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Luxembourg Income Study Working Paper Series

Working Paper No. 116

A Cross-National Comparison of Education and Earnings

Inge O'Connor

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"A Cross-National Comparison of Education and Earnings"

Inge O'Connor

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Introduction

It is well-established that people with higher levels of education earn more on average than those with less education. In fact, in the 1960's a theory of "human capital" was developed (Becker, 1962, 1964; Becker and Chiswick, 1966; Mincer, 1974) to explain how "the imbedding of resources in people influences real future income." (Becker, 1962:9) In 1974, Mincer laid a framework for estimating the rate of return to education using an earnings function that measures the log of earnings as it relates to education, experience and experience squared. This relationship has been estimated numerous times in various forms. Much of this analysis began in the United States, where Mincer and Becker work and where public use data is readily available. Studies have since been conducted on almost every country. The results of these studies have been compared, but because the methodologies were often quite different, only broad generalizations have been drawn. Recent research comparing education and earnings in the United States has focused on changes in the rate of return over time; few such studies have been completed in other nations.

This paper attempts to bridge the gap between the previous cross-national work estimating rates of return to education and the current trend toward examining rates over time. I build on previous cross-national work by comparing education and earnings across five countries in a systematic way.¹ Using Mincer earnings functions I estimate

¹The only other work I am aware of which attempts to systematically estimate earnings functions across countries is two working papers by Jochim Wagner and Wilhelm Lorenz (Wagner & Lorenz, 1988, 1990).

the rate of return to education for two waves of data for each of the countries. I find that the rate of return to education increased most dramatically during the 1980's in the United States. Other countries saw either small increases during the studied time period (Australia), or decreases in the rate of return to education (the Netherlands).

This paper is organized as follows. Section two looks at the previous research in this area. The third section describes the data and provides a brief rationale for my choice of coding for the education variable. The fourth section contains the empirical results while the final section summarizes the findings.

Previous Research

The earliest formal work in the area of human capital investment began with an article by Gary Becker in which he described how such things as on the job training, schooling and medical care can effect earnings and what incentives exist to invest in these various forms of human capital (Becker, 1962). It is with this article that education (and human capital in general) came to be viewed as an investment and as such had an associated rate of return.

Based on the work of Becker, Jacob Mincer formally developed a model for estimating the rate of return to education (Mincer, 1974). (See Appendix A for derivation.) The earnings function Mincer developed is:

$$\ln Y = b_0 + b_1 S + b_2 \text{exp} + b_3 \text{exp}^2$$

where: Y = annual earnings of an individual
 S = years of school for an individual
 exp = years of experience of an individual

This model is based on the assumptions that the only cost to schooling is foregone

earnings and that the length of an individual's working life is independent of his or her schooling. Evidence suggests that the Mincer earnings function is of the appropriate functional form to relate earnings, education and experience (Heckman & Polachek, 1974).

When the Mincer earnings equation is estimated empirically, the coefficient on schooling is often interpreted as the rate of return to education. As Griliches notes, this is only true "if foregone income is the only cost of an additional year of schooling and if the increment in log income due to this additional year of schooling is constant in perpetuity." (Griliches, 1977 4) In addition, there are two types of returns to education--social and private. The social rate of return is the return from society's point of view and, as such, benefits are gross earnings and costs are all costs associated with obtaining that level of education. The private rate of return, on the other hand, is from the individual's point of view so benefits are net earnings while costs are only what the individual pays directly or forgoes. So, while many studies have attempted to estimate the rate of return to education, it is perhaps more accurate to state that they have examined the association between education and earnings.

There are three main criticisms of the Mincer earnings equation. First, school quality is omitted, second, ability is omitted and third, there is a selection problem associated with who chooses to obtain more education.

If it is assumed that people who attend higher quality schools also obtain more education, then omitting school quality from an earnings equation will cause the coefficient on schooling to be biased upward. While estimates of the bias range from as

little as six percent (Card & Krueger, 1992b) to as much as 90 percent (Behrman & Birdsall, 1987), the effect is strongly overstated when cohort effects are also omitted (Card & Krueger, 1992b). So, while school quality is important, the magnitude of its effect is uncertain.

Omitting ability will have the similar effect of biasing upward the coefficients on the schooling variable if it is true that high ability individuals on average obtain more education. However, if there is measurement error associated with the schooling variable then the coefficient will be biased downward. Based on various analyses using different measures of ability and different estimation techniques, Griliches concludes that "in optimizing models there is no good a priori reason to expect the ability bias to be positive" (Griliches, 1977: 18).

The third criticism of the earnings equation is one of selection. If it is true that people who choose to obtain more education are different (in unobservable ways) from those who choose to obtain less education, then conclusions should not be drawn which state, for example, that if people who currently only have a high school education were to attend college then their earnings would increase by a certain amount. The unobservable differences across these groups means we do not know if those with a high school education would be effected the same way by obtaining a college education as those who chose to do so in the first place. Rather, all that can be said is that those who chose to obtain a college education earn so much more on average than those who chose to obtain a high school education. Kane and Rouse attempt to correct for both selection bias (using test scores, class rank and family income) as well as for measurement error

(using self-reported education as an instrument for school transcript measures) and found that the effects are nearly equal in magnitude and opposite in sign so that correcting for neither yields similar results as correcting for both (Kane & Rouse, 1993).

Mincer earnings equations have been estimated by many people in various countries. (Demetriades and Psacharopoulos, 1987; Murphy & Welch, 1989; Papanicolaou and Psacharopoulos, 1979; Psacharopoulos and Layard, 1979; and Psacharopoulos and Velez, 1992). The methodology and results of these individual studies are summarized in Table 1. They generally find that earnings functions explain about 30% of income variability and that private rates of return are around ten percent.

Psacharopoulos has likely done the most work on compiling results from various studies in an attempt to make cross-national comparisons of the return to education. In his studies (Psacharopoulos 1972, 1973, 1985), he found fairly consistent estimates of private rates of return to education in developed countries of around ten to fifteen percent. He also found diminishing returns to education and an overall estimate of the coefficient on schooling in the Mincer earnings function of around nine percent in advanced countries. Comparability across countries, however, is a problem because the results were estimated using different methodologies and assumptions.

Recent research in the United States has focused on changes in the rate of return to education over time. Since 1979, the earnings of college educated men relative to high school educated men have increased sharply (Burtless, 1990; Levy & Mumane, 1992; Bound & Johnson, 1992; Murphy & Welch, 1992). This is particularly true for those who are young and for those who work in blue collar occupations where earnings have

TABLE 1

| Author (date) | Data | Estimation Method | Variables | Schooling | Country | Results |
|--------------------------------------|---|---|---|---|----------------|--|
| Demetriades & Psacharopoulos (1979) | 30,000 wage earners | Mincerian Earnings Functions | schooling, potential experience | years | Cyprus | Private: (Mincerian): 11% (12.7% female, 8.9% male) Shortcut method: Social: 3-13% Private: 5-15% |
| Murphy & Welch (1989) | March demographic supplement to CPS 1964-1987 | Earnings differentials ie: college vs. high school | schooling, potential experience, race, sex, age, industry | 0-7 yrs 8-11 yrs 12 yrs 13-15 yrs 16 yrs 17+ yrs | United States | not college vs. high school: 1970: 46% 1979: 32% 1986: 70% |
| Papanicolaou & Psacharopoulos (1979) | 1972 General Household Survey | Mincerian Earnings Functions by father's occupations | schooling, potential experience, occupations of father | not provided | United Kingdom | Range: 8% - 13% depending on father's occupation |
| Psacharopoulos & Layard (1979) | 1972 General Household Survey-- 6873 men age 15-64 who worked at least 1 week in prior year | Age-Earnings Profiles Mincerian Earnings Functions | schooling, potential experience | not provided | United Kingdom | Private: 10% Earnings max. at 30 years experience |
| Psacharopoulos & Velez (1992) | 2087 workers in 1988 in Bogota, Columbia | Mincerian Earnings Functions | schooling, potential experience, reasoning and cognitive ability, father's occupation | years as well as degree attained | Columbia | Private: 10.5%, ability has little effect |

declined (Blackburn, Bloom & Freeman, 1990/1991). In addition, people are on average obtaining more education (Kosters, 1991). For both of these to hold true (increased supply and increased returns), standard economic theory suggests a larger increase in demand for than supply of highly educated workers. This is often attributed to changing technology such as computerization (Bartel & Lichtenberg, 1987; Krueger, 1993; Gottschalk and Joyce, 1992) as well as to a phenomenon often referred to as deindustrialization whereby shifts in product demand cause a decrease in the number of manufacturing jobs which typically employ those with less education (Katz & Murphy, 1992; Murphy and Welch, 1991).

The available research therefore suggests that while it is important to keep potential biases in mind when estimating earnings equations, the size of these biases is disputed in the literature. This paper attempts to improve on previous cross-national work as well as to address questions existing in the current U.S. literature by systematically estimating Mincer earnings equations across countries and over time. In addition, because of the importance of the industrial structure on earnings (Gottschalk and Joyce, 1992), controls for industry and occupation have been included.

Data

This study uses data from the Luxembourg Income Study (LIS), a collection of data sets obtained primarily from income surveys in various countries. Substantial effort has been made to make the data as comparable as possible across the countries. Appendix Table B-1 lists the surveys used in the five countries I examine: the United States, Canada, Australia, the Netherlands and Germany. The choice of these countries was

primarily data driven. In addition, because the popular press often compares the United States educational system with that of other countries (Celis, 1993), I wanted to include countries with very different educational systems from the U.S. such as the Netherlands and Germany. I look at two waves of data for each of the five countries--one from the early 1980's and one from the later 1980's.²

This study examines non-disabled, male, household heads between the ages of 25 and 55 who work full-year, full-time. Because I estimate Mincer earnings equations and calculate experience as potential experience (age minus education minus six), by focusing on men I am more likely to avoid the problem of interrupted labor market experiences more common among women. I look at those who work full-year, full-time in an attempt to avoid the problems associated with whether increased earnings are a function of increased hours or increased wages as other authors have done (Blackburn, Bloom & Freeman, 1991; Gottschalk and Joyce, 1992). In general, full-year, full-time is defined to be those who work at least 35 hours a week at least 48 weeks a year, though this varies slightly by survey. Another option I had was to use hourly wages as the dependent variable and expand the analysis to cover everyone with positive earnings. Hourly wages for several countries, however, would have to be calculated as earnings divided by hours worked and for several countries we know only whether someone worked full-time or part-time, full-year or part-year, not actual total hours worked. It is for these reasons that this paper looks only at men who work full-year, full-time. The measure of income used

²The second wave of data for Germany (1989) is not yet available in LIS, but should be soon.

is gross wage and salary income. Although net income might be theoretically preferred due to different tax structures across countries, only gross income is available at the individual level.

Table 2 shows the proportion of men who work full-year, full-time by educational status as an indication of the potential bias which may result by not including those who work less than full-year, full-time in the analysis. We see that in the United States and Canada, the percentage of men working full-year, full-time increases with their level of education. Whether this is by choice or by necessity (eg: the inability to find full-time employment) is unclear. From 70 to 83 percent of men worked full-year, full-time in the United States in 1979 while in 1986 only from 44 to 79 percent did so. This represents the largest difference across educational categories in full-time status among the five countries examined. If there is a bias that results from examining full-year, full-time workers exclusively, it will likely have the largest effect in the United States. In Canada the employment status was also closely related to educational levels with the percent of men working full-year, full-time ranging from 62 to 87 percent in 1981 and from 54 to 86 percent in 1986.

There is much less variation in full-year, full-time employment in the remaining three countries and the correlation with educational status is no longer so strong. For example, in Australia in 1981 the percent of men working full-year, full-time ranged from 89 to 95 percent, a much narrower range than was seen in the United States or Canada. In addition, the fewest men worked full-year, full-time in the middle education category. The range was similar in 1985 with from 82 to 88 percent of men working full-year, full-

Table 2

Percent of Men Aged 25-55 who Work Full-Year, Full-Time by Educational Level

| | US79 | US86 | CN81 | CN87 | AS81 | AS85 | NL83 | NL87 | GE84 | GE89 |
|-----------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|
| No / Very Low School | 70.41 | 44.44 | 62.25 | 54.37 | 91.64 | na | 95.18 | 93.31 | na | |
| Low School | 77.23 | 59.62 | 74.37 | 65.87 | 92.64 | 82.34 | 96.70 | 90.75 | 78.00 | |
| High School | 81.73 | 70.46 | 86.22 | 77.28 | 89.43 | 84.26 | 87.64 | 84.66 | 83.01 | |
| Other School | 82.53 | 72.55 | 80.75 | 79.76 | 93.30 | 86.37 | na | na | 85.49 | |
| College or More | 83.28 | 79.15 | 87.15 | 86.08 | 95.14 | 87.74 | 91.08 | 79.19 | 80.25 | |
| Overall | 81.31 | 71.61 | 77.64 | 73.65 | 93.00 | 85.02 | 94.41 | 89.66 | 81.49 | |

time. Results from Germany 1984 are similar with from 78 to 85 percent working full-year full-time. Those with a low level of education worked the least while those with the next to highest level of education worked the most.

In the Netherlands, we see the largest percent of men working full-year, full-time. In 1983, from 88 to 95 percent did so while in 1987 from 79 to 93 percent did so. Again, the association between full-year, full-time employment status and educational attainment is weak. In 1983, those with a high school education worked the least while those with the lowest level of education worked the most. In 1987, the association between employment status and education level in the Netherlands appears to be exactly opposite to that seen in the United States and Canada. Here, those with the lowest levels of education work the most while those with the highest levels of education work the least.

It appears, then, that while there is some variation in the number of men who work full-year, full-time based on educational attainment, this association is much weaker and less systematic when looking across countries than would be predicted by looking at these trends in the United States alone.

