Chapter 2

Trends in educational inequality in the Netherlands:
A replication and a critique

2.1 Introduction

The degree to which a person's success in education is predetermined by family background is often regarded as the most important indicator of the extent to which a society's resources are distributed based on merits rather than on ascribed statuses. Historical changes in this pattern of achievement versus ascription are therefore of eminent importance. Fortunately, changes over time in educational attainment can be properly monitored by comparing (synthetic) cohorts. Persons born in the same year are likely to enter the schooling system at the same point in time, and the rather rigid nature of formal schooling will ensure that most persons from the same cohort will be subjected to approximately the same educational arrangements. Using cohort comparisons, even a single cross-sectional survey with data on the respondents' education and their family background will contain enough information to enable a historical trend in educational inequality over a period of approximately 40 years to be studied. Many previous studies have enhanced this design by combining data from multiple surveys held at different points in time. Such pooling of cross-sectional surveys leads to larger sample sizes, and thus more statistical power, but also makes it possible to study longer periods of time by combining recent and older surveys covering cohorts that are no longer or not yet available in a single dataset. Also, by continuing