Chapter 5
EMPIRICAL RESULTS

This chapter presents the findings of the study. The proper assessment of an educational investment strategy, whether by the individual or the state, requires that benefits be related to costs at a common point in time. The net present value (NPV) helps to do this by discounting the benefits and costs of an educational investment, to a common time period. The benefit streams, costs and the NPVs of a Virginia Tech education are presented in this chapter using standard OLS earnings function estimates as well as earnings function estimates that are corrected for the endogenous workforce participation decision. The first half of the chapter (Section 5.1) presents the results using the standard OLS approach (without the correction for the workforce participation decision), while the second half of the chapter (Section 5.2) presents the results using the model that corrects for the endogeneity in the workforce participation decision. The private rates of return to a VT undergraduate education generated from these models are presented in Section 5.3.

In the first half (Section 5.1) of the chapter, the OLS approach is used to model the natural logarithm of wages as a function of education, age and other personal characteristics of individuals. First, the national earnings function estimates are presented (Section 5.1.1). As discussed earlier, CPS 1999 data were used to estimate this function. The national earnings function helps to reveal the increase in earnings with age. It also reveals the earnings premium associated with a college degree, over a high school education. Second, the initial earnings estimates of Virginia Tech graduates are presented (Section 5.1.2). Starting salaries and personal characteristics of 1998-99 graduates were used to estimate this function. Third, national age-earnings profiles are combined with VT initial earnings estimates to create earnings profiles of the graduates, with and without the VT degree. Fourth, the financial and labor market opportunity costs of a VT education are presented. Finally, the benefit streams (Section 5.1.3) and costs (Section 5.1.4) are combined to estimate the NPV (Section 5.1.5) of a VT education. The findings are discussed in Section 5.1.6.

One of the problems with the OLS approach is that it considers only individuals who are working, in the estimation of the earnings equation. As discussed earlier, selectivity is a major issue in the human capital literature. Some people choose to work, while others do not. The decision to participate in the laborforce is likely to be correlated with earnings. The inability of the OLS approach to account for the decision to participate in the laborforce results in inconsistent parameter estimates (selectivity bias), in the earnings equation. Heckman (1976a, 1979) developed models to deal with selectivity problems. The Heckman two-step procedure is used, in the second half (Section 5.2) of the chapter, to estimate the earnings functions. First, the national earnings function estimates (Section 5.2.1) are presented, followed by the selection equation parameter estimates for the model. The selection equation models the decision to participate in the laborforce as a function of age, education, personal characteristics and some other variables (number of children under the age of six in the family and the interaction between gender and the number of children under six in the family) that are not included in the earnings function. Second, the VT initial earnings parameter estimates (Section 5.2.2) are presented, followed by the selection equation parameter estimates. In this case the selection equation models the decision to participate in the laborforce as a function of college, major, personal characteristics and Quality Credit Average (QCA), the last variable not being included in the earnings function. Third, national age-earnings profiles are combined with VT initial earnings estimates to create the earnings profiles of the graduates, with and without the VT degree. Fourth, the CPS selection equation is used to predict the probabilities of workforce participation for VT graduates over life-time (with and without the VT degree). The probabilities of workforce participation for engineering majors are presented to demonstrate the results. Fifth, the predicted wages of VT graduates are multiplied by the predicted probabilities of workforce participation (from Step Four) to obtain the probability-adjusted (or expected) earnings in each year of the individual's age-earnings profile. Finally, these probability-adjusted earnings are used to calculate the discounted benefits (Section 5.2.3), costs (Section 5.2.4) and the NPVs (Section 5.2.5). The results are discussed in Section 5.2.6.

5.1 NPV estimates using OLS method

5.1.1 CPS Earnings Function

The parameter estimates and the standard errors for the earnings function estimated using CPS data are given in Table 5.1. The estimates have the expected signs and most coefficient estimates are significant at the p=0.05 or p=0.01 levels of statistical significance. The relation between earnings and the explanatory variables (gender, high school degree, African American, American Indian, Asian, age, age squared and age*high school) is discussed below.

Gender

There exists a negative relationship between being a female and earnings. A female earns about 61 percent of the earnings of a typical male. The coefficient is large and statistically significant at the p=0.01 level.

High school

The CPS Earnings function reveals that a college degree plays an important role in determining earnings. The parameter estimate for the high school dummy is large, negative and highly significant (at p=0.01 level), implying that high school graduates earn considerably less than college graduates. The earnings of a high school graduate are about 40 percent less than that of a college graduate. The high school coefficient gives the earnings premium associated with a college degree, for the nation as a whole. This coefficient is used in creating the earnings profiles in the scenario where the VT graduates do not come to Tech (and thus have a high school education only).

Race

Race plays an important role in determining earnings. African Americans earn about 11 percent less than the whites. The coefficient is statistically significant at the p=0.01 level. American Indians are estimated to earn about 7 percent less than the whites, however, they seem to be doing better than the African Americans. The variable is negative but not significant at conventional levels. Asians earn about 7 percent less than the whites. The coefficient is negative and statistically significant at the p=0.01 level.

Age

Age has an important influence on earnings. Other things being equal, earnings usually increase with age. Age is estimated to raise earnings of individuals in the CPS sample by about 5 percent per year. The variable is statistically significant at the p=0.01 level. The coefficient of age was combined with VT initial earnings estimates to create the lifetime earnings profiles of VT graduates.