In an attempt to make my results as comparable across countries as possible, I examined and reclassified the coding of several variables. The most important one was education. Although many studies (and Mincer's theoretical model) use years of education attained, much of the data I have is coded as degree attained (which is not highly comparable across countries with different educational systems). It is because of this that I chose to categorize educational attainment into various groups as others have done (Murphy & Welch, 1989). I use a unique classification system which I developed to code

education into five categories: Low or No Education (approximately 0-6 years), Low Education (7-11 years), High School (12 years), Other (13-15 years), and College (16 or more years). Appendix Table B-2 summarizes the recoding for the five countries while Appendix Table B-3 indicates what proportion of the sample falls into the various educational categories. In addition, Appendix C, which contains a description and diagram of each of the educational systems, is included to help explain the choices I made in coding education. Occupation is classified into four groups: Professional and Administrative; Sales, Service and Clerical; Blue Collar; and Other. Industry is categorized as: Primary, Manufacturing, Commerce, Other Service, Financial Service, Utilities, Construction and Missing. The percent of the sample falling into the various occupational and industrial categories are found in Appendix Tables B-4 and B-5.

Empirical Estimates

This study begins with the estimation of the following Mincer earnings equation:

$$\ln Y = b_0 + b_1 \text{Low/No} + b_2 \text{Low} + b_3 \text{Other} + b_4 \text{College} + b_5 \text{Exp} + b_6 \text{Exp}^2$$

where:

- $\ln Y$ = log of gross wage and salary income
- Low/No = a dummy variable for low or no education
- Low = a dummy variable for low education
- Other = a dummy variable for other education
- College = a dummy variable for College or more education
- Exp = potential experience
- Exp² = potential experience squared

Potential experience is calculated as age minus education minus six where education is the years of education for that level of education. (I use 6 years for Low/No education, 10 for Low, 12 for High School, 14 for Other and 16 for College.)

Because high school is the omitted dummy variable, it is expected that the

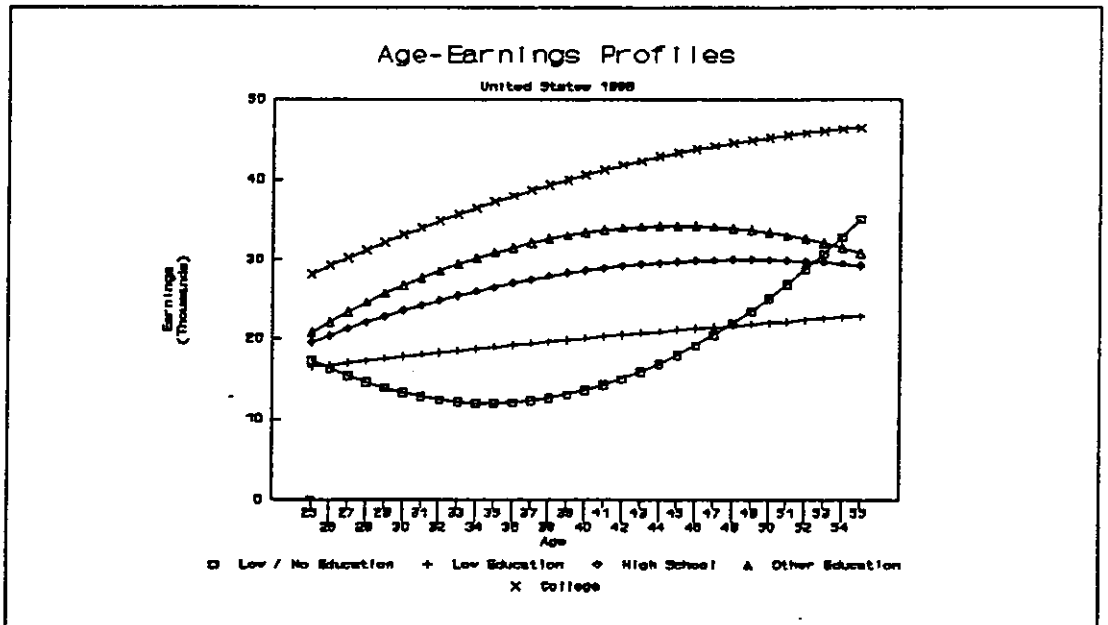
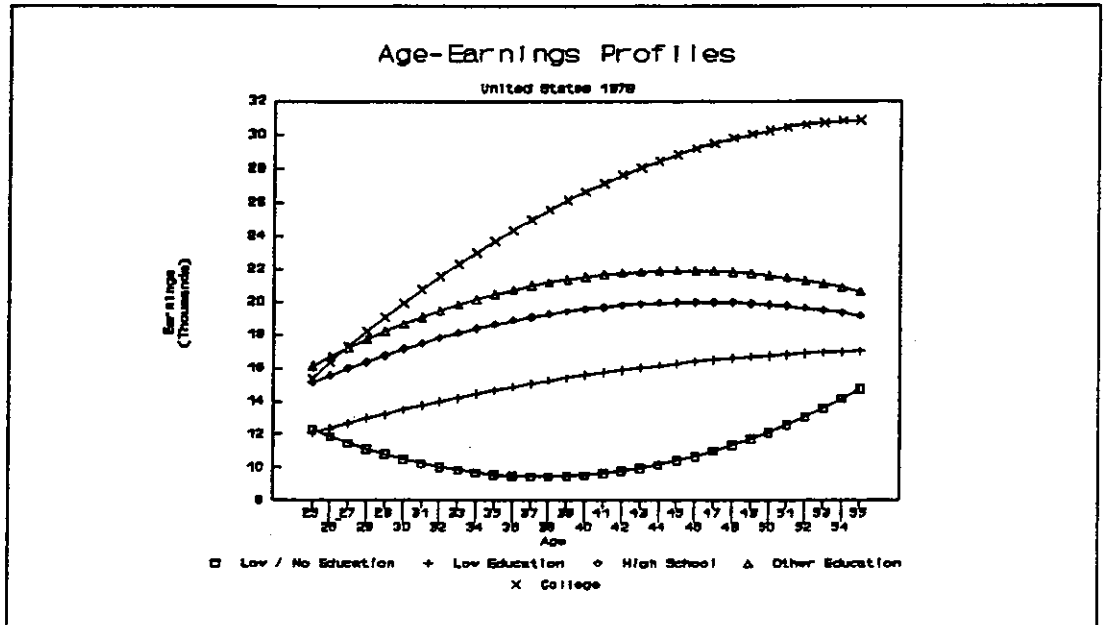
coefficients on Low/No and Low Education will be negative (those with less than a high school education would be expected to earn less than those with a high school education), while the coefficients on Other and College would be expected to be positive. It is also expected that experience generally has a positive effect on earnings, but at a declining rate so that the coefficient on experience squared would be expected to be negative.

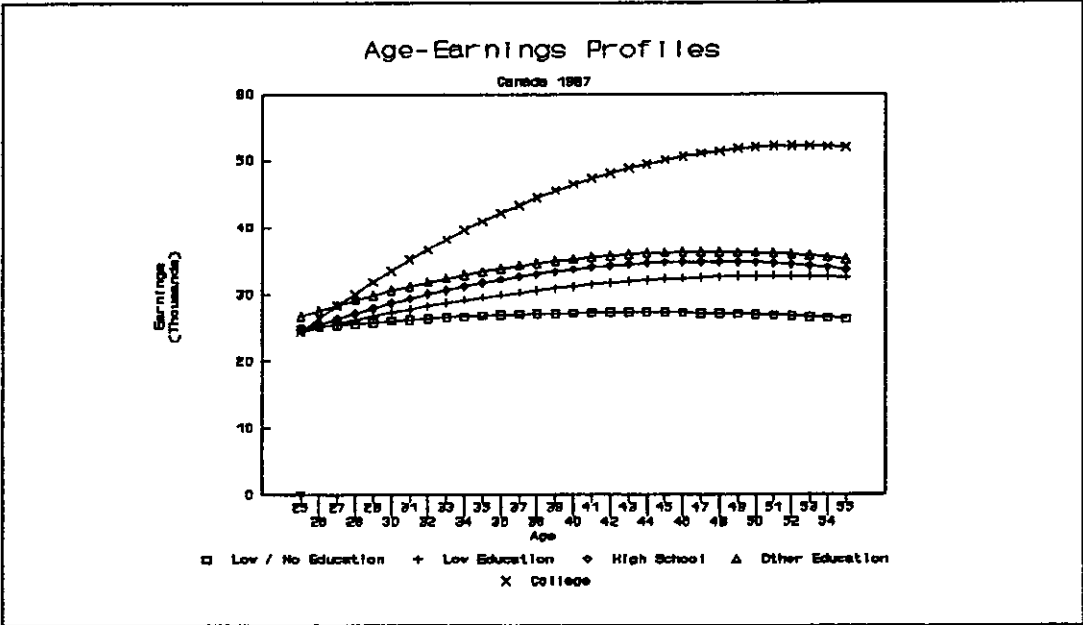
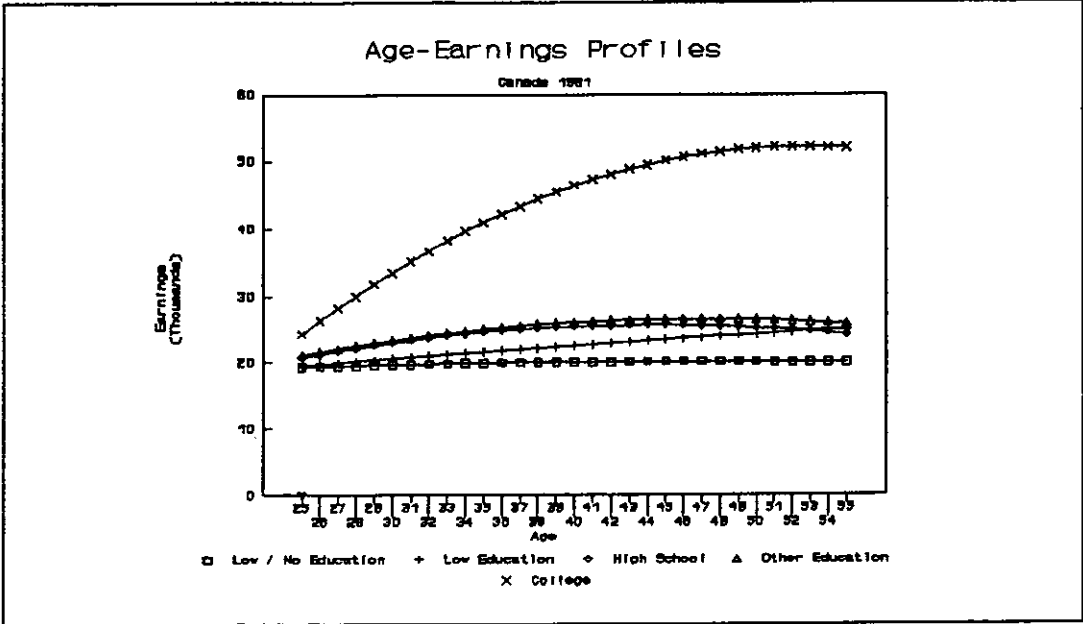
The basic earning equation yields standard shaped age-earnings profiles. This can be seen in Figure 1 where earnings profiles in all countries rise quickly at younger ages then taper off at later ages. As the level of education increases, so does the steepness of the earnings profile. Only in the United States for the lowest level of education does the earnings profile not exhibit the anticipated shape. This is potentially a result of examining only those who work full-year, full-time or the small number of workers in the lowest educational category.

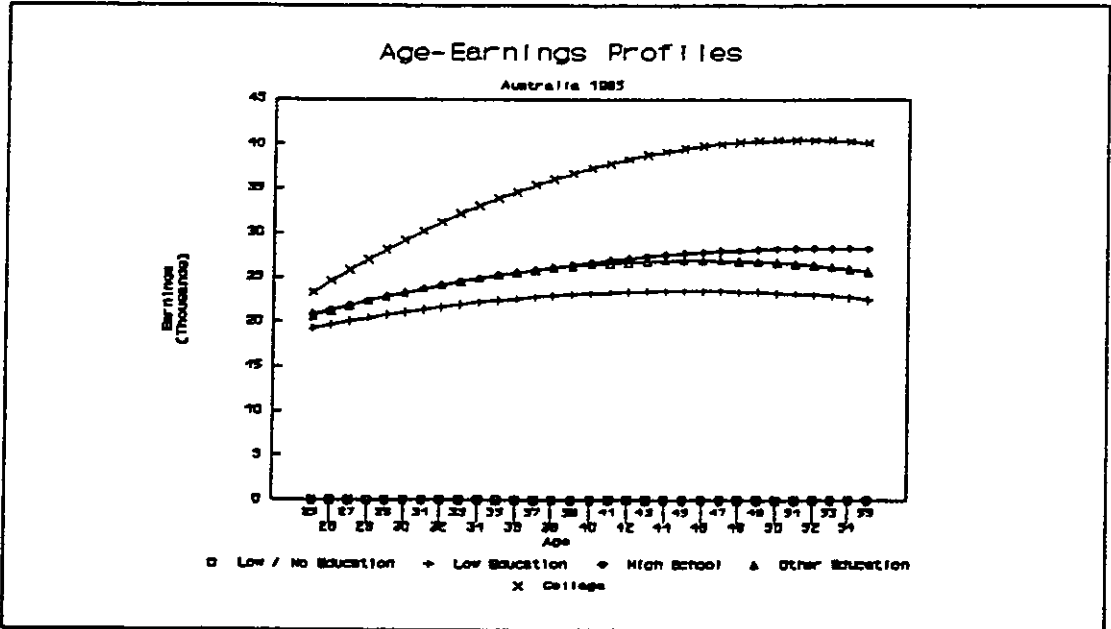
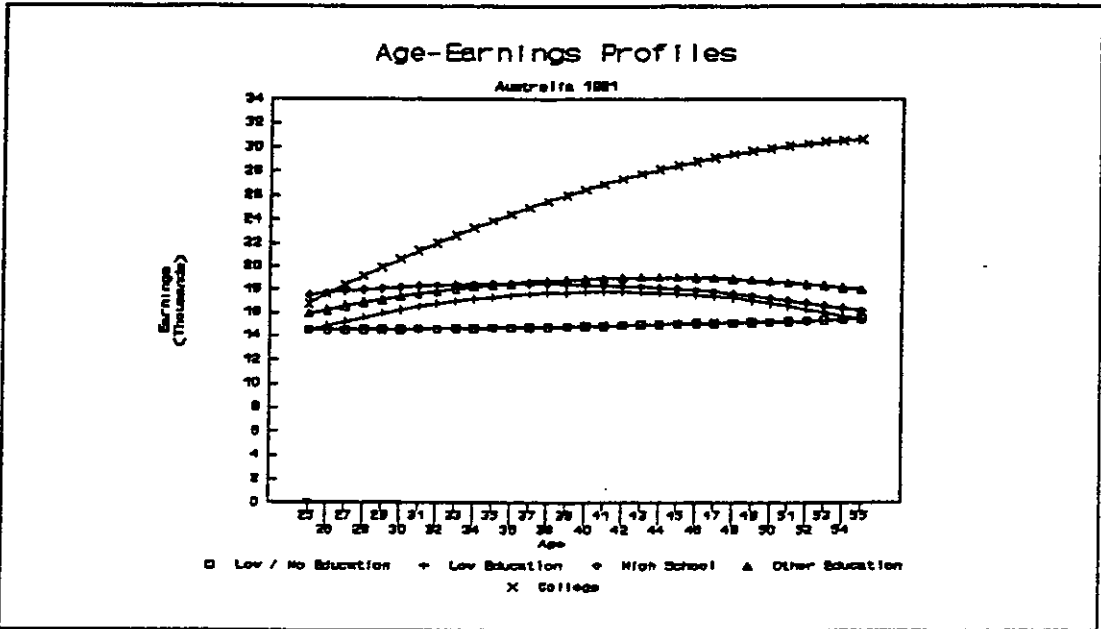
Table 3 presents the results of the estimation of the above earnings equation. Nearly every coefficient is statistically significant at the one percent level. The only two that are not are the coefficients on other education for Australia in both 1981 and 1985. This may be a result of the coding of the education variable in this country. As would be expected, the coefficient on the schooling dummy variable is lowest for the Low/No education category and increases with each subsequent level of education. The coefficient on experience is always positive and between 0.03 and 0.06 for all the countries. Experience squared, as would be expected, has a negative effect--of between 0.0004 and 0.0009.

