that we had only 2374 were usable, and 1406 were not usable owing to vital data omissions. This represented 62.8% of the returned questionnaires and 40% of the initial 6000 targeted students. Omissions were rife in Harare province, Manicaland, and Mashonaland East. This might have been due to inadequate training of our research assistants owing to budgetary constraints.

2.4 Data descriptive statistics

Our effective sample size was 2374. The table below shows some summary statistics with respect to the sample. We will discuss some few selected individual, family and school characteristics.

Summary Statistics

	Variable	Mean	Median	Max	Min	SDev	Skew	Kurto	JB	P(JB)
DEPENDANT	SUBCH	0.189	0	1	0	0.392	1.58	3.51	1018	0
INDIVIDUAL	AGE	17.9	18	24	16	1.21	1.2	5.24	1064	0
	CONT	0.61	1	2	0	0.49	-0.4	1.31	339	0
	GEN	0.41	0	1	0	0.49	0.35	1.12	397	0
	OQUAL	-0.876	-1	14	10	2.23	0.33	9.689	4463.31	0
	SSC	0.56	0.67	1	0	0.27	-0.3	2.09	126	0
	ARES	0.505	1	2	0	0,502	0.002	1.052	375.06	0
	ORES	0.514	1	2	0	0.513	0.09	1.373	265.26	0
	OSCI	0.678	1	1	0	0.467	-0.76	1.582	429.16	0
FAMILY	FAMP	2.17	1	14	1	1.89	2.25	8.66	5170	0
	FAMS	3.56	4	9	1	2.11	0.31	2.22	98.2	0
	PAYDIF	0.27	0	1	0	0.44	1.04	2.08	511	0
	SPO	0.70	1	1	0	0.46	-0.87	1.763	453.2	0
	DECP	0.274	0	11	0	0.576	6.77	107.8	1E+06	0
	PAROCC	0.60657	1	1	0	0.4887	-0.44	1.19	399.25	0
SCHOOL	ASCOR	0.572	1	1	0	0.495	-0.29	1.084	396.37	0
	OSCOR	0.752	1	1	0	0.432	-1.17	2.367	580.41	0
	OMAN	0.63	1	1	0	0.483	-0.54	1.287	403.8	0
	AGEO	0.36	0	4	0	0.5	1.15	5.85	1327	0
	OGEO	0.4	0	4	0	0.53	1.37	8.08	3297	0
	ATYP	0.891	1	1	0	0.3113	-2.52	7.323	4350.98	0
	OTYP	0.892	1	1	0	0.31	-2.52	7.39	4440.1	0
	AMAN	0.954	1	1	0	0.21	-4.32	19.63	34729	0

According to the data, 41.4% of the students were males against 58.6% females. This seems to be an encouraging statistic for feminist groups in light with gender balance in overall enrolment. However, of the students enrolling in sciences, only 36% are females. This, therefore, implies that even though women are not excluded from schooling in general, they seem not to be well represented in science specializations. We also observe that social capital index have an overall average of 0.56 showing that in general students will be having considerable science information. The average for science students is 0.6 while that for non-scientists is 0.5. The science quality of ordinary level passes has an overall average of -0.876 implying that in general students pass nonsciences better than sciences. The average for science students is 0.533 while for non-sciences it is -1.206. This statistic shows that in general sciences at ordinary level yield lower pass rates in comparison to arts and commercials. Major highlights for family characteristics were that 70% of our participants were sponsored by their parents and the remaining 30% were sponsored either by members of the extended family, the government and also non-governmental organizations. Only 19% of students doing sciences have nonparental sponsors. For school-related characteristics, we observe that 36% of the respondents were drawn from urban schools and 64% were drawn from either rural or farm/mine schools. This shows that 64% of A' level students are studying outside major town and cities which is proportional the 70:30 rural to the urban demographic statistic for Zimbabwe. Another interesting statistic is that 63% of the students were drawn from government schools and 27% where from either private/ mission schools. If the government and rural schools are expected to be generally underfunded, these statistics will imply that the majority of the students are likely to be excluded from science specialization. These statistics also poses infrastructural concerns especially in a situation where rural schools are expected to be underequipped both in terms of physical and human resources. The Jarque Bera statistics shows nonnormality for all variables. However since logit doesn't depend heavily on normality, we continue with our estimation.