Age squared

While earnings increase with age, the negative coefficient of this variable implies that earnings increase at a diminishing rate, as predicted by human capital theory. This term causes earnings to decrease by 0.1 percent per year of age. The coefficient is statistically significant at the p=0.01 level. Earnings peak (around mid-life) and then start falling as the individual ages. This coefficient is also used to create the earnings profiles of VT graduates.

Age*high school

To see how the earnings premium associated with college education changes with experience, an age*high school interaction term was employed. The positive coefficient of this term implies that although high school graduates earn less than college graduates, the difference in earnings (between the 2 groups) decrease with age. This term decreases the college premium by about 0.2 percent per year of age. The coefficient is statistically

significant at the p=0.01 level. The earnings profiles of college graduates and high school graduates are presented in Figure 5.1. The figure reveals that individuals with a college degree earn considerably more than high school graduates over their lifetime.

Table 5.1: CPS Earnings Function – Parameter estimates

Predictor	Coefficient	Standard Error	t
Intercept	9.9393	0.0188	527.66
Gender	- 0.4929	0.0095	- 51.86
High School	- 0.5024	0.0191	- 26.32
African American	- 0.1208	0.0168	- 7.18
American Indian	- 0.0742	0.0496	- 1.50
Asian	- 0.0756	0.0266	- 2.84
Age	0.0516	0.0016	33.09
Age squared	- 0.0011	0.0000	- 30.22
Age*High School	0.0023	0.0009	2.44

5.1.2 Virginia Tech Earnings Function

The regression results for the Virginia Tech earnings function is provided in Table 5.2.

Gender

The VT regression reveals that female students earn slightly less than their male counterparts. On an average, the earnings of female graduates are about 7.7 percent less

than male graduates. The coefficient is negative and statistically significant (at the p=0.01 level), but not as large as the gender coefficient in the CPS regression.

Race

The positive coefficient of this variable implies that African-Americans graduating from VT earn about 10 percent more than the whites. This fact is in direct contrast to the CPS sample, where African Americans earn considerably less than the whites. The coefficient is statistically significant at the p=0.05 level. American Indians also have a statistically significant (at the p=0.01 level), positive coefficient, and are estimated to earn about 65 percent more than the whites. However, this estimate need to be interpreted with caution as American Indians constituted a very small fraction of the sample. Asian students earn about 5 percent more than their white counterparts. The coefficient is positive and statistically significant at the p=0.05 level. The regression results reveal that foreign students earn less than the whites, however the coefficient is not significant at conventional levels. The earnings being about 5 percent less than the earnings of whites. Hispanic students are also estimated to earn about 6 percent less than the whites, and in this case too the coefficient is not significant at conventional levels.

College

Dummy variables indicate that earnings also vary by college. A College of Agriculture graduate earns 9 percent less than an Arts and Sciences college (control group) graduate, as revealed by the negative, statistically significant (at the p=0.01 level) coefficient of Agriculture. The coefficient of Architecture implies that Architecture graduates make about 8 percent more than the control group. The coefficient is statistically significant at the p=0.05 level. The coefficient for College of Business is positive, large and highly significant (at the p=0.01 level), implying that a business degree significantly increases earnings. Business majors earn 27 percent more than the earnings of Arts and Sciences graduates. An engineering degree significantly increases earnings as seen by the large, positive and highly significant (at the p=0.01 level) coefficient of this variable. An

engineering degree raises earnings by about 43 percent over an Arts and Sciences degree. A human resources degree lowers earnings (by 3 percent) as seen by the negative coefficient of this variable. The coefficient is however not significant at conventional levels. The coefficient for College of Natural Resources is large and negative, implying that a natural resources graduate earns considerably less (about 12 percent) than an Arts and Sciences graduate. The coefficient is statistically significant at the p=0.01 level.

Table 5.2: VT Earnings Function – Parameter estimates

Variable	Coefficient	Standard Error	t
Intercept	10.0125	0.0149	667.74
Gender	- 0.0798	0.0145	- 5.49
African American	0.0957	0.0467	2.05
American Indian	0.5016	0.1388	3.62
Asian	0.0539	0.0253	2.13
Foreign	- 0.0473	0.0985	- 0.48
Hispanic	- 0.0599	0.0609	- 0.98
Agriculture	- 0.0919	0.0283	- 3.25
Architecture	0.0783	0.0371	2.11
Business	0.2414	0.0189	12.74
Engineering	0.3547	0.0192	18.49
Human Resources	- 0.0303	0.0238	- 1.28
Natural Resources	- 0.1323	0.0369	- 3.59

Previous studies have not accounted for racial differences in earnings. This study addresses the issue by including race as an explanatory variable. However, the results reveal that race (and gender) play a limited role in determining the earnings of VT graduates. The choice of major plays an important role.

5.1.3 Benefits of a VT degree

National estimates of the age-earnings relationship and the age-specific premium from a college education are combined with estimates of initial earnings for VT graduates to create the earnings profiles of VT graduates. A VT degree significantly increases individual earnings over lifetime, over what they would have had earned only with a high school degree. Future earnings of graduates are discounted at the rate of 5 percent per annum to get the present value of benefits. Previous studies have used discount rates between 5 and 9. In the calculation of benefits it is assumed that a VT graduate starts earning from age 22 and retires at 65. In the high school scenario, the individual works between 18 and 65. The discounted benefits of a VT degree are presented for males and females, in Table 5.3 and Table 5.4, respectively.