The basic earnings function estimated here appears to do a better job of explaining

Figure 1

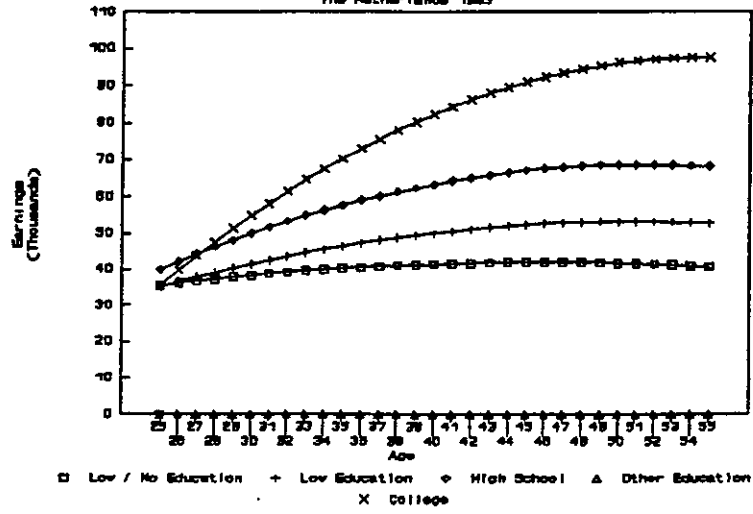






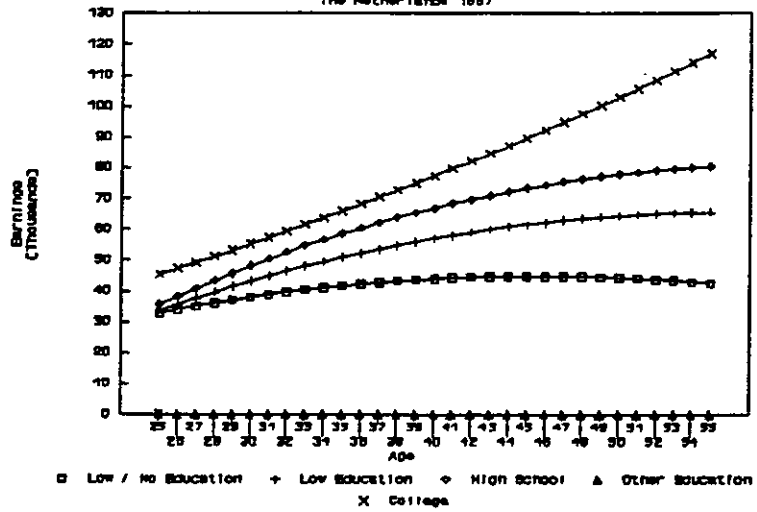
Age-Earnings Profiles

The Netherlands 1983



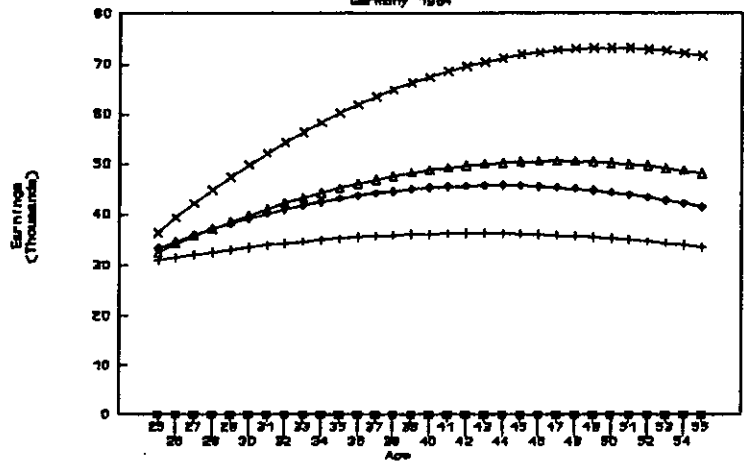
Age-Earnings Profiles

The Netherlands 1987



Age-Earnings Profiles

Germany 1994



□ Low / No Education + Low Education ♦ High School ▲ Other Education
X College

Table 3
Dependent Variable = Log Wage
Regression Estimates for Male Household Heads Who Work FYFT
Standard Variables--Education, Experience, Experience Squared
standard errors in parentheses

| | United States | | Canada | | Australia | | Netherlands | | | Germany | |
|--|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|---------|--|
| | 1979 | 1986 | 1981 | 1987 | 1981 | 1985 | 1983 | 1987 | 1984 | 1989 | |
| Constant | 9.269 (0.041) | 9.599 (0.064) | 9.694 (0.036) | 9.814 (0.047) | 9.448 (0.042) | 9.694 (0.067) | 10.305 (0.052) | 10.169 (0.049) | 10.090 (0.047) | | |
| Schooling and Experience | | | | | | | | | | | |
| Low / No Education | -0.606 (0.054) | -0.659 (0.127) | -0.268 (0.027) | -0.199 (0.039) | -0.207 (0.045) | na na | -0.433 (0.027) | -0.478 (0.024) | na na | | |
| Low Education | -0.234 (0.027) | -0.296 (0.050) | -0.121 (0.020) | -0.086 (0.027) | -0.108 (0.030) | -0.135 (0.037) | -0.249 (0.025) | -0.175 (0.025) | -0.199 (0.019) | | |
| Other Education | 0.134 (0.023) | 0.142 (0.034) | 0.063 (0.021) | 0.079 (0.024) | -0.002 (0.030) | 0.006 (0.035) | na na | na na | 0.099 (0.023) | | |
| College | 0.312 (0.021) | 0.399 (0.029) | 0.310 (0.023) | 0.315 (0.027) | 0.285 (0.033) | 0.338 (0.042) | 0.312 (0.035) | 0.278 (0.031) | 0.427 (0.023) | | |
| Experience | 0.036 (0.004) | 0.038 (0.007) | 0.025 (0.003) | 0.036 (0.004) | 0.027 (0.003) | 0.030 (0.006) | 0.048 (0.005) | 0.059 (0.004) | 0.046 (0.005) | | |
| Experience² (E-04) | -5.673 (0.956) | -6.571 (1.596) | -3.765 (0.718) | -5.936 (0.983) | -5.220 (0.799) | -5.568 (1.551) | -7.649 (0.906) | -8.548 (0.815) | -8.822 (1.045) | | |
| R2 | 0.126 | 0.121 | 0.103 | 0.085 | 0.071 | 0.064 | 0.267 | 0.330 | 0.307 | | |

Table 4

Dependent Variable = Log Wage
Regression Estimates for Male Household Heads Who Work FYFT
All Variables--Education, Experience, Occupation, Industry
standard errors in parentheses

| | United States | | Canada | | Australia | | Netherlands | | Germany | |
|--------------------------------------|-------------------|-------------------|-------------------|-------------------|--------------------|-------------------|-------------------|-------------------|-------------------|------|
| | 1979 | 1986 | 1981 | 1987 | 1981 | 1985 | 1983 | 1987 | 1984 | 1989 |
| Constant | 9.297 (0.042) | 9.672 (0.068) | 9.730 (0.037) | 9.887 (0.049) | 9.407 (0.043) | 9.723 (0.069) | 10.261 (0.055) | 10.166 (0.051) | 10.089 (0.046) | |
| Schooling and Experience | | | | | | | | | | |
| Low / No | -0.550 (0.054) | -0.560 (0.124) | -0.275 (0.028) | -0.201 (0.039) | -0.154 (0.044) | na na | -0.396 (0.029) | -0.472 (0.026) | na na | |
| Low Education | -0.209 (0.027) | -0.267 (0.049) | -0.126 (0.020) | -0.095 (0.026) | -0.076 (0.030) | -0.084 (0.037) | -0.226 (0.026) | -0.172 (0.025) | -0.152 (0.019) | |
| Other Education | 0.124 (0.023) | 0.137 (0.034) | 0.039 (0.021) | 0.072 (0.024) | 0.027 (0.029) | 0.015 (0.035) | na na | na na | 0.073 (0.023) | |
| College | 0.282 (0.025) | 0.362 (0.031) | 0.246 (0.026) | 0.289 (0.030) | 0.202 (0.034) | 0.257 (0.044) | 0.309 (0.035) | 0.278 (0.031) | 0.283 (0.028) | |
| Experience | 0.035 (0.004) | 0.037 (0.006) | 0.024 (0.003) | 0.036 (0.004) | 0.023 (0.003) | 0.026 (0.006) | 0.048 (0.005) | 0.059 (0.004) | 0.042 (0.004) | |
| Exper.² (E-04) | 5.684 (0.939) | -6.524 (1.556) | -3.713 (0.712) | -5.954 (0.964) | -4.355 (-0.779) | -4.811 (1.531) | -7.525 (0.913) | -8.622 (0.817) | -7.935 (0.993) | |
| Occupation | | | | | | | | | | |
| Profess., Admin. | 0.175 (0.023) | 0.243 (0.031) | 0.052 (0.020) | 0.100 (0.025) | 0.208 (0.017) | 0.180 (0.028) | na na | na na | 0.281 (0.026) | |
| Sales, Serv Clerical | 0.014 (0.012) | 0.059 (0.015) | -0.055 (0.009) | -0.026 (0.013) | 0.056 (0.010) | 0.041 (0.016) | na na | na na | 0.055 (0.010) | |
| Industry | | | | | | | | | | |
| Primary | 0.119 (0.048) | -0.205 (0.043) | na na | 0.133 (0.037) | 0.295 (0.033) | -0.337 (0.050) | -0.148 (0.054) | -0.064 (0.062) | 0.049 (0.062) | |
| Commerce | -0.106 (0.026) | -0.235 (0.041) | na na | -0.173 (0.029) | -0.128 (0.020) | -0.163 (0.036) | 0.002 (0.030) | 0.007 (0.025) | -0.060 (0.027) | |
| Other Service | -0.208 (0.023) | -0.259 (0.034) | na na | -0.172 (0.028) | -0.053 (0.020) | -0.073 (0.034) | 0.038 (0.022) | 0.006 (0.021) | -0.100 (0.021) | |
| Financial Service | -0.106 (0.042) | -0.167 (0.061) | na na | -0.113 (0.049) | 0.003 (0.024) | -0.078 (0.044) | 0.135 (0.031) | na na | 0.169 (0.037) | |
| Utilities | 0.050 (0.028) | -0.008 (0.039) | na na | -0.010 (0.030) | -0.022 (0.023) | 0.030 (0.035) | 0.003 (0.028) | -0.006 (0.030) | -0.057 (0.028) | |
| Construct. | -0.058 (0.031) | na na | na na | -0.212 (0.039) | -0.127 (0.033) | -0.108 (0.046) | -0.004 (0.029) | -0.017 (0.029) | -0.098 (0.028) | |
| R2 | 0.162 | 0.173 | 0.117 | 0.125 | 0.124 | 0.101 | 0.281 | 0.330 | 0.384 | |

the variation in earnings in the Netherlands and Germany than in Canada and the United States. This can be seen roughly by looking at the value of R^2 . In Germany and the Netherlands, education and experience explain about 30 percent of the variation in earnings but these variables explain only about 10 percent of the variation in the United States and Canada. This is likely a result of the extent to which educational background and employment are related. As indicated in Appendix C, the systems of education in Germany and the Netherlands are more structured and career-paths more well-defined. For example, in Germany to become an engineer you must attend Fachhochschule. In the United States, on the other hand, it is possible to become an engineer by attending a variety of different types of schools.