Of the provinces Masvingo provided the highest number of respondents 584 representing 24.6%, Matebeleland South province 472 representing 20%, Bulawayo 318 representing to 13.4%, Manicaland had 217 respondents resulting in 9%, Mashonaland East had 188 resulting in 8%, Matebeleland North had 163 results to 6.8%, Midlands had 146 resulting to 6%, Mashonaland central had 119 representing 5.0%, Harare had 96 respondents resulting in 4%, and Mashonaland West had 71 respondents representing 3%.

Data will be analysed through logit modelling using Stata version 11. Granger causality test would also be done using Eviews 7 software package to establish whether there is a causality between our independent variables and subject choice. Microsoft Excel would also be used for preliminary statistical tests like analysis of variance.

3. Results and discussion

The results indicate that 18.9% of the students sampled in 2014 up took sciences. The remainder did either commercials or arts. We test a hypothesis that science uptake is indeed low in Zimbabwe. By assumption, assuming homogeneous preference of discipline we observe that a student's probability of up taking sciences should be 33%. The results demonstrate an observed probability of 19%. Running a t-test assuming equal variance under the null hypothesis of zero mean difference indicates a t statistic of -17,865 significant at all levels. We, therefore, reject the null hypothesis of zero mean difference and conclude that 19% is indeed statistically lower than 33% given our sample size and variances hence the results support the claim that there is the general low uptake of sciences in Zimbabwe.

We also establish that there is a significant gender difference in uptake. In particular, only 36% of students studying science in 2014 were girls. Running a sample t-test under the hypothesis of zero mean difference and equal variance a test of -11,1% was obtained indicating evidence against the null hypothesis. We, therefore, concluded that boys on average uptake sciences more than girls.

Logit and Granger causality results

Dependant variable: SUBCH

Category	Variable	Odds ratios	P value	GC F-statistic	p-value
individual	**SSC**	**6.629406*** **	**0.0000**	**22.0396*** **	**0.0000**
	GEN	**3.733484*** **	**0.0000**	**3.25131 ** **	**0.0397**
	OQUAL	**1.397724*** **	**0.0000**	**4.63624 *** **	**0.0098**
	OSCI	**19.96466*** **	**0.0000**	**5.48792 *** **	**0.0042**
	ORES	**0.4824528*****	0.0000	0.45822	0.6325
	AGE	**0.921235**	0.2116	2.78405	0.0620
	ARES	**1.06449**	0.7302	0.18002	0.8353
	CONTI	**1.064503**	0.6713	1.34572	0.2606
Family	FAMP	**0.8854279*****	0.0035	0.53413	0.5862
	FAMS	**1.124486*** **	**0.0008**	**3.92206 ** **	**0.0199**
	SPO	**1.525501** **	**0.0127**	**5.32489 *** **	**0.0049**
	DECP	**0.7255025** **	**0.0368**	**3.68884 ** **	**0.0251**
	PAROCC	**0.5856709*****	0.0003	1.51254	0.2206
	PAYDIF	**1.160179**	0.3422	2.69628	0.0677
School	**AGEO**	**1.455757** **	**0.0439**	**9.91401 *** **	**0.0005**
	OGEO	**1.789881*** **	**0.0002**	**4.84139 *** **	**0.0080**
	AMAN	**0.1492324*** **	**0.0000**	**4.56949 ** **	**0.0105**
	OMAN	**2.011098 *** **	**0.0000**	**3.67894 ** **	**0.0254**
	ASCOR	**1.844594*** **	**0.0001**	**3.24132 ** **	**0.0393**
	OSCOR	**2.485998*****	0.0000	1.47990	0.2279
	ATYP	**0.464871**	0.1163	2.78870	0.0617
	OTYP	**1.319368**	0.550	0.85365	0.4260

After running logit regression of equation 7, using Stata 11 software we found that of our 22 specified regressions, 16 regressors were significant in determining subject choice for our high school students in 2014. Specifically, of the individual factors, the students age, A' level continuation, and A' level residence status were found not to be significant in explaining the subject choice. For family-related characteristics, the difference between tuition payable to sciences and non-science and the parent's occupation doesn't affect choice. For school-related characteristics, the school type both at an ordinary and advanced level doesn't affect choice advanced level subject choice.