Table 5.3: Discounted benefits for males, by major and race ($)

	Agriculture	Arts & Sciences	Architecture	Business	Engineering	Human Resources	Natural Resources
White	171,507*	188,027	203,341	239,371	268,085	182,407	164,724
American Indian	283,231	310,512	335,803	395,304	442,723	301,233	272,030
African American	188,737	206,916	223,769	263,418	295,017	200,733	181,273
Asian	181,016	198,451	214,614	252,642	282,948	192,521	173,857
Hispanic	161,532	177,091	191,514	225,449	252,493	171,799	155,144
Foreign	163,585	179,342	193,949	228,314	255,702	173,982	157,116

* 1995-96 dollars

The figures reveal that engineering graduates (of both sexes) have the greatest discounted benefits over lifetime. Business and Architecture college graduates have the second and third highest discounted benefits, respectively.

Table 5.4: Discounted benefits for females, by major and race ($)

	Agriculture	Arts & Sciences	Architecture	Business	Engineering	Human Resources	Natural Resources
White	158,360	173,614	187,754	221,022	247,535	168,425	152,098
American Indian	261,521	286,711	310,063	365,003	408,787	278,143	251,178
African American	174,269	191,055	206,616	243,227	272,403	185,346	167,378
Asian	167,140	183,239	198,164	233,276	261,259	177,763	160,530
Hispanic	149,150	163,516	176,834	208,168	233,139	158,630	143,252
Foreign	151,046	165,595	179,082	210,813	236,102	160,646	145,072

However, there exist differences across gender. Male graduates seem to earn slightly more than female graduates over their lifetime.

5.1.4 Costs of a VT degree

As discussed before, two types of costs are incurred by the individual attending VT. First, the direct costs, which include tuition and fees, and second, the foregone earnings, that is, what the individual would have earned had he/she not come to VT, but had worked at the prevailing level of earnings.

Based on the instate tuition rates and fees between 1995-96 and 1998-99, the direct costs (discounted) sum to $15,494, for a VT undergraduate education. The foregone earnings, which are an important component of the total cost, are presented for males and females, in Table 5.5 and Table 5.6, respectively. The foregone earnings are the sum of the discounted earnings that the VT graduate could have expected to earn with only a high school degree, between 18 and 22 years. In calculating the foregone earnings it is assumed that a VT graduate loses 9 months earnings each year, while pursuing the

degree. The rest of the time (3 months) the VT student works at the HS degree level of earnings.

Table 5.5: Foregone earnings for males, by major and race ($)

	Agriculture	Arts & Sciences	Architecture	Business	Engineering	Human Resources	Natural Resources
White	29,761	32,628	35,286	41,538	46,521	31,653	28,584
American Indian	49,149	53,883	58,272	68,597	76,826	52,273	47,205
African American	32,751	35,906	38,831	45,711	51,194	34,833	31,456
Asian	31,412	34,437	37,242	43,841	49,100	33,408	30,169
Hispanic	28,030	30,730	33,233	39,122	43,815	29,812	26,922
Foreign	28,387	31,121	33,656	39,619	44,372	30,191	27,264

Table 5.6: Foregone earnings for females, by major and race ($)

	Agriculture	Arts & Sciences	Architecture	Business	Engineering	Human Resources	Natural Resources
White	27,480	30,127	32,581	38,354	42,955	29,227	26,393
American Indian	45,382	49,753	53,805	63,339	70,937	48,266	43,587
African American	30,241	33,154	35,854	42,207	47,270	32,163	29,045
Asian	29,004	31,797	34,387	40,480	45,336	30,847	27,857
Hispanic	25,882	28,375	30,686	36,123	40,457	27,527	24,858
Foreign	26,211	28,736	31,076	36,582	40,971	27,877	25,174

The figures reveal that the opportunity costs (foregone earnings) are higher for male graduates. Across majors, opportunity costs are the highest for engineering graduates, while being the lowest for natural resources graduates. The opportunity costs are significantly higher than tuition and fees.

5.1.5 Net Present Value (NPV) of a VT degree

The discounted costs were subtracted from the discounted benefits to get the NPVs. Table 5.7 presents the NPVs for males, while Table 5.8 presents the NPVs for females.

Table 5.7: Net Present Values for males by college and race ($)

	Agriculture	Arts & Sciences	Architecture	Business	Engineering	Human Resources	Natural Resources
White	126,251	139,904	152,561	182,338	206,070	135,260	120,645
African American	140,491	155,515	169,444	202,213	228,328	150,405	134,322
American Indian	218,588	241,135	262,036	311,212	350,403	233,465	209,330
Asian	134,110	148,520	161,878	193,307	218,354	143,618	128,193
Foreign	119,704	132,726	144,798	173,201	195,836	128,297	114,357
Hispanic	118,007	130,866	142,787	170,832	193,183	126,492	112,727

5.1.6 Discussion of results

Returns to education are not strictly based on the number of years of schooling, as predicted by human capital theory, but are significantly determined by the choice of major/occupation.