As mentioned earlier, other authors have found that the occupation and industry in which an individual works may effect his earnings (Blackburn, Bloom & Freeman, 1990/1991). If this is true, the coefficients on schooling in Table 3 may be picking up some of the effects of occupation and industry. Table 4 is therefore included to show the effect on the regression results when industry and occupation have been controlled for. The coefficients on schooling are somewhat smaller indicating that occupation and industry are important. The overall fit is improved slightly in the United States, Canada and Australia, not at all in the Netherlands and quite a bit in Germany. The fact that occupation and industry have no effect in the Netherlands may be the result of the way the variables are coded while the improved fit in Germany is likely due to the more rigid structure of the German system of education and subsequent employment.

Before comparing the results of Tables 3 and 4 with previous research, it is helpful

to convert the coefficients so they have more meaningful interpretations. If schooling entered the above equation in continuous form, the appropriate interpretation of the coefficient on schooling would be the percentage increase in earnings associated with a one year increase in educational attainment. This interpretation, however, is flawed when education enters the equation as dummy variables. In a semilogarithmic equation with a continuous independent variable, the coefficient on that variable is the derivative of the dependent variable (log earnings, for example) with respect to the independent variable (years of schooling). (Halvorsen and Palmquist, 1980). However, the derivative of the dependent variable with respect to a dummy variable does not exist. The coefficient of a dummy variable simply indicates, for example, the effect on earnings of the presence of that which is represented by the dummy variable (such as college education) (Halvorsen and Palmquist, 1980). To transform the coefficients into percentage changes in earnings, the following method is adopted. Let g be the relative effect on Y of the presence of the factor represented by the dummy ($g = (Y_1 - Y_0)/Y_0$). The Mincer earnings function can then be written (assume for simplicity the dummy variable can take only two values--educated and not):

$$Y = (1 + g)^S \exp(b_0 + b_2 \text{experience} + b_3 \text{experience}^2)$$

The coefficient on schooling is therefore $\ln(1+g)$ and the relative effect on Y is $g = \exp(b_1) - 1$. (Halvorsen and Palmquist, 1980)

The results of Tables 3 and 4 have been converted to estimates of the increased earnings of college versus high school or high school versus low school and are presented in Table 5. The converted results show that individuals with a college education on

Table 5**Percent Increase in Earnings for Various Levels of Education
for Male Household Heads Who Work Full-Year, Full-Time**

| | Standard Earnings Function Estimates | | Estimates with Controls for Industry and Occupation | |
|----------------------|---|-------------------------|--|-------------------------|
| | College/ High School | High School/ Low Ed. | College/ High School | High School/ Low Ed. |
| United States | | | | |
| 1979 | 36.64 | 26.39 | 32.6 | 23.2 |
| 1986 | 49.00 | 34.51 | 43.6 | 30.6 |
| Canada | | | | |
| 1981 | 36.29 | 12.88 | 27.9 | 13.4 |
| 1987 | 37.05 | 9.01 | 33.5 | 10.0 |
| Australia | | | | |
| 1981 | 32.99 | 11.44 | 22.4 | 7.9 |
| 1985 | 40.23 | 14.46 | 29.3 | 8.8 |
| Netherlands | | | | |
| 1983 | 36.59 | 28.23 | 36.2 | 25.4 |
| 1987 | 32.00 | 19.13 | 32.0 | 18.8 |
| Germany | | | | |
| 1984 | 53.19 | 22.04 | 32.7 | 16.4 |
| 1989 | | | | |

average earned about 36 percent more than those with a high school education in the United States in 1979, Canada in 1981 and the Netherlands in 1983. Australian college educated workers earned slightly less (33 percent) while the German college educated earned 53 percent more than those with only a high school education. The higher earnings of college versus high school educated men appears to have increased during the 1980's in the United States, Canada and Australia. These results are very similar to estimates by Koster who found that in the United States in 1978, those with a college education earned on average 35 percent more than those with a high school education, 48 percent more in 1983 and 78 percent more in 1988 (Koster, 1991). In the Netherlands, on the other hand, the earnings of college educated workers fell slightly. A second wave of data for Germany is not yet available, although others have found declining earnings ratios of the college to the high school educated in Germany (Lehrman & Lane, 1993).

While the college educated clearly earned more than the high school educated, what about those with a high school education relative to those with less education? In the United States, high school educated men earned 26 percent more than those with low education earned in 1979 and nearly 35 percent more in 1986. In Canada and Australia, high school educated men earned only about 12 percent more than those with low education, while in the Netherlands and Germany the figure was closer to that of the United States. During the 1980's, it appears high school educated men saw increased earnings relative to those with less education only in the United States and Australia. In Canada and the Netherlands their earnings, while still higher, fell relative to their less well-educated counterparts.

Table 5 also includes the results when occupation and industry are controlled for. Overall, the trends hold, however, the increased earnings associated with any given level of education are generally smaller. So, for example, college educated men in the United States in 1986 earned 43.6 percent more than high school educated men when industry and occupation were controlled for, lower than the 49 percent that was indicated without the controls. This pattern of lower returns with industry and occupation controls holds across time, countries and educational levels.

It is perhaps most useful to convert the results to estimates of the increased earnings associated with an additional year of schooling. This makes the results more comparable to rate of return estimates. To do this, the average number of years associated with each level of education must be assumed (as noted before, I use 6, 10, 12, 14, and 16 years for the five educational categories). Using the notation from the prior conversion, the increased earnings of the college educated relative to the high school educated can be written as the following ratio of earnings³:

$$1 + g = \frac{\exp (b_0 + b_4 + b_5 E_c + b_6 E_c^2)}{\exp (b_0 + b_5 E_h + b_6 E_h^2)}$$

where E_c = experience of someone of a certain age with college education
 E_h = experience of someone of a certain age with high school education

So, for example, E_c for a 45 year old man would be 23 (45-16-6). The yearly percentage increase in earnings for each year of college education over high school education is:

³Wagner and Lorenz performed similar conversions in their working papers.

$$r = [\sqrt[n]{(1+g)} - 1] * 100$$

where n is the difference in years of education for the two levels being compared (four for college and high school). This is similar to a compound interest calculation.

The converted results for college vs. high school education and high school vs. low education are shown in Table 6. The results without controlling for occupation and industry range from about six to sixteen percent--very close to the estimates of Psacharopoulos for advanced countries. With controls, the estimates of the rate of return to education are slightly smaller (from five to nine percent for college and from four to fourteen percent for high school), except in Canada where the rates for high school actually increase slightly.

Comparing the rate of return of a high school versus a low education with the return of a college to high school education is also illuminating. In most countries, (all but Australia and Canada 1987), there appear to be diminishing returns to education. For example, in Germany the rate of return to a high school education is higher (eight percent) than the return to a college education (seven percent). This is also consistent with Psacharopoulos findings.

Because the results of other studies are often taken from an earnings equation with years of education as the school variable, I have also computed rates for the United States⁴ this way. Calculating the return in this fashion assumes a constant rate across different educational levels. I find a rate of return to a year of education of 7.2 percent

⁴The United States is the only one of the five countries I examine where education is coded in years and as such is the only country for which I am able to make this comparison.

in 1979 and 8.8 percent in 1986. These results are consistent with the Psacharopoulos results (Psacharopoulos, 1985). The rates are somewhat smaller than those in Table 6, likely because those rates of return pertain to specific levels of education while the above calculations are for all levels of education. In any case, the results in Table 6 using dummy variables for educational levels are in the right range and move in the same direction over time as rates calculated using a more standard earnings equation with education measured in years.

In addition to examining the rate of return to various levels of education, we can look at how the rates have changed across time in the four of the five countries. As mentioned before, research in the United States has generally found increasing rates of return during the 1980's (Levy & Murnane, 1992; Katz & Murphy, 1992; Bound & Johnson, 1992). The results in Table 6 are consistent with this finding. With controls for occupation and industry, the rate of return to a college versus a high school education increased from 6.6 to 9 percent between 1979 and 1986 while the high school to low education rate increased from 10.7 to 14.2 percent. Is this trend unique to the United States? In many ways, it appears to be unique among the countries I examine. In the Netherlands the rate of return appears to have declined during the 1980's. This is also true in Canada for the high school to low education rate. The Canadian rate for college to high school as well as both rates in Australia appear to have increased over time as in the United States, but by a much smaller amount. So, it appears that large increases in the rate of return to education during the 1980's are a phenomenon unique to the United States, although several other countries exhibited similar, though smaller, trends.

Table 6**Yearly Increase in Earnings for Various Levels of Education
for Male Household Heads Who Work Full-Year, Full-Time**

| | Standard Earnings Functions Estimates | | Estimates with Controls for Occupation and Industry | |
|----------------------|--|-------------------------|--|-------------------------|
| | College/ High School | High School/ Low Ed. | College/ High School | High School/ Low Ed. |
| United States | | | | |
| 1979 | 7.29 | 11.94 | 6.60 | 10.67 |
| 1986 | 9.92 | 15.81 | 9.00 | 14.23 |
| Canada | | | | |
| 1981 | 7.39 | 5.82 | 5.77 | 6.16 |
| 1987 | 7.29 | 4.11 | 6.77 | 4.59 |
| Australia | | | | |
| 1981 | 7.29 | 5.78 | 5.05 | 3.97 |
| 1985 | 8.58 | 7.11 | 6.43 | 4.39 |
| Netherlands | | | | |
| 1983 | 7.06 | 12.67 | 6.92 | 11.31 |
| 1987 | 5.47 | 7.94 | 5.51 | 7.82 |
| Germany | | | | |
| 1984 | 11.06 | 10.84 | 7.08 | 8.16 |
| 1989 | | | | |

In examining these changes in the rate of return to education over time we might ask, for example, whether it is the increased earnings of those with a college education or the decreased earnings of those with a high school education driving the results. Tables 7A and 7B, which present changes over time in mean and median earnings (in 1986 United States dollars), allows us to explore this issue.

Overall, average earnings increased during the 1980's in all four countries examined (by a low of 1.2 percent in the United States to a high of 3.8 percent in Canada). Similarly, median earnings rose in three of the four countries examined (in Canada by 2.9 percent, Australia by 2.3 percent and the Netherlands by 0.4%). Only in the United States did median earnings fall (by 2.6 percent) while average earnings rose (by 1.0 percent). This suggests a widening of the earnings distribution in the United States with more people in the lower tail of the distribution (hence the lower median) but with those at the top of the distribution earning more (and thereby bringing up the average). In the other three countries, on the other hand, the overall trends suggest that earnings generally increased as both the median and the mean rose. The relatively small overall trends, however, mask substantial variation which occurred across educational categories--variations which can shed some light on the changes in the rates of return to education reported earlier.

In the United States, for example, we see in Panel A of Table 7A that the average earnings of those with the three lowest levels of education fell (by 6.9, 10.9 and 7.8 percent) during the 1980's while the earnings of those with higher levels of education saw increased earnings (of as much as 6.1 percent for the college educated). In Table 6, we

Table 7A
Changes Over Time in Average Earnings (in 1986 US dollars) of Men Aged 25-55 by Educational Level
Weighted by PWEIGHT

| | United States | | | Canada | | | Australia | | | Netherlands | | | Germany |
|-----------------------------------|---------------|-------|--------|--------|-------|--------|-----------|-------|--------|-------------|-------|--------|---------|
| | 1979 | 1986 | change | 1981 | 1987 | change | 1981 | 1985 | change | 1983 | 1987 | change | 1984 |
| Panel A: All Men Age 25-55 | | | | | | | | | | | | | |
| No / Very Low School | 16665 | 15515 | -6.9 | 21298 | 20907 | -1.8 | 15929 | na | na | 17104 | 17387 | 1.7 | na |
| Low School | 23711 | 21136 | -10.9 | 23771 | 23536 | -1.0 | 18417 | 18476 | 0.3 | 20294 | 22240 | 9.6 | 14790 |
| High School | 28568 | 26345 | -7.8 | 26302 | 25628 | -2.6 | 19606 | 20382 | 4.0 | 24840 | 24930 | 0.4 | 17531 |
| Other School | 30728 | 31470 | 2.4 | 26639 | 26514 | -0.5 | 20488 | 20937 | 2.2 | na | na | na | 19531 |
| College or More | 39159 | 41537 | 6.1 | 35030 | 35944 | 2.6 | 28427 | 28468 | 0.1 | 33754 | 31094 | -7.9 | 27123 |
| Overall | 31004 | 31371 | 1.2 | 26220 | 27307 | 3.8 | 20391 | 21052 | 3.2 | 20717 | 21008 | 1.4 | 19110 |
| Panel B: Age 25-34 | | | | | | | | | | | | | |
| No / Very Low School | 14425 | 12212 | -15.3 | 21774 | 20845 | -4.3 | 14529 | na | na | 16281 | 15744 | -3.3 | na |
| Low School | 20442 | 18227 | -10.8 | 21497 | 21769 | 1.3 | 17413 | 17213 | -1.1 | 17555 | 17656 | 0.6 | 14193 |
| High School | 25153 | 22772 | -9.5 | 25085 | 22817 | -9.0 | 20389 | 18131 | -11.1 | 21318 | 19786 | -7.2 | 16050 |
| Other School | 28068 | 26372 | -6.0 | 24984 | 23679 | -5.2 | 19571 | 19074 | -2.5 | na | na | na | 16690 |
| College or More | 31858 | 34642 | 8.7 | 29492 | 27521 | -6.7 | 23319 | 24163 | 3.6 | 24076 | 23484 | -2.5 | 21814 |
| Overall | 27399 | 25937 | -5.3 | 24778 | 23572 | -4.9 | 19110 | 19080 | -0.2 | 18079 | 17770 | -1.7 | 16827 |
| Panel C: Age 35-55 | | | | | | | | | | | | | |
| No / Very Low School | 17180 | 16526 | -3.8 | 21220 | 20916 | -1.4 | 16212 | na | na | 17491 | 17980 | 2.8 | na |
| Low School | 24602 | 22490 | -8.6 | 24735 | 24324 | -1.7 | 19039 | 19026 | -0.1 | 21419 | 24262 | 13.3 | 14916 |
| High School | 30273 | 28729 | -5.1 | 27194 | 27364 | 0.6 | 18495 | 22427 | 21.3 | 27288 | 28311 | 3.7 | 18080 |
| Other School | 32729 | 34116 | 4.2 | 28057 | 28242 | 0.7 | 20935 | 21813 | 4.2 | na | na | na | 20471 |
| College or More | 43459 | 44155 | 1.6 | 38553 | 38567 | 0.0 | 30867 | 30865 | 0.0 | 37006 | 34519 | -6.7 | 28550 |
| Overall | 32884 | 34150 | 3.8 | 27005 | 28858 | 6.9 | 21080 | 22057 | 4.6 | 21919 | 22382 | 2.1 | 19839 |