Individual characteristics

As the results in table 2 show, only four of the seven individual factors affect subject choice at A' level. The student social capital affects subject choice. The coefficient of the SSC is 1.83 which is significant at all levels. Granger causality tests yielded an F statistic of 22.04. Under the null hypothesis that SSC doesn't Granger-cause subject choice with a p-value of 0.0000. Therefore, we reject the null hypothesis and conclude that SSC granger causes subject choice. As expected the MLE coefficient is positive implying that individual's chances of choosing A' level sciences are higher if the student possesses elements in the student social capital index as explained before.

Gender also significantly determines student subject choice. The results indicate that male students are 1.31 times more likely to choose science subjects that their female counterparts other things being held constant. The coefficient is statistically significant at all levels. Granger causality results also support the regression results. An F statistic of 3.25 significant at the 5% significance level allows us to reject the null hypothesis of no causality at least with 95% confidence. The result might bear testimony to the patriarchal nature of our Zimbabwean society. It certainly provides support the conventional family labour market decision models where the role of women is largely supportive hence in a situation where sciences are deemed more difficult in comparison to non-sciences, girls might be content with studying non-sciences. The result might also support the claim that household chores for girls are more time consuming than those for boys and hence girls have lesser time to commit to a school. This would thus force them into choosing non-science specialisations which they deem to be less demanding.

Quality of ordinary level passes affects subject choice. The coefficient of this variable is 0.33 significant at all levels. Granger causality shows give an F statistic of 4.64 significant at 1% level. The results show that individuals who would have passed sciences better in comparison to non-sciences as measured by OQUAL are likely to choose them at A' level. The reasons behind this are numerous, for example, if one fails sciences relative to non-sciences he will be discouraged to take them. Above all, the initial ordinary level science performance might be due to science interest at the junior level or mere science ability all of which are upward in science uptake. As expected, students who would not have done sciences at ordinary levels are three times less likely to do sciences at A' level than those who would have done them. This is largely because of the absence of firm foundation upon which to build A' level studies. It is also important to highlight that they might be simultaneity bias for the result in the sense that an underlying variable that made one not to do sciences at ordinary level might still affect choice at an advanced level. Even in light of this for our purposes, we can still argue that students with a weak science background shy away from them.

Family characteristics

Three of the six family characteristics affected subject choice. Students with either or both of the parents deceased are 0.314 times less likely to choose sciences at an advanced level other things being equal. The coefficient of the variable is statistically significant at the 5% significance level. A Granger causality test for this variable produces an F statistic of 3.689 again significant at the 5%. We, therefore, conclude that having a deceased parent negatively affects science uptake at an advanced level. As highlighted earlier this might show the indirect cost of schooling in terms of forgone income especially in a situation where sciences are deemed to have an elongated path to the labour market.

Closely related to deceased parent is the sources of school-related funding. We found that students who have their parents paying for school related cost are 0.424 times more likely to do sciences ceteris paribus. The coefficient is significant at the 5% significance level. Granger causality results confirm that sponsor affect uptakes with an F statistic of 5.3 significant at the 1% level of significance. The effect of this variable can be thought of as both direct and indirect. A direct effect arises as a student shy away from sciences merely because his sponsor cannot afford to send him to schools that can competently teach sciences. This is more likely to be the case when the sponsor is part of the extended family is as the most common case. Sending to school in these situations normally covers basic schooling which is relatively cheaper and hence might have shortcomings in their ability to sciences. Indirectly, the student himself might understand the pressure that he is putting on these well-wishers and the desire to reduce their burden might indirectly force the student into nonscience specialisations which are relatively cheaper.