Table 5.8: Net Present Values for females by college and race ($)

	Agriculture	Arts & Sciences	Architecture	Business	Engineering	Human Resources	Natural Resources
White	115,386	127,992	139,679	167,174	189,086	123,704	110,210
African American	128,534	142,407	155,268	185,525	209,639	137,688	122,838
American Indian	200,645	221,463	240,763	286,169	322,355	214,382	192,097
Asian	122,642	135,947	148,282	177,301	200,429	131,422	117,179
Foreign	109,340	121,365	132,511	158,736	179,637	117,275	104,404
Hispanic	107,774	119,647	130,654	156,550	177,188	115,608	102,899

An engineering degree has the highest NPV, followed by business and architecture. The NPVs also differ by race and gender. The NPVs are the highest for American Indians. However, the estimates need to be viewed with caution, as there were very few American Indians in the sample. African Americans have the second highest NPVs. The NPVs were found to be higher for males relative to females. The figures indicate the high returns on a VT undergraduate education.

5.2 NPV estimates using the Workforce Selection Model

The OLS method does not account for the endogenous choice of workforce participation, in the estimation of the earnings functions. Thus, the OLS estimates may be inconsistent (Maddala, 1983). To account for the selection bias that arises due to the endogenous laborforce participation decision, the two-step Heckman procedure was used to estimate the national and VT earnings functions. In this case the samples (CPS and VT) consisted of both employed (earnings observed) and unemployed (earnings unobserved) individuals.

5.2.1 CPS Earnings Function

Table 5.9 provides the parameter estimates and standard errors, using the workforce selection model. The variables for the selection equation are gender, high school, African American, American Indian, Asian, age, age-squared, number of children in the family under the age of six, and the interaction between gender and the number of children in the family under the age of six.

Table 5.9: CPS Earnings Function – Parameter estimates

Predictor	Coefficient	Standard Error	z
Intercept	10.0245	0.0213	471.46*
Gender	-0.3790	0.0114	-33.205*
High School	-0.4582	0.0199	-23.005*
African American	-0.1289	0.0199	-6.493*
American Indian	-0.0842	0.0551	-1.527
Asian	0.0248	0.0312	0.794
Age	0.0445	0.0018	25.413*
Age squared	-0.0006	0.00004	-16.128*
Age*High School	0.0042	0.0009	4.804*

* Statistically significant at p = 0.01

The variables (in the earnings function) have the expected signs and most of them are significant at conventional levels. All the coefficients have the same signs as obtained by the OLS method, except the Asian dummy, which is positive in this case. The estimates reveal that females earn about 68 percent of the earnings of males, while a high school degree-holder earns about 63 percent of the earnings of a typical college graduate.

Table 5.10: CPS Earnings Function – Selection Equation Parameter estimates

Predictor	Coefficient	Standard Error	z
Intercept	1.2770	0.0245	52.121*
Gender	-0.1686	0.0144	-11.727*
High School	-0.2416	0.0151	-15.982*
African American	-0.0001	0.0232	-0.003
American Indian	-0.0773	0.0631	-1.225
Asian	-0.1998	0.0351	-5.688*
Age	-0.0013	0.0019	-0.654
Age squared	-0.0005	0.0000	-10.916*
Number of children Under six in family	0.0688	0.0187	3.675*
Number of children Under six * gender	-0.2711	0.0215	-12.634*

Lambda= -0.9818

* Statistically significant at p = 0.01

While African Americans and American Indians earn about 12 and 8 percent less, respectively, than the whites, Asians earn 2.5 percent more than the whites. The marginal increase in earnings with age is about 4.6 percent, while the age squared term decreases earnings by 0.1 percent per year of age. The effect of the interaction term (age*high school) is a 0.4 percent negative impact on the college premium per year.

The selection equation parameter estimates (Table 5.10) reveal that being a female reduces the probability of workforce participation. Individuals with only a high school degree are also less likely to participate in the workforce. The minority groups are less likely to participate in the workforce relative to the whites. The coefficient of age suggests that individuals are less likely to participate in the workforce with age. The coefficient of the age-squared term implies that the probability of workforce participation decreases at a decreasing rate. The presence of children in the family is likely to increase

the chances of workforce participation of individuals, as seen by the positive coefficient of 'number of children under six in the family.' However, the presence of children in the family reduces women's chances of workforce participation, as reflected by the negative coefficient of the interaction between gender and 'number of children under six in the family.'

5.2.2 VT Earnings function

Table 5.11 provides the parameter estimates and the standard errors for the VT sample, using the workforce selection model. The dummy indicator for American Indian was dropped from the model because of collinearity.

Most of the parameter estimates (Table 5.11) are significant at conventional levels. A female graduate earns about 7.8 percent less than a male graduate. African Americans and Asians earn about 10 and 5 percent more, respectively, than whites, while Foreigners and Hispanics earn 5 and 6 percent less, respectively, than whites. Architecture, Business and Engineering majors earn 8, 27 and 43 percent more, respectively, than Arts and Sciences graduates, while Human Resources, Agriculture and Natural Resources graduates earn 3, 9 and 12 percent less, respectively, than Arts and Sciences graduates.