Table 7B
Changes Over Time in Median Earnings (in 1986 US dollars) of Men Aged 25-55 by Educational Level
Weighted by PWEIGHT

| | United States | | Canada | | Australia | | Netherlands | | Germany |
|-----------------------------------|---------------|--------|--------|--------|-----------|--------|-------------|--------|---------|
| | 1979 | 1986 | 1981 | 1987 | 1981 | 1985 | 1983 | 1987 | 1984 |
| | | change | | change | | change | | change | |
| Panel A: All Men Age 25-55 | | | | | | | | | |
| No / Very Low School | 14432 | 12640 | 20717 | 20947 | 15206 | na | 16379 | 16312 | na |
| Low School | 21890 | 19000 | 22542 | 23109 | 17656 | 17604 | 19020 | 20537 | 14484 |
| High School | 27309 | 25000 | 25079 | 25046 | 18550 | 18369 | 23904 | 23436 | 16066 |
| Other School | 30193 | 29000 | 26033 | 25802 | 19863 | 19964 | na | na | 18582 |
| College or More | 36080 | 36000 | 33645 | 34069 | 27620 | 26858 | 32758 | 28866 | 25966 |
| Overall | 28683 | 27950 | 24754 | 25470 | 19366 | 19802 | 18605 | 18677 | 17081 |
| Panel B: Age 25-34 | | | | | | | | | |
| No / Very Low School | 12077 | 9500 | 20204 | 20832 | 14069 | na | 16281 | 14907 | na |
| Low School | 18116 | 17000 | 20350 | 22290 | 17247 | 17091 | 17555 | 16471 | 13835 |
| High School | 24366 | 21000 | 23590 | 22067 | 18759 | 17905 | 21318 | 18046 | 15295 |
| Other School | 27174 | 26570 | 24712 | 23155 | 19554 | 18581 | na | na | 15417 |
| College or More | 28683 | 30000 | 28308 | 27554 | 23173 | 24538 | 24076 | 22640 | 21178 |
| Overall | 26419 | 24000 | 23580 | 23155 | 18759 | 18353 | 18079 | 16275 | 15620 |
| Panel C: Age 35-55 | | | | | | | | | |
| No / Very Low School | 15851 | 14300 | 20717 | 20947 | 15669 | na | 16472 | 17069 | na |
| Low School | 22645 | 20000 | 23391 | 23155 | 18230 | 17970 | 20078 | 22430 | 14484 |
| High School | 28925 | 27000 | 26274 | 27014 | 17656 | 20347 | 26960 | 26758 | 16472 |
| Other School | 31506 | 32000 | 27679 | 27053 | 20083 | 20542 | na | na | 19596 |
| College or More | 39251 | 39390 | 37723 | 36307 | 30324 | 28771 | 34722 | 32298 | 27305 |
| Overall | 30193 | 30000 | 25561 | 27014 | 19863 | 20493 | 19655 | 20012 | 17689 |

saw that between 1979 and 1986 the rate of return to education for a college versus a high school educated man in the United States rose from 6.6 to 9.0 percent. Table 7A allows us to see that this was not only the result of those with a college education earning more, but also of those with a high school education earning less. Although median earnings fell for U.S. workers in all five educational categories, they declined the most for those with the lower levels of education, results which support the findings in Table 7A.

At the other end of the spectrum is the Netherlands where, in Table 6, we saw a declining rate of return to education. For example, the return to a college versus a high school education fell from 6.9 to 5.5 percent. In Table 7A we see that, unlike in the United States, this result was primarily driven by the diminished earnings of those with a college education. Similarly, the decrease in the rate of return to education of those with a high school versus a low school education was driven primarily by the increased earnings of those with low levels of education. Here, median earnings trends generally mimic the mean earnings trends.

Tables 7A and 7B also allow us to see from where these changes in overall earnings came--young workers (aged 25 to 34) or older workers (aged 35-55). Evidence in the United States has shown that during the 1970's and 1980's, the earnings of younger workers fell relative to older workers (Freeman, 1979; Bound and Johnson, 1992). A variety of theories have been put forth to explain this trend. One, based on a theory of internal labor markets states that "in the face of downward wage pressures from globalization, older workers are better able to immunize themselves from growing wage

competition as a result of seniority rules, firm specific training and other institutional barriers that favor job incumbents over new labor market entrants" (Morissette, Myles and Picot, 1993:12). Morissette, Myles and Picot offer another possibility they call de-skilling whereby new firms that employ younger workers may be introducing technologies that require less skill and pay lower wages than in the past. Whatever the reason, this could have important implications for the changing rates of return to education both over time and across countries.

Recall that in the United States the increased rate of return to a college versus a high school education between 1979 and 1986 was attributed to declining earnings of those with a high school education coupled with increased earnings of the college educated. Panels B and C of Table 7A show that the earnings gain was almost entirely due to gains by younger workers. The decreased earnings of those with a high school education appear to have effected both younger and older workers, though the young faced a sharper decline. In Canada, the younger workers earnings changes were also the driving force to many of the overall trends.⁵ In Australia, the increased overall earnings were generally the result of increased earnings of older workers while the earnings of the younger workers fell. The only exception to this was for the college educated where the younger workers saw increased earnings.

In contrast to the United States, the Netherlands saw declining rates of return to

⁵The large overall increase in average earnings among older workers (6.9 percent) in Canada during the 1980's despite relatively small changes occurring in the various educational levels is likely the result of the overall upward trend in educational attainment which can be seen in Appendix Table B-3.

education for the college versus the high school educated workers. The driving force behind this, as seen in Table 7A, is the decline in earnings of those with a college education. This, in turn, resulted from lower earnings of both younger workers (somewhat) and older workers (more so). The large overall increase in average earnings of those with a low education (9.6 percent) was driven almost entirely by the older workers.

And so it appears that many of the trends in average earnings in the United States and Canada were driven by changes effecting younger workers while the trends in Australia and the Netherlands appear to have been driven by changes effecting both younger and older workers.

Summary

The LIS data used for this study allowed a systematic estimation of earnings equations across countries and over time. This opened the door for more meaningful cross-country comparisons than previous research which compared results from a variety of sources that used different methodologies and assumptions (Psacharopoulos, 1985). Four main conclusions can be drawn from the work in this paper.

The first result is that, as expected, education was found to strongly influence earnings in all five countries examined. Rates of return ranged from six to sixteen percent. In addition, Mincer earnings equations were able to explain from ten to thirty-eight percent of the variation in earnings. The earnings equation explained more of the variation in countries with highly structured educational systems such as the Netherlands and Germany than in the United States and Canada.

The second main finding of this paper is that there appear to be diminishing returns to education in most countries. In the United States, the Netherlands and Germany, the annual rate of return to education was higher when comparing high school to low education than when comparing college to high school. In Canada and Australia, on the other hand, there appear to be either constant or even increasing returns.

The third point made in this paper is that the large increases in the rate of return to education in the United States during the 1980's was not matched in other countries. While some countries did see increasing returns, such as Australia, they were of a much smaller amount. In other countries, such as the Netherlands, the rate of return to education actually declined between 1983 and 1987.

The final result of this paper is that these changes in the returns to education in the 1980's were driven by different forces across the countries. For example, the large increase in the rate of return to a college versus a high school education in the United States during the 1980's was primarily driven by a combination of increased earnings of young college educated workers and decreased earnings of young high school educated workers. In the Netherlands, on the other hand, the decline in the rate of return to a college versus a high school education was almost exclusively driven by falling earnings of those with a college education--particularly older workers.

Overall, it appears that Mincer earnings equations continue to successfully explain a large portion of the variation in earnings. Education remains an important determinant of earnings. The variation in rates of return to education over time found in this paper suggest that educational investment and its associated return may be an important factor

in earnings inequality in these countries. This is where I intend to focus my future research of this topic.

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Appendix A

Derivation of the Mincer Earnings Equation

In his book Schooling, Experience and Earnings, Mincer derives his now famous earnings equation. (Mincer 1974) Much of this appendix is taken from his book. He notes in the book that his work is based on the work of Becker and Chiswick (1966).

- Assume:
- The only cost of schooling is foregone earnings
 - Individuals enter the labor market at $t = S + 6$
 - The length of one's working life is independent of their schooling
 - Individuals enter school at time $t = 0$
 - Individuals begin at time $t=0$ with a stock of human capital $E(0)$
 - Individuals invest at time t a portion, k_t , of their earnings capacity to investment in human capital

Define: $E_j = Y_j + C_j$

$$k_j = C_j / E_j$$

where:

C_j = investment cost

E_j = earnings capacity in period j

Y_j = earnings in period j

So,

$$E_j = E_{j-1} + rC_{j-1} = E_{j-1}(1 + rk_{j-1})$$

By recursion,

$$E_j = E_0 \prod_{t=0}^{j-1} (1 + r_t k_t)$$

Assuming $k < 1$ and r is small, then $r_t k_t = \exp\{r_t k_t\}$ and

$$\ln E_j = \ln E_0 + \sum_{t=0}^{j-1} r_t k_t$$

Assume an individual attends school for s periods then works for p periods. Also assume the rate of return is the same throughout each period. Then,

$$\ln E_t = E_0 + r_s \sum_{i=0}^{s-1} k_i + r_p \sum_{j=0}^{t-1} k_j$$

Assuming the individual spends all his or her time accumulating human capital in the first s periods, $k_i = 1$. Assuming a linearly declining investment schedule, $k_j = k_0 + k_0/T*j$. So,

$$\ln E_t = \ln E_0 + r_s \sum_{i=0}^{s-1} 1 + r_p \sum_{j=0}^{t-1} (k_0 - \frac{k_0}{T}j)$$

$$\ln E_t = \ln E_0 + r_s S + r_p [k_0 t - \frac{k_0}{2T} t(t-1)]$$

Using the fact that $Y_t = E_t (1-k_t)$, gives

$$\ln Y_t = \ln E_0 + r_s S + r_p [k_0 t - \frac{k_0}{2T} t(t-1)] + \ln(1 - k_t)$$

Taking a second order Taylor series expansion around $k_t=0$ yields

$$\ln(1-k_t) = -k_t - k_t^2/2$$

Using the fact that $k_t = (k_0 - k_0/T *t)$,

$$\ln(1-k_t) = - [k_0 - \frac{k_0}{T} t + \frac{1}{2} (k_0 - \frac{k_0}{T})^2]$$

So,

$$\ln Y_t = [\ln E_0 - k_0(1 + \frac{k_0}{2})] + r_s S + [r_p k_0(1 + \frac{1}{2T}) + \frac{k_0}{T}(1 + k_0)]t - (r_p \frac{k_0}{2T} + (\frac{k_0}{2T})^2)t^2$$

or, $\ln Y_t = b_0 + b_1 S + ct - dt^2$

Appendix B

Data Tables

Table B-1

Household Surveys

| | |
|----------------------|---|
| United States | March Current Population Survey |
| Canada | Survey of Consumer Finance |
| Australia | The Income and Housing Survey |
| Netherlands | The Survey of Income and Program Users |
| Germany | German SocioEconomic Panel |

Table B-2

Coding of Education Variable

| | No School / Very Low School | Low School | High School | Other | College or More |
|--------------------------------|---|---|---|--|---|
| United States 1979 and 1986 | 1=No Schooling 2=1 year ed 7=6 years ed | 8=7 years ed 9=8 years ed 12=11 years ed | 13=12 years ed | 14=13 years ed 15=14 years ed 16=15 years ed | 17=16 years ed 18=17 years ed 19=18+ years ed |
| Canada 1981 | 1=No School / Primary School | 2=Less than 10 yrs 3=11 years ed | 4=12 years ed 5=13 years ed | 6=some post-secondary 7=Certificate /Diploma | 8=University |
| Canada 1987 | 1=No Schooling | 2=Less than 10 yrs 3=11 yrs ed | 3=11 yrs ed* 4=12 yrs ed 5=13 yrs ed | 6=some postsecondary 7=Postsecondary Diploma | 8=University Degree |
| Australia 1981 | 10=Left Ed Age 13- 11=No Schooling | 9=Left Ed Age 14/15 8=Left Ed Age 16 7=Left Ed Age 17 | 6=Left Ed Age 18+ 5=Secondary Sch. Cert. | 4=Trade Qualification 3=Certificate / Diploma | 2=Bach. Degree or similar |
| Australia 1985 | 9=Never Attended | 2=Nonqualified | 3=Completed Secondary 4=Completed Since Leave 8=Other Qualification | 5=Trade Certificate 6=Other Certificate | 7=Bachelor's + |
| Netherlands 1983 | 6=No Schooling 1=1-6 yrs ed | 2=7-9 yrs ed 3=10-11 yrs ed | 4=12 yrs ed | | 5=University |
| Netherlands 1987 | 0=None / NA 1=Primary | 2=Extended Primary | 3=Secondary | | 4=University |
| Germany 1984 | | Hauptschule + No Occup Code, No Ed Code + Lehre, Realschule + No Occup Train., Lehre+ Other ed | Realschule + Lehre; Fachoberschule + No Occup or Lehre; Gymnasium + No Occup; Gen Apprenticeship, Berufsfachschule + any ed | Public Health School, Fachschule (Senior Craftsmen), or Beamtenausbildung (Public Train)+ Any Ed | Fachschule (engineering), University |