Logit regression shows a negative relationship between science uptake and family position. However, Granger causality results show that family position does not Granger cause subject choice. Granger causality test results in the acceptance of the null hypothesis of non-causality. Therefore we conclude that family position doesn't affect the subject of choice.

School related characteristics

School related characteristics are very important in determining A' level subject choice. In this study, five of the school characteristics seem to have a strong correlation with the subject choice. Granger causality results also confirm the significance of these characteristics. Before we could individually explain these characteristics, it is important that we mention endogeinety problems associated with the foregoing. An upward bias is created especially if we consider the effect of a school related characteristics on science uptake when a student possesses information beforehand about the likely effect of those characteristics on pass rate. If potential students doubt the ability of the schools to offer sciences competently, then those who would want to do sciences would obviously shy away from such schools.

From the results, we observe that students studying in urban centers at O' level and A' level are 0.38 and 0.58 times more likely to do sciences respectively than their counterparts in rural setups. Granger causality results for the two variables are significant at the 1% significance level, and hence we reject the null hypothesis that geographical location at an ordinary and advanced level does not Granger cause subject choice. We, therefore, conclude that geographical location Granger cause subject choice. This might be due to infrastructural deficiencies in rural schools. The state of laboratories, sources of power and human resources diminishes the ability of rural schools to teach sciences competently. This result implies that rural students do not really get the requisite foundation to do sciences at A' level and hence they do not normally choose them. An interesting finding is that those studying O' level in government schools are 0.7 times more likely to take up sciences than those in private and missionary schools.

In addition, students who enroll in government schools for A' levels are 1.92 times less likely to do sciences than their counterparts enrolling in either private or missionary schools. The Granger causality results are significant at 1%. We thus conclude those students who are to study at private schools are more likely to choose sciences. This might as well be due to infrastructural deficiencies in government schools just as we explained for rural schools. However, based on our data, for ordinary level students studying in government schools at ordinary levels are more likely to do sciences than private schools. Granger causality test also confirms the finding. Above all, students who enroll in schools that have a strong science bias at O' level are 0.9 times more likely to take up sciences at A' level while those who enroll at a science-oriented school for A' level are 0.62 times more likely to take up the science subjects other things being held constant.

The model exhibit a low McFadden R2 of 0.372% signifying a relatively low predictive power of the model. However for cross-sectional analysis of this nature especially in a situation where the model is not going to be used for forecasting but rather lay the foundation for establishing a basis for A' level subject choice we would take it as permissible. We also observe a probability of the likelihood ration LR to be significant at all levels signifying a correctly specified model. For the goodness of fit, we also ran a Hosmer-Lemeshow test for binary specification and based on randomized times an H-L statistic of 20.88 was obtained significant at 1%. This, therefore, means the model was correctly fitted.

4. Recommendations for policy

In light with the above findings, we recommend that since the factors affecting subject choice are numerous and diverse, efforts to successfully increase science uptake at A' level in Zimbabwe does require more than just the government alone but collaborative efforts from various stakeholders including non-governmental organisations, industry, tertiary institutions and social organisations such as the family and the church.

As the results show, quite a number of individual factors affect science uptake on such variables like social capital is important that industry and science-based universities offer science-oriented career guidance workshops to students in both primary and secondary schools. The importance of timing of these carrier guidance workshops cannot be overemphasized. Offering them too earlier poses cost without benefits as the pupils might still be too young to make sense of such workshops. Offering career guidance too late also defeats the purpose as individual pupils would have already developed a dislike of sciences or that the transition back to sciences might be costly enough that students might not consider it.

Because the probability of students succeeding in science specialisations is important in determining the subject choice, it is imperative that effort to improve uptake also aim at improving pass rate in sciences even at junior levels thereby avoiding losses of risk averse would be science students. Such efforts include but are not limited to providing necessary infrastructure and equipped laboratories for both urban and rural students. As sciences are more practical, this is likely to improve interest and hence pass rates. Moreover, the government should try to have high-quality teachers both in urban and rural schools through fair compensation in comparison to regional standards. This would reduce human resource flight both in terms of rural-urban balance and also regional comparisons.