The VT selection equation parameter estimates (Table 5.12) reveal that female VT graduates are less likely to participate in the workforce relative to male graduates. African Americans, Hispanics and foreign nationals are less likely to participate in the workforce relative to whites. Business, engineering and architecture graduates are more likely to participate in the workforce relative to other majors.

Table 5.11: VT Earnings function – parameter estimates

Predictor	Coefficient	Standard Error	z
Intercept	10.0131	0.0305	328.806**
Gender	-0.0817	0.0148	-5.526**
African American	0.0936	0.0472	1.982*
Asian	0.0529	0.0253	2.091*
Foreign	-0.0501	0.1011	-0.495
Hispanic	-0.0618	0.0611	-1.012
Architecture	0.0764	0.0379	2.014*
Human Resources	-0.0315	0.0244	-1.292
Business	0.2406	0.0239	10.057**
Agriculture	-0.0938	0.0287	-3.263**
Engineering	0.3553	0.0228	15.563**
Natural Resources	-0.1344	0.0374	-3.598**

*Statistically significant at p = 0.05; ** Statistically significant at p = 0.01

A graduate with a higher QCA is less likely to participate in the workforce (a graduate with a higher QCA is more likely to pursue graduate studies than a graduate with a lower QCA).

The VT initial earnings estimates were combined with estimates from the CPS earnings function to create the earnings profiles of graduates (as done before). However, once the earnings profiles (of VT graduates) are created, the earnings are adjusted for the probabilities of workforce participation, based on the CPS sample (selection equation). Table 5.13 provides the probabilities of workforce participation of white male and white female graduates with age. Fig.5.1 presents the earnings profiles of white, male VT engineering graduates, while Fig.5.2 compares the earnings of a VT graduate to the earnings of an individual in the CPS sample.

Table 5.12: VT Earnings function – selection equation parameter estimates

Predictor	Coefficient	Standard Error	z
Intercept	0.5554	0.1545	3.596**
Gender	-0.1340	0.0518	-2.586**
African American	-0.4453	0.1471	-3.026**
Asian	0.0431	0.0974	0.443
Foreign	-1.1364	0.2468	-4.604**
Hispanic	-0.2878	0.2018	-1.426
Architecture	0.4476	0.1315	3.403**
Human Resources	0.2853	0.0773	3.691**
Business	0.8123	0.0712	11.407**
Agriculture	0.2490	0.0935	2.663**
Engineering	0.6786	0.0699	9.705**
Natural Resources	0.2546	0.1274	1.998*
QCA	-0.2048	0.0503	-4.069**

Lambda= 0.0031

* Statistically significant at p = 0.05; ** Statistically significant at p = 0.01

Table 5.13 Probabilities of workforce participation – white male and white female VT graduates

Age	White male		White female		Age	White male		White female	
	VT*	HS	VT	HS		VT	HS	VT	HS
18		0.8534		0.7908	42	0.8593	0.7946	0.7913	0.7284
19		0.8539		0.7915	43	0.8505	0.7860	0.7995	0.7292
20		0.8542		0.7918	44	0.8451	0.7794	0.7931	0.7217
21		0.8542		0.7919	45	0.8394	0.7723	0.7863	0.7137
22	0.8999	0.8541	0.8635	0.7917	46	0.8333	0.7648	0.7790	0.7052
23	0.9011	0.8583	0.8577	0.7733	47	0.8268	0.7568	0.7713	0.6963
24	0.9006	0.8577	0.8571	0.7725	48	0.8185	0.7477	0.7682	0.6891
25	0.8999	0.8569	0.8563	0.7713	49	0.8111	0.7388	0.7596	0.6793
26	0.8991	0.8558	0.8552	0.7699	50	0.8032	0.7294	0.7506	0.6689
27	0.8981	0.8545	0.8539	0.7681	51	0.7949	0.7195	0.7411	0.6581
28	0.9008	0.8534	0.8369	0.7642	52	0.7861	0.7091	0.7311	0.6468
29	0.8994	0.8516	0.8350	0.7618	53	0.7764	0.6979	0.7220	0.6357
30	0.8978	0.8496	0.8328	0.7591	54	0.7665	0.6864	0.7109	0.6234
31	0.8961	0.8473	0.8303	0.7561	55	0.7561	0.6744	0.6993	0.6106
32	0.8942	0.8448	0.8276	0.7527	56	0.7451	0.6619	0.6871	0.5972
33	0.8941	0.8386	0.8156	0.7617	57	0.7335	0.6487	0.6744	0.5834
34	0.8918	0.8355	0.8122	0.7577	58	0.7211	0.6351	0.6619	0.5691
35	0.8892	0.8321	0.8085	0.7534	59	0.7084	0.6209	0.6480	0.5542
36	0.8864	0.8283	0.8044	0.7488	60	0.6950	0.6061	0.6336	0.5389
37	0.8834	0.8243	0.8001	0.7437	61	0.6810	0.5908	0.6186	0.5232
38	0.8758	0.8158	0.8127	0.7532	62	0.6663	0.5749	0.6030	0.5070
39	0.8721	0.8110	0.8079	0.7476	63	0.6511	0.5583	0.5869	0.4912
40	0.8681	0.8059	0.8027	0.7416	64	0.6352	0.5414	0.5702	0.4743
41	0.8639	0.8005	0.7972	0.7352	65	0.6187	0.5241	0.5531	0.4569

* VT implies with VT degree; HS implies without VT degree

A VT graduate has a higher probability of laborforce participation compared to the scenario where they terminate their education with a high school degree. In general, males have a higher probability of participating in the laborforce than females. Also, the probability of laborforce participation decreases with age.