Table B-3

Frequencies of Education Variable for Male Household Heads who work FYFT
unweighted numbers, must have occupation and industry observation

| | US79 | US86 | CN81 | CN87 | AS81 | AS85 | NL83 | NL87 | GE84 | GE89 |
|----------------------|------|------|------|------|------|------|------|------|------|------|
| Frequency | | | | | | | | | | |
| 1 No/Very Low School | 115 | 25 | 601 | 331 | 222 | 2 | 619 | 826 | 5 | |
| 2 Low School | 586 | 199 | 1153 | 698 | 1646 | 811 | 735 | 444 | 439 | |
| 3 High School | 1433 | 855 | 947 | 958 | 280 | 327 | 229 | 254 | 677 | |
| 4 Other | 963 | 572 | 927 | 954 | 2244 | 1140 | 0 | 0 | 229 | |
| 5 College or More | 1303 | 1048 | 679 | 667 | 646 | 371 | 140 | 174 | 226 | |
| Total | 4400 | 2699 | 4307 | 3608 | 5038 | 2651 | 1723 | 1698 | 1576 | |
| Percent | | | | | | | | | | |
| 1 No/Very Low School | 2.6 | 0.9 | 14.0 | 9.2 | 4.4 | 0.1 | 35.9 | 48.6 | 0.3 | |
| 2 Low School | 13.3 | 7.4 | 26.8 | 19.3 | 32.7 | 30.6 | 42.7 | 26.1 | 27.9 | |
| 3 High School | 32.6 | 31.7 | 22.0 | 26.6 | 5.6 | 12.3 | 13.3 | 15.0 | 43.0 | |
| 4 Other | 21.9 | 21.2 | 21.5 | 26.4 | 44.5 | 43.0 | 0.0 | 0.0 | 14.5 | |
| 5 College or More | 29.6 | 38.8 | 15.8 | 18.5 | 12.8 | 14.0 | 8.1 | 10.2 | 14.3 | |

Table B-4

Frequencies of Occupation Variable for Male Household Heads who work FYFT
unweighted numbers, must have occupation and industry observation

| | US79 | US86 | CN81 | CN87 | AS81 | AS85 | NL83 | NL87 | GE84 | GE89 |
|---------------------------------|------|------|------|------|------|------|------|------|------|------|
| Frequency | | | | | | | | | | |
| 1 Professional / Administrative | 1687 | 780 | 1304 | 1267 | 1666 | 1025 | na | na | 286 | |
| 2 Sales / Service / Clerical | 853 | 940 | 1086 | 728 | 957 | 440 | na | na | 425 | |
| 3 Blue Collar | 1860 | 979 | 1917 | 1613 | 2415 | 1186 | na | na | 865 | |
| Total | 4400 | 2699 | 4307 | 3608 | 5038 | 2651 | na | na | 1576 | |
| Percent | | | | | | | | | | |
| 1 Professional / Administrative | 38.3 | 28.9 | 30.3 | 35.1 | 33.1 | 38.7 | na | na | 18.1 | |
| 2 Sales / Service / Clerical | 19.4 | 34.8 | 25.2 | 20.2 | 19.0 | 16.6 | na | na | 27.0 | |
| 3 Blue Collar | 42.3 | 36.3 | 44.5 | 44.7 | 47.9 | 44.7 | na | na | 54.9 | |

Table B-5

Frequencies of Industry Variable for Male Household Heads who work FYFT
unweighted numbers, must have occupation and industry observation

| | US79 | US86 | CN81 | CN87 | AS81 | AS85 | NL83 | NL87 | GE81 | GE84 |
|----------------------|------|------|------|------|------|------|------|------|------|------|
| Frequency | | | | | | | | | | |
| 1 Primary | 136 | 317 | na | 253 | 229 | 157 | 40 | 27 | 22 | |
| 2 Manufacturing | 1292 | 557 | na | 780 | 1312 | 539 | 430 | 363 | 754 | |
| 3 Commerce | 618 | 412 | na | 617 | 821 | 423 | 164 | 266 | 146 | |
| 4 Other Service | 1305 | 832 | na | 1080 | 1270 | 666 | 547 | 715 | 336 | |
| 5 Financial Services | 200 | 123 | na | 143 | 608 | 248 | 167 | 0 | 71 | |
| 6 Utilities | 470 | 447 | na | 503 | 571 | 432 | 194 | 150 | 127 | |
| 7 Construction | 379 | 11 | na | 232 | 227 | 186 | 181 | 177 | 120 | |
| Total | 4400 | 2699 | na | 3608 | 5038 | 2651 | 1723 | 1698 | 1576 | |
| Percent | | | | | | | | | | |
| 1 Primary | 3.1 | 11.7 | na | 7.0 | 4.5 | 5.9 | 2.3 | 1.6 | 1.4 | |
| 2 Manufacturing | 29.4 | 20.6 | na | 21.6 | 26.0 | 20.3 | 25.0 | 21.4 | 47.8 | |
| 3 Commerce | 14.0 | 15.3 | na | 17.1 | 16.3 | 16.0 | 9.5 | 15.7 | 9.3 | |
| 4 Other Service | 29.7 | 30.8 | na | 29.9 | 25.2 | 25.1 | 31.7 | 42.1 | 21.3 | |
| 5 Financial Services | 4.5 | 4.6 | na | 4.0 | 12.1 | 9.4 | 9.7 | 0.0 | 4.5 | |
| 6 Utilities | 10.7 | 16.6 | na | 13.9 | 11.3 | 16.3 | 11.3 | 8.8 | 8.1 | |
| 7 Construction | 8.6 | 0.4 | na | 6.4 | 4.5 | 7.0 | 10.5 | 10.4 | 7.6 | |

Appendix C

Educational Systems

The United States

Education in the United States today is extremely diverse. There are many differences in what is taught both across and within states with textbooks often chosen by individual teachers. There are three main levels of education: primary, secondary and post-secondary with vocational education available at both the secondary and post-secondary levels. Schooling is compulsory from age six to sixteen and public schools are free through grade twelve.

Preprimary education has grown substantially in recent years due in large part to the increased employment of mothers with young children. In 1920 there were only three nursery schools, but by 1982 nearly 5.5 million students were enrolled in them with the estimated figure for 1992 at 7 million students. The main emphasis in preprimary education is on developing good work and play habits. Kindergartens, which precede formal education, are separate from both nursery schools and formal education. Typically, however, they are physically a part of the elementary school.

Primary education generally begins at age six and lasts for six years (eight in some school districts). Although many differences exist across schools, most typically this level of education is characterized by a classroom with one teacher responsible for the majority of activities. Much of the day is devoted to language development—reading, spelling, writing, speaking, listening etc. There are many non-public schools in the United States, particularly at the primary level. These schools must follow state laws in much the same

way public schools do. Catholic schools account for 90 percent of parochial enrollments, and 8 percent of total primary school enrollments. The curriculum in parochial schools is quite similar to the public schools, but also includes religious instruction.

The next level of education is typically the middle school or junior high school. Generally this includes grades seven through eight or nine, although some school systems do not have this level at all. These schools are geared to be "transitional schools which focus on the needs of early adolescents." (World Education Encyclopedia, 1363) Students are often allowed to choose electives, the curriculum is more specialized and students take classes from a variety of teachers.

Secondary education, or high school, typically begins with grade nine (ten in some places) and goes through grade twelve. Students can take either academic or vocational courses of study or both, all of which lead to a high school diploma. Although the schools remain very diverse, there is some consistency in teaching due to minimum competency exams, some standardization of textbooks, and requirements for entrance exams. Unlike in European schools, American teachers often use classroom tests and quizzes to assess their students' comprehension of the material.

Vocational education often begins at the secondary level and continues for two years at the post-secondary level, though either can be done without the other. In 1982, 27 percent of all high school seniors were enrolled in vocational or occupational preparation programs--51 percent were female.

There are three main types of higher education in the United States: two year community or junior colleges, four year undergraduate colleges, and universities. The two

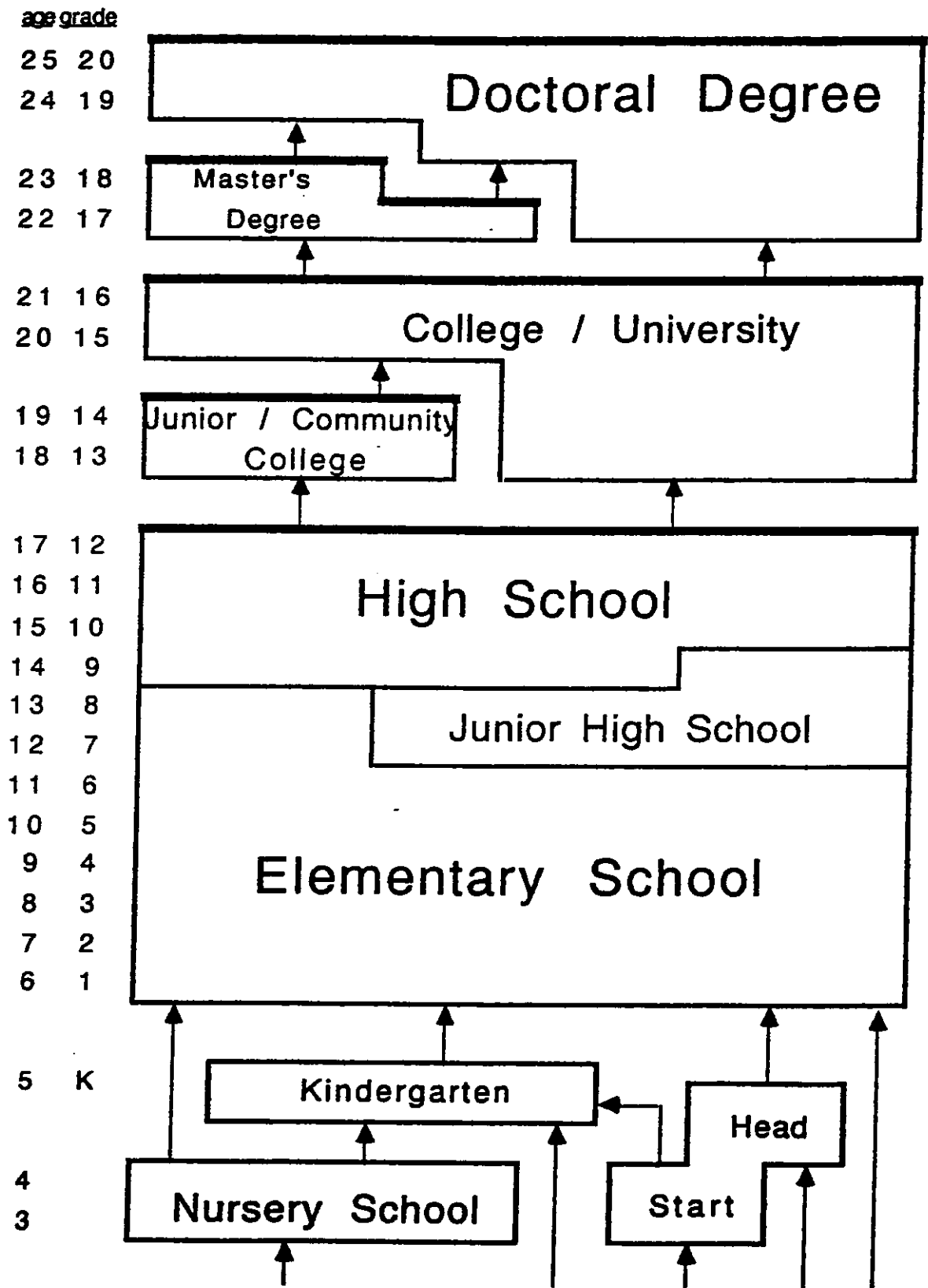
year schools are often open to enrollment by anyone with a high school degree and focus, though not exclusively, on vocational and occupational training. After two years of study at a community or junior college students earn an associates degree. It is becoming more common for students looking to save money to attend such a college for two years taking a general course of study with the intention of transferring to a four year school.

Admissions to colleges and universities usually require, in addition to a high school degree, such things as minimum secondary grades, scores on national tests, recommendations from secondary teachers and interviews with admissions officers. After four years of study, students receive a bachelor's degree. The number of students studying full-time at the undergraduate level has decreased in recent years with more students working while attending school part-time.

Study beyond the bachelor's degree is typically undertaken at a university. Students can obtain a Master's degree usually with one or two additional years of study combined with a thesis or final oral examination. Requirements for a Doctoral degree, the highest degree conferred in the United States vary considerably. Most typically it requires two years of study beyond the Master's degree, a foreign language or statistics, qualifying examinations and a dissertation.

Although based on a European educational system, the United States educational system has become it's own unique system. It is to this system that I will compare the remaining four systems of Canada, Australia, the Netherlands and Germany.

The United States Educational System



Canada

The Canadian educational system has much in common with that of the United States. Both systems can trace their origins and much of their population to Europe. In the United States, control over education is left to the states and as a result, a very diverse system has developed across the country. Similarly, because each of the ten provinces has its own government which sees to educational matters, the educational system varies quite widely across Canada. Even the structure of the two systems are very similar (the most similar of any two countries examined in this study) with primary, secondary and post-secondary schooling following similar patterns.

Pre-primary education in Canada is very similar to that in the United States. Nursery schools are optional but widely used and kindergartens are provided by virtually all the provinces. The focus of pre-primary education is on building social skills.

First level, or elementary school, begins at age six in Alberta, Nova Scotia, Ontario and Quebec and at age seven in the other provinces. Compulsory education also varies by province—to age twelve in the North West territories; to age fifteen in British Columbia, Newfoundland, New Brunswick, Prince Edward Island, Quebec and the Yukon; and to age sixteen in Alberta, Manitoba, Nova Scotia, Ontario and Saskatchewan.

Students originally attended elementary school for eight years followed by four years of secondary education, though now it is common to see systems that contain the equivalent of a middle school which students attend for two or three years after

attending elementary school for six years. Both elementary education and middle school education are considered to be at the first level. Enrollments in elementary schools have been falling lately due to a declining birth rate and slowed immigration. Subjects taught at the first level include: reading, writing, arithmetic, science, social studies, music, art and physical education.