The results show that girls are less likely to take up sciences than boys presumably due to the patriarchal nature of our society. The effort to increase the number of girls will obviously begin with the family. We recommend that parents reduce preference for boy child and possibly reduce the household chores for the girl child thus offering equal study time to girls as to boys. More so, the status of the girl child and women in general in the family should move away from being supportive. The role of the women in the household economy should just be a stochastic function independent of gender. This is a long-term recommendation and requires a mindset change and involves the family and the church to a larger extend.

For family characteristics, much of the solutions are relatively long-term in nature. For instance, having deceased parents put pressure on the affected student to choose nonscience specialisation. We recommend that having a vibrant social security system that meaningfully takes care of the deceased beneficiaries will reduce pressure both directly and indirectly on the student. The government should also regulate education insurance that it be made accessible and affordable to the majority of the populace.

On the other hand, biased science institutions should reduce the cost taking up sciences both monetary, psychological and in terms of time. This could be done improving chances of enrolling in top ends science programmes such as medicine and engineering. The small numbers taken into these programmes reduce the probability of a student getting into them, and hence sciences will remain a case of winners take all. (For instance, in Zimbabwe 17% of A-level science students will do the lucrative medicine and engineering, and the remaining 83% would do lower end sciences with limited employability). Hence, improving employment opportunity and providing better pay for science graduates would obviously change perception. In addition, the science phobia within some elements should be done with, presumably by employing qualified teachers in high schools, improve the state of teaching capital that would improve pass rates and at least in the long run clear the science phobia.

We also recommend that the government should increase science facilities in government and rural schools. Results have indicated that enrolling in government and or schools actually reduces the probability of science uptake. This is an important result which suggests a general perception amongst students that government schools might not properly teach sciences at A' level. Closely related to this is that government should fund a rural school to have functional science laboratories. Given that 70% of the population of the population leaves in rural and would school their children in rural areas, the government should ensure that every school has a science focus thereby increasing the probability of science uptake.

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References

i. *Ainley, J., Robinson, L., Harvey-Beavis, A., Elsworth, G., & Fleming, M. (1994). "Subject choice in Years 11 and 12". Australian Government Publishing Service, Canberra.*

ii. *Bandura, A. Barbaranelli, c., Caprara, G., and Pastorelli, C. (2001). "Self-efficacy beliefs as aspirations and Carrier trajectories". Child Development, volume 72*

iii. *Bindu, S., Chigusiwa, L. (2013). Examining the sources of smallholder horticultural farmers' exclusion from formal urban markets in Zimbabwe: The case of Chihota Communal Areas. Int. J. Eco. Res, 1-12*

iv. *Caprara, G.V. and Cervone, D. (2000). "Personality; Determinants, dynamics and potentials". Cambridge University Press. New York.*

v. *Debay, A. N. et al. (1980). The Sociology of Nigeria Education. London: Mac Milan Press.*

vi. *Dellar, G. (1994). "The school subject selection process: A case study". Journal of Career Development, 2 (3)*

vii. *Gujarati D N. (2004). Basic Econometrics 4th edition McGraw-Hill Company.*

viii. *Harvey, M. (1984). "Pupil awareness of the career pathways and choice points in high school". Educational Review, 36 (1)*

ix. *Hewitt, J. (2010). "Factors influencing career choice". Cited from www.ehow.com on 15/07/2017*

x. *Kerka, S. (2000). "Career development, gender, race and class". Eric Clearing house on Adult Career and Vocational Education. Columbus. ED 421641*

xi. *MoPSE (2014) Annual Statistical Report (2014) cited form www.mopse.gov.zw>document-category on 02/08/17*

xii. *Taylor, J., Harris, M. and Taylor, S. (2004). "Parents have their say about their college aged children's career decisions". National Association of Colleges and Employers Journal, 64 (3).*

xiii. *White, D. W. (2014). What is STEM education and why is it important? Florida Association of Teacher Educators Journal, 1(14), 1-8. Retrieved from http://www.fate1.org/journals/2014/white.pdf*