Fig.5.1: Earnings profiles of white, male VT engineering graduates

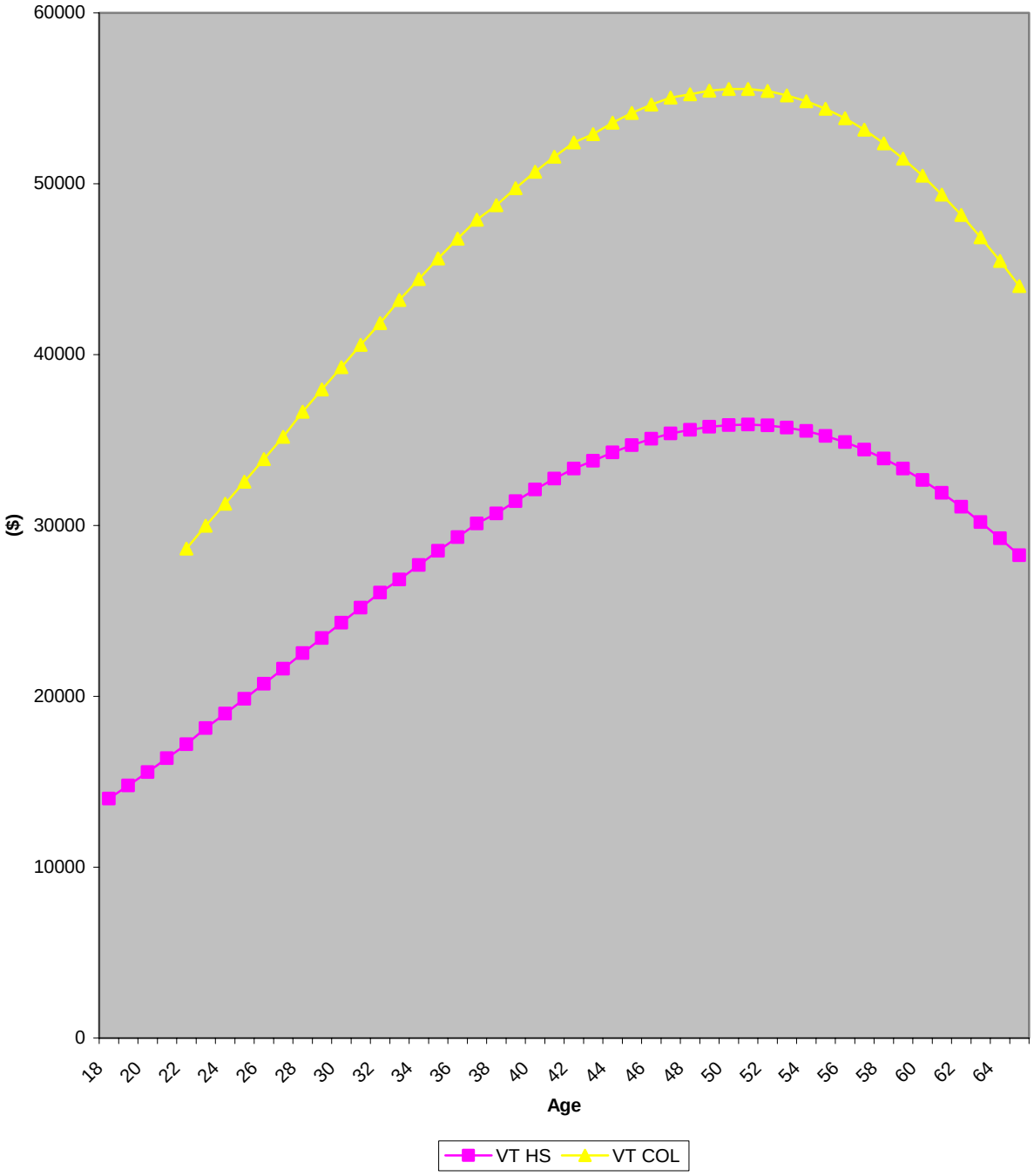
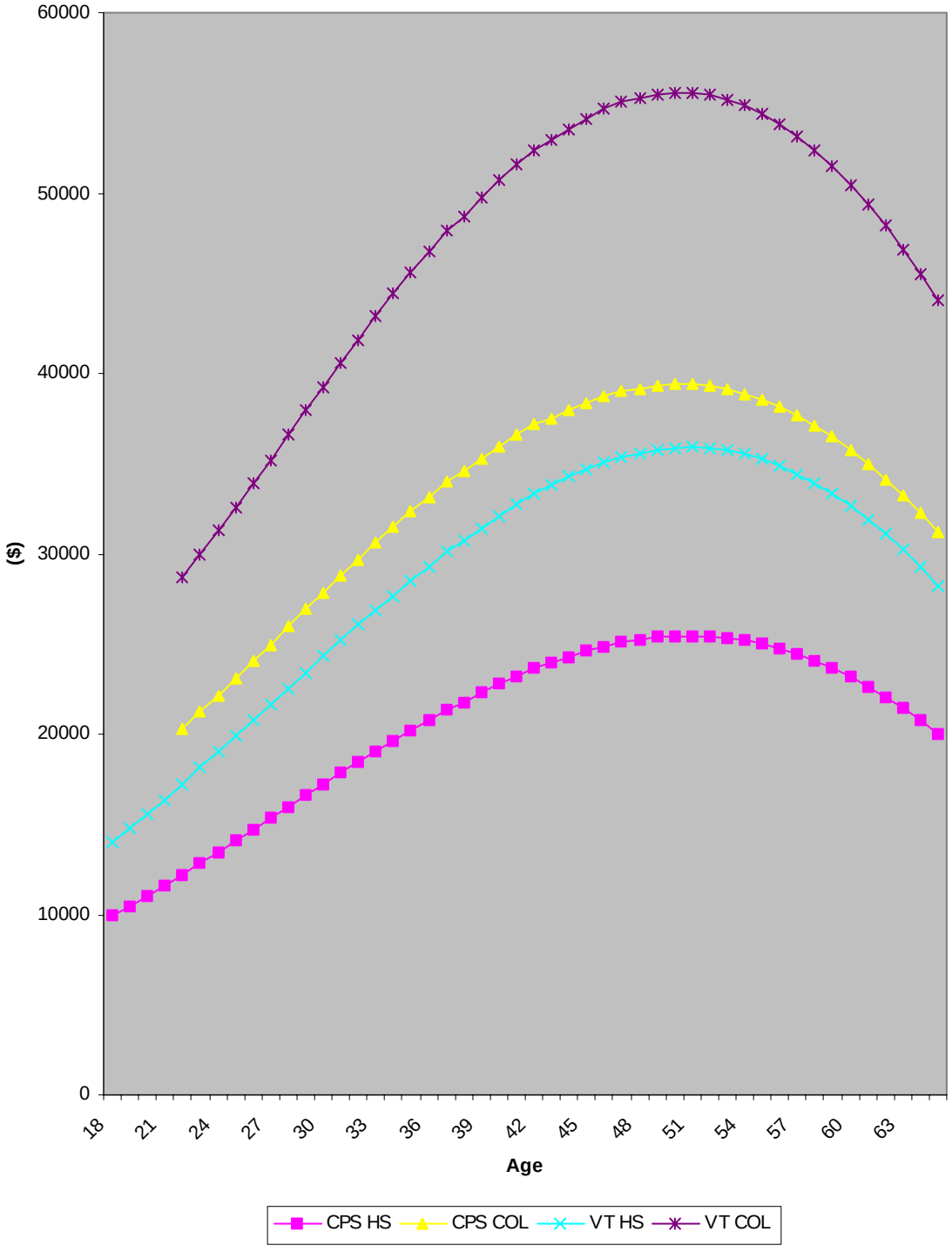