While most students attend provincially funded and run schools, about five percent are enrolled in private schools where enrollments are growing. The private school system in Canada is fairly well regulated and supervised and even partially funded by the government. As in the United States, the curriculum in Canadian private schools is similar to that in public schools, with the addition of religious instruction.

Second level, or secondary education, begins at either grade nine or ten and continues through grade eleven (Newfoundland, Quebec), twelve (most provinces) or thirteen (Quebec-precollege level) depending on the province. Schools at this level vary in size from one room in remote areas to huge schools with as many as 3000 students. Students choose from a variety of academic, commercial and technical courses. Tests and quizzes given in class, while historically less common in Canada, are increasingly being used. The first two years of secondary education are exploratory with students taking a wide range of classes.

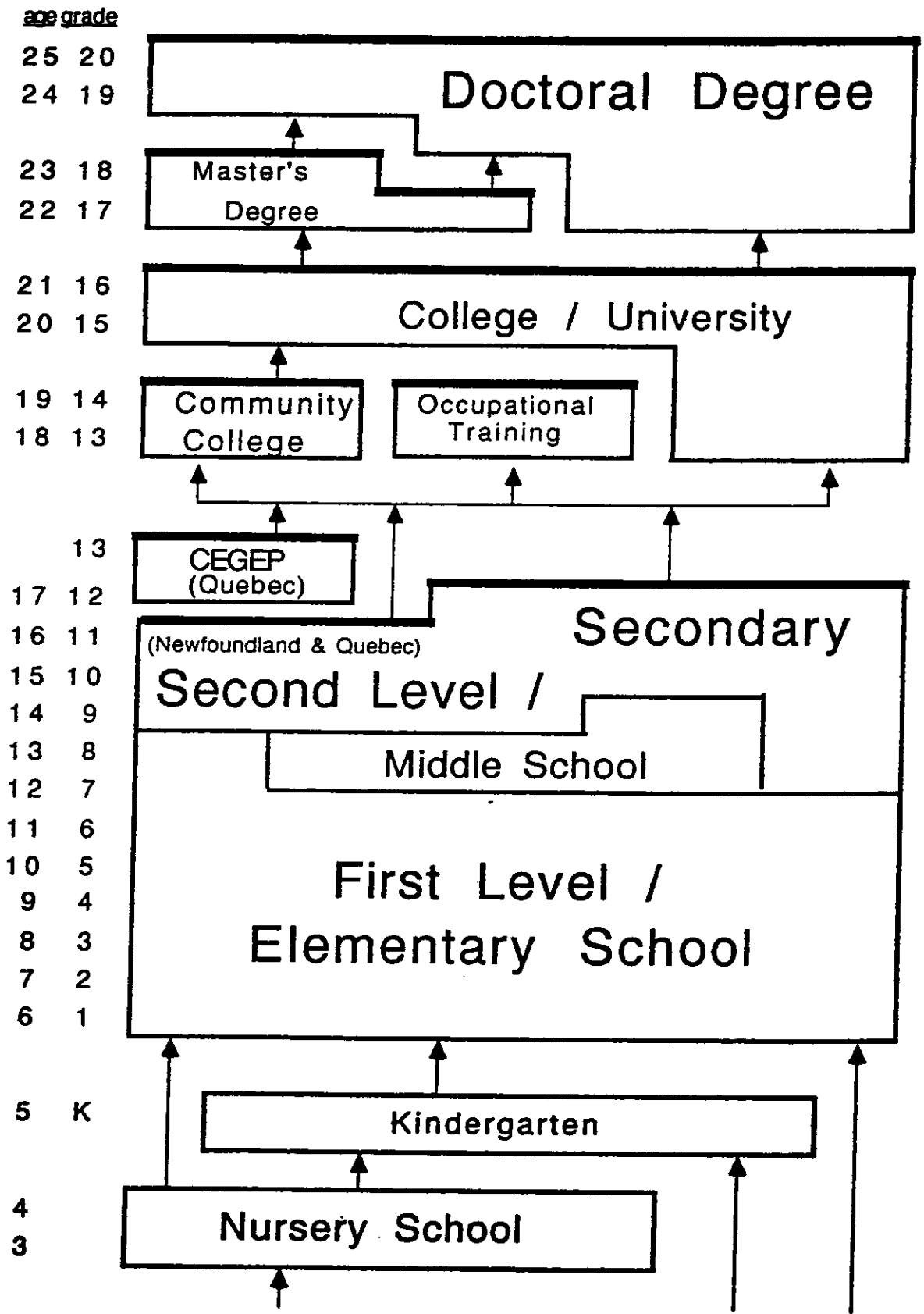
Third level, or higher education, is also much like that in the United States. Community colleges have flexible admission policies and provide degrees or allow a student to transfer to a university after two years. Technical and vocational training is available at the post-secondary level in trade and occupational training schools, which

require a high school degree for admission, as well as at community colleges.

The majority of universities in Canada were founded as private religious schools, but have since become largely dependent on public funding. Admission to a university generally requires a high school degree, although in Quebec students are required to have completed two years at a college d'enseignement general et professionnel (CEGEP), a program which follows high school for those students intending to continue their studies. As in the United States, the individual universities set their own admissions standards, but most rely on a student's academic record to assess whether admission should be granted. Students attending a university for four years receive a bachelor's degree upon completion. As in the U.S., a Master's degree may be obtained with one to two years of additional study and a Doctoral degree may be obtained with two or more years study beyond the Master's degree.

So, although differences in the educational systems in the U.S. and Canada exist, the two systems are generally very similar. This is most likely due to the European influences on both countries during their earlier years.

The Canadian Educational System



Australia

As in the United States and Canada, the educational system in Australia has British origins. Attendance is compulsory from the age of six to the age of fifteen (sixteen in Tasmania). Approximately twenty percent of students attend non-government schools, 80 percent of which are Catholic. However, because all students take the same public examinations, the curricula in government and non-government schools are quite similar.

All states have pre-schools for students age four and above and nearly 80 percent of such children attend these schools. There is no fee to attend pre-school, although parents often volunteer their time.

Primary education generally begins at age five with kindergarten, although compulsory schooling begins at age six. Students typically attend primary school for seven or eight years—until grade six or seven. The emphasis at this level of education is on reading and arithmetic although students are introduced to social studies, science, music, art and health. A variety of solutions have been devised to provide primary education to all students, even those in very rural areas. These include small schools with one teacher for all grades, correspondence schools, and busing to larger schools.

Secondary education begins at age twelve or thirteen and lasts for up to six years. Students at this level study a basic core of subjects with a variety of additional options. Students can obtain "leaving certificates," or diplomas, after grades ten, eleven, or twelve.

Technical education in Australia has grown in the last few decades and can

now be found at all levels from secondary to post-graduate. Students choosing a technical career would typically attend a technical and further education (TAFE) institute starting anywhere from after grade nine to after grade twelve. Students graduating after grade twelve receive a technical certificate, after grade thirteen an advanced certificate and after grade fourteen an associate diploma. After completing their studies at a TAFE, students may either join the workforce or transfer to a college of advanced education (CAE).

Colleges of Advanced Education began following recommendations by the Marin Committee in 1964 "to expand tertiary education into a non-university sector." (International Handbook of Educational Systems, 57) They are a combination of technical colleges, agriculture colleges and other colleges offering degrees in industry, commerce and government. Students typically attend a CAE after leaving secondary education although it is quite acceptable to attend after attending a TAFE. Students can obtain a variety of diplomas by attending a CAE. Students who attend for two years receive either an advanced certificate or an associate diploma, those attending for three years receive a three year bachelor's degree and those attending for four years receive a four year bachelor's degree. The majority of students attend a CAE on a part-time basis. After completing their studies at a CAE, students may enter the workforce or continue their education and work toward a master's degree.

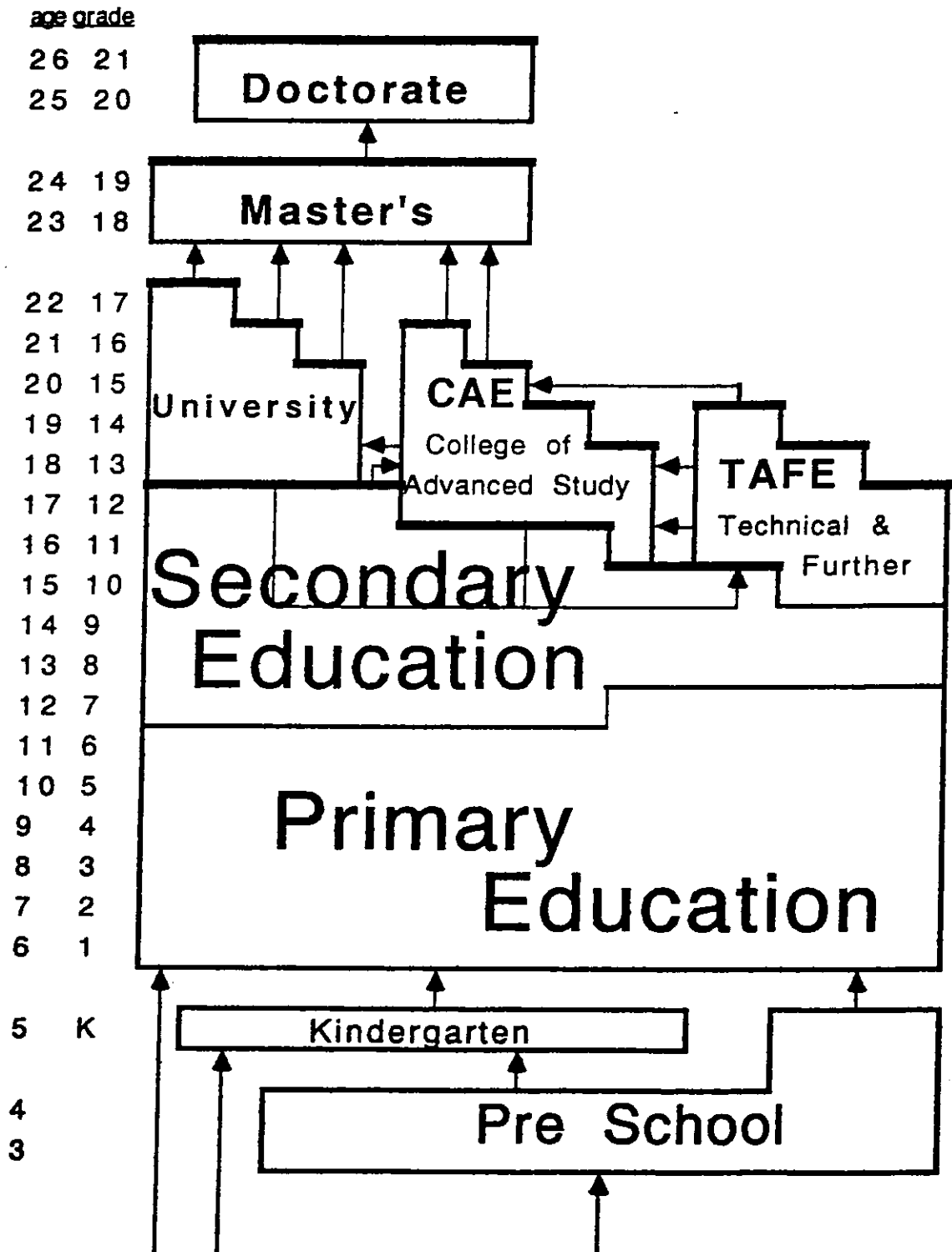
There are 19 universities in Australia each of which was established by its own Act of Parliament. Admission to a university requires, among other things, passing a state matriculation exam. Most students attend universities on a full-time basis for

three to five years. Students obtain a bachelor's degree after three or four years of study and a professional bachelor's or post-graduate diploma after five years of study. Enrollments increased at this level of education in the 1970's and as a result there are now quotas on enrollments. Students completing a bachelor's degree are qualified to either enter the workforce or to continue studying at a university.

Students who have received a bachelor's degree are eligible to study for a Master's degree. This degree typically requires one or two years of further study at a university. Beyond the Master's degree, students may work toward a PH.D. which typically requires an additional two years of study.

It appears that the Australian system of education, while similar in many ways to that of the U.S. and Canadian systems with its British influences, is a unique system. Although some differences exist across states, the system is remarkably similar throughout the country considering it is administered at the state level.

The Australian Educational System



The Netherlands

As in other countries, education in the Netherlands can roughly be categorized into primary, secondary, vocational and post-secondary schooling. Schooling is compulsory for students age six to sixteen although as many as 95 percent of children attend pre-primary school. Students generally attend school for five days a week, though in the past six was more common, for anywhere from 26 to 36 hours a week. The school year lasts approximately 42 weeks. Students receive report cards several times a year indicating their progress on a scale of 1 (very poor) to 10 (excellent), however, it is becoming increasingly common for teachers to provide parents with written reports on the students.

Pre-Primary education is encouraged by the government for children aged three to five. While attendance is lower for younger children, by the time they are five years old, nearly all children attend some form of preschool. As a result of regulation, schools at this level provide common activities including games, drawing, physical activity, and music.

Primary education, or first level, begins at age six and continues for six years. By law, primary education is required to consist of at least 1040 one hour lessons. While the focus is on play and social interaction, students study such subjects as: language, literature, history, geography, sciences, mathematics, music, art and physical education. Workbooks are a common form of instruction at this level.

Traditionally the year following primary school was transitional so that students, parents and teachers could decide which track was best suited for the

children. However, recently it has become more common for school to be similar for all students from age twelve to approximately age fifteen to have similar schooling, regardless of which track they have chosen.

Parents, with recommendations from the schools, choose which of the four types of secondary school to send their child to: LAVO, MAVO, HAVO, or VWO. Lager Algemeen Voortgezet Onderwijs (LAVO), or lower general secondary education is essentially a continuation of primary school. Students attend for several years prior to attending MAVO, a typical secondary school, or either LBO, a low level vocational school for boys or LHNO, a school for girls which focuses on home skills. This type of school (LBO and LHNO) is being a less attractive option which fewer students are choosing.