Fig.5.2: Comparison of earnings profiles of white males - VT Engineering vs CPS



5.2.3 Benefits of a VT degree

National estimates of the age-earnings relationship and premium from a college education are combined with estimates of initial earnings for VT graduates to create the earnings profiles of VT graduates. The discounted benefits are slightly lower in this case compared to the estimates that were obtained by the OLS approach. This is because the earnings are weighted by the probabilities of workforce participation, which causes the entire stream of benefits to fall. However, this effect is offset to a certain extent by higher probabilities of laborforce participation among VT graduates, than the scenario where they do not come to Tech and have a high school education only. The discounted benefits are presented for males and females in Table 5.14 and Table 5.15, respectively. The discounted benefits are the highest for engineering graduates, followed by business and architecture graduates, respectively. The discounted benefits are higher for males relative to females. Across races, African Americans have higher discounted benefits relative to Asians and whites. The average value of discounted benefits for VT graduates is $191,894. The average value of undiscounted benefits was found to be equal to $591,497.

Table 5.14: Discounted benefits for males by college ($)

College	White	African American	Asian
Engineering	244,397	268,087	250,228
Arts & Sciences	171,313	187,920	175,400
Business	217,999	239,132	223,201
Agriculture	155,974	171,094	159,696
Architecture	184,914	202,840	189,326
Human Resources	166,001	182,093	169,961
Natural Resources	149,829	164,353	153,403

Table 5.15: Discounted benefits for females by college ($)

College	White	African American	Asian
Engineering	218,073	240,636	221,702
Arts & Sciences	152,861	168,677	155,405
Business	194,519	214,645	197,756
Agriculture	139,175	153,575	141,491
Architecture	164,998	182,069	167,743
Human Resources	148,121	163,447	150,586
Natural Resources	133,691	147,523	135,916

5.2.4 Costs of a VT degree

The direct cost is the amount of tuition, which is equal to $15,494. The indirect cost is the earnings foregone during the student's studies at Tech. The foregone earnings (based on 9 months earnings) are the highest for engineering graduates and the lowest for natural resources graduates. Foregone earnings are higher for males than for females. Table 5.16 and Table 5.17 provide the probability-adjusted foregone earnings for VT male and VT female graduates, respectively. The average foregone earnings for VT graduates is $32,564.