The standard secondary school for students is the MAVO (Middelbaar Algemeen Voortgezet Onderwijs), or intermediate general secondary school. Students typically attend MAVO for four years which prepares them for employment, transfer to a HAVO school as a fourth year student or continuation at an intermediate technical and vocational school.

The third type of school, HAVO (Hoger Algemeen Voortgezet Onderwijs), or higher secondary education, became an educational option in 1968. Students attend for five years; the first three years all students take similar classes while the last two provide students with a choice of subjects. The HAVO prepares students for higher education other than university education, although students may attend a university after the HAVO with additional schooling and an exam.

Students who anticipate attending a university choose to attend VWO (Voorbereidend Wetenschappelijk Onderwijs), or pre-university secondary school. There are three types of VWO, each lasting six years beginning right after primary school. The first, gymnasium, focuses on classics, math and science. There are two tracks—the first with an emphasis on Greek, Latin and modern languages, the second with an emphasis on math, physics, chemistry and biology. The first four years of study are identical for each track. The next type of VWO, atheneum, focuses on modern languages, math and science. Again, there are two tracks—the first with an emphasis on modern languages and economics, the second with an emphasis on math and natural sciences. Here, the first three years of study are common while the last two offer specialization along the lines of one of the tracks. The final type of VWO is the lyceum which is essentially a combination of the other two. At all levels of secondary school, students are eligible to receive a certificate upon completion. This requires a two part exam—a school exam and a public exam.

Technical and vocational education is a common option for students in the Netherlands. Approximately 40 percent of children of compulsory secondary school age choose this form of education. At the secondary level, technical and vocational education is provided at LBO, or junior vocational, schools. Here students are taught very practical skills with an emphasis on being exposed to potential careers and other further training at vocational schools. Students typically attend an LBO for three or four years, the first two of which provide general secondary education, the latter provide vocational training, sometimes on a part-time basis.

Intermediate vocational education (MBO) is available to students with general secondary or junior vocational education. Commonly students study mechanical, civil or electrical engineering. The goal of this type of schooling is to prepare students for middle level executive positions or self-employment in their chosen profession. A certificate from this level of education also entitles students to attend post-secondary vocational schools or teacher training for vocational schools.

Higher vocational education (HBO) is "intended to give the student a theoretical and practical training at such a level that he is equipped, after having acquired some experience, to occupy a managerial or senior position." (International Handbook of Educational Systems, 517) This type of education is provided at technical colleges. Upon completion, students are eligible for employment or may transfer to a university for further study.

Although apprenticeships have become less popular in recent decades, it remains a viable option for many students. The standard educational prerequisite for apprenticeship is completion of lower vocational education (LBO), although other students, such as those who have completed intermediate secondary school (MAVO) are also eligible. Typically students work as apprentices four days a week and attend school one day a week.

There are two main types of higher education in the Netherlands—higher vocational education and university education. Higher vocational education is provided at 350 specialized colleges. Students generally attend for four or five years. Courses of study include teacher training, health and medical care, and nautical, agricultural and

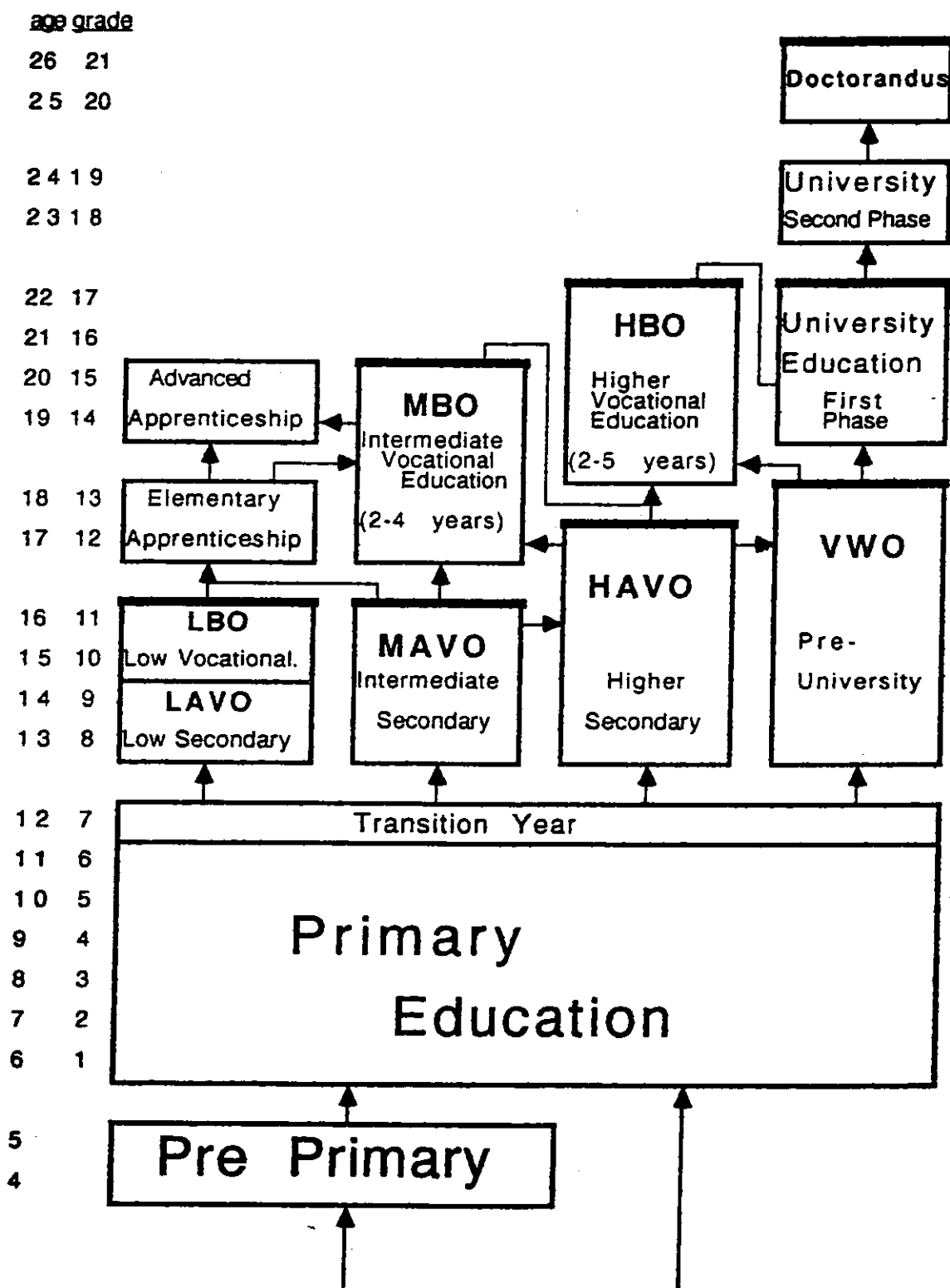
domestic training. Students are eligible to attend after completing higher general education (HAVO) or intermediate vocational education (MBO).

While primary and secondary education is provided by the state, higher education requires some payment by students. Financial aid, however, is available to all students and does not generally depend on achievement or income.

Students wishing to attend one of the 21 universities in the Netherlands must have a certificate from a pre-university secondary school. While this is the primary criteria for entrance, restrictions have been made in recent years requiring students to participate in a lottery for admission to certain fields. The purpose of Dutch universities is "to conduct research, teach, help individuals develop, foster a sense of social responsibility, prepare people for employment in the more advanced professions, and further the understanding of science and scholarship." (World Education Encyclopedia, 918) Students typically attend the university for four years and if they choose, post-graduate training generally for another four years.

The Dutch education system appears quite different from the previous three examined, particularly because of its tracking system. This system looks more like, though still different in many ways, the German system—the next one to be examined.

The Netherlands Educational System



Germany

Education in Germany is supervised by the government and differs somewhat across Lander, or states. Compulsory education begins full-time at age six, continues for nine years to age fifteen, and is followed by three years of part-time study. Less than one percent of students attend private schools. Students typically attend school six mornings a week approximately 40 weeks a year.

Pre-primary education is entirely voluntary. Kindergarten is considered pre-primary education and is not part of the formal school system. Vorklasse is a pre-school attached to Grundschule which caters to children age five and above. The Schulkindergarten is also attached to Grundschule, but is intended for students age eligible but otherwise not ready to begin school.

Primary education in Germany is provided through Grundschule, or first level schools. Attendance at these schools is free and mandatory. Typically students attend for four years although in some places, like Berlin and Bremen, attendance is for six years. Classes are mornings only and focus primarily on German and mathematics.

Students in Germany are tracked according to ability and desires beginning at the secondary school level. Movement across tracks is not only possible, but common. There are two levels of secondary education—Sekundarstufe I covering grades five through ten, and Sekundarstufe II covering grades eleven to thirteen. There are three main secondary tracks: Hauptschule, or main school; Realschule, or middle school; and Gymnasium, or college preparatory school. A fourth, Gesamtschule, or comprehensive school, is an experimental type of school providing all three tracks.

Hauptschule is the main type of secondary school. The goal of this track is to introduce children (typically from low social groups, single-parents and foreign workers) to the working world. Students are exposed to many subjects each for only a few hours a week. Upon completion after grade nine, students receive either a certificate of completion (Abschlusszeugnis) without taking an exam or a qualifying school leaving certificate (Hauptschulabschlusszeugnis) after passing an exam. While most students enter an apprenticeship with part-time vocational schooling after completing Hauptschule, it is possible to transfer to Realschule or enter full-time vocational education.

Realschule is a higher level of secondary education than Hauptschule and is a popular choice among the lower and middle class. Although students study a variety of subjects, the focus is on math, German and a foreign language, often English. Students are prepared for positions in agriculture, industry, social services and administration which do not require gymnasium level training. Upon completion at grade ten, students receive an intermediate certificate (Realschulabschlusszeugnis); some states also require taking an exam (Abschlussprüfung). The most common path taken after Realschule is to attend either full-time or part-time vocational schools. Apprenticeships are another alternative. Students with excellent grades can transfer to the gymnasium at the level of eleventh grade.

Entrance exams are generally required to attend gymnasium, the most academic and prestigious of the secondary schools. There are three types of gymnasium—the classical, which emphasizes Latin and Greek, the modern language type, which

typically emphasizes English, and the scientific type, which deemphasizes language study to devote more time to the exploration of math and science. Prior to grade eleven there is little difference among the three types. Students are required to meet high standards and repeating a grade is quite common. Students have the option of leaving after grade ten and obtaining the equivalent certificate to that obtained by those attending Realschule. After grade thirteen, students must take an exam to obtain a Abitur or Reifezeugnis, secondary school leaving certificates.

Vocational education, or Berufsbildende Schulen, is well-developed in Germany. As many as 50 percent of students attend some form of vocational education which is considered to be at the upper-secondary level. There are five main types of vocational education: Berufsschule, Berufsfachschule, Berufsaufbauschule, Fachoberschule and Fachschule.

The Berufsschule, or part-time vocational school, is the most common of the five types enrolling nearly 75 percent of all vocational students. Because this type of school is aimed at those students who leave at grade nine or ten, part of the curriculum is devoted to general studies like German, social studies, economics and English. This type of combined schooling and training meets the compulsory part-time schooling required after age fifteen. The Berufsschule is designed to be combined with an apprenticeship. Upon completion at grade thirteen to fifteen, students receive an Abschlusszeugnis which enables them to take the final apprentice exam (Lehrabschlussprüfung) administered by the industry. While it is possible to go on to higher education after this, most students move into the workforce.

The Berufsfachschule is a full-time vocational school which was designed to be an alternative to the Berufsschule. Students typically attend for one year and do not participate in an apprenticeship while attending. Common fields of study include hotel work, medical and laboratory work, child care and hairdressing. Upon completion students receive an Abschlusszeugnis which qualifies them as a Facharbeiter, or skilled worker.

The Berufsaufbauschule, or extended vocational school, provides a somewhat higher level of education. Students take both vocational and general courses, but at a higher level than the Berufsschule provides. After a year or two of study, students must take an exam (Abschlussprüfung) which is equivalent to a Realschule intermediate certificate and qualifies them for certain types of employment, typically in business and industry, at a higher level than could be attained by attending either of the other two vocational schools discussed thus far.

The fourth type of vocational school, the Fachoberschule, or specialized secondary school, began in 1968. It is intended to be a two year full-time course of study for students who have completed Realschule or its equivalent. Upon completion, students receive a certificate (Abschlusszeugnis) which qualifies them for attendance at a Fachhochschule.

The final type of vocational school, the Fachhochschule, is the most advanced vocational school. Admission requires completion of Fachoberschule or part-time vocational schooling. Full-time training is available in most all fields almost all requiring three years of study. There are two general types: Meisterschulen, which

train master craftspeople, and Technikerschulen, which train advanced industrial technicians.

Higher education in Germany can be found at a variety of schools. The first, Fachhochschulen has already been discussed. Kunsthochschulen, or Colleges of the Arts, requires the Abitur for admission. Students here devote most of their time to studying music, dance, painting, etc. Padagogische Hochschulen, or Colleges of Education, also require an Abitur for admission and devote themselves to the training of teachers for primary and secondary education.

The first university in Germany was Heidelberg which was established in 1386. Traditionally, the only requirement for admission was the Abitur, however, limits due to overcrowding have been imposed recently. There is no set course of study, rather, students choose to take exams when they feel they are ready. The first exam, which entitles students to a Vordiplom or Zwischenprüfung, is typically taken after four to six semesters. Acceptable performance on the next exam, after at least eight semesters but up to twelve, earns the student a Diplomingenieur or Diplomkaufmann. The highest degree attainable is the Diplom Doctorate degree. Students wanting to teach at the University level must also have completed a Habilitation, or thesis.

Germany likely has the most well-developed and widely-known system of vocational education in the world. Although students at the primary level receive roughly equivalent schooling, student are tracked beginning at grade five and begin receive very different instruction. Despite this, there is a great deal of mobility across the various tracks.

The German Educational System