Table 5.16: Foregone earnings for males, by college ($)

College	White	African American	Asian
Engineering	42,257	46,411	41,923
Arts & Sciences	29,620	32,532	29,387
Business	37,692	41,398	37,395
Agriculture	26,968	29,619	26,756
Architecture	31,972	35,115	31,720
Human Resources	28,702	31,523	28,476
Natural Resources	25,906	28,452	25,701

Table 5.17: Foregone earnings for females, by college ($)

College	White	African American	Asian
Engineering	36,094	39,606	35,051
Arts & Sciences	25,301	27,762	24,569
Business	32,196	35,328	31,265
Agriculture	23,035	25,277	22,370
Architecture	27,309	29,966	26,520
Human Resources	24,516	26,901	23,807
Natural Resources	22,128	24,281	21,488

5.2.5 NPV of a VT degree

The discounted costs (tuition plus foregone earnings) were deducted from the discounted benefits to get the NPVs. The NPVs are presented for males and females in Table 5.18 and Table 5.19, respectively. The average NPV was found to be $143,738.

Table 5.18: NPV of a VT degree for males ($)

College	White	African American	Asian
Engineering	186,646	206,183	192,810
Arts & Sciences	126,199	139,894	130,520
Business	164,813	182,240	170,311
Agriculture	113,512	125,981	117,446
Architecture	137,448	152,231	142,112
Human Resources	121,805	135,075	125,992
Natural Resources	108,429	120,407	112,208

Table 5.19: NPV of a VT degree for females ($)

College	White	African American	Asian
Engineering	166,485	185,536	171,157
Arts & Sciences	112,067	125,421	115,342
Business	146,830	163,823	150,997
Agriculture	100,645	112,804	103,627
Architecture	122,194	136,609	125,729
Human Resources	108,111	121,051	111,285
Natural Resources	96,069	107,749	98,034

5.2.6 Discussion of results

Returns to education are not strictly based on the number of years of schooling. School quality and the choice of major are important determinants of earnings. An engineering degree has the highest NPV, followed by business and architecture.

Across majors, a VT degree has a higher NPV for African Americans, American Indians and Asians. The NPVs are higher for males relative to females.

The NPV estimates obtained using the workforce selection model are lower than the NPV estimates obtained using the model without the correction for the endogenous workforce decision (first part of the chapter). The workforce selection model estimates take into account the probabilities of laborforce participation, based on the probabilities of workforce participation of individuals in the CPS sample. The probability-adjusted earnings cause the earnings streams, and therefore, the NPVs to go down. However, the NPVs obtained by the workforce selection model are quite close to the NPVs obtained without the correction for the endogenous workforce decision, implying that although the earnings streams fall as a whole, the higher probabilities of VT graduates to participate in the labor-force has a positive effect on earnings differentials, and thus the NPVs.

The average value of discounted benefits (using the workforce selection model) for a VT undergraduate education was found to be equal to $191,894. Out of the 4,215 undergraduate degrees conferred in 1998-99, if we consider that approximately 50 percent of the graduates, say 2000 graduates remain in the state after graduation, it implies that approximately $383,788,000 of additional private income (per year) is added to the state GDP because of VT undergraduates. A VT education not only increases the income of the graduates, but also leads to higher taxes for the state. It was found that the present value of state income tax (assuming a marginal tax rate of 5.5 percent) that could be attributed to a VT undergraduate education was $15,082 per student[1]. If we consider that approximately 2,000 undergraduates remain in the state each year, it implies that $30,164,000 of state income tax is added by VT undergraduates each year. The importance of a VT undergraduate education to the state economy is clearly revealed in these statistics without examining other spillover benefits from a VT education.

5.3 Private rates of return

Rates of return are often used to make investment decisions. The higher the rate of return, the better the investment. Investments in education offer very high rates of return, often higher than many capital market investments. The discount rate that equates the discounted benefits to the discounted costs is the rate of return. The private rates of return to a VT undergraduate education are presented in the Table 5.20. A VT engineering degree offers the highest rate of return, followed by a business degree. The high returns associated with these degrees is the reason for the higher demand for these degrees. From an economic perspective the high rates of return to these degrees implies underinvestment in these degrees.

[1] Earnings before taxes were used to calculate the discounted benefits. A 5.5 percent tax rate was used to calculate the present value of state income tax that could be attributed to a VT undergraduate degree.

Table 5.20: Private rates of return to a VT undergraduate education (%)

College	White		African American		Asian	
	Male	Female	Male	Female	Male	Female
Engineering	16.8	17.0	17.1	17.4	17.2	17.6
Arts & Sciences	15.4	15.5	15.8	15.9	15.8	16.0
Business	16.4	16.5	16.7	16.9	16.8	17.1
Agriculture	15.0	15.1	15.4	15.5	15.4	15.5
Architecture	15.7	15.8	16.1	16.2	16.1	16.4
Human Resources	15.3	15.3	15.7	15.8	15.7	15.8
Natural Resources	14.9	14.9	15.3	15.3	15.2	15.3

The rates of return are higher for Asians relative to Whites and African Americans, and they (rates of return) are higher for females relative to males across most races and majors. The average private rate of return to a VT undergraduate degree is about 16.2 percent. The high rates of return associated with a Virginia Tech degree could be an important reason for the increasing number of students at Virginia Tech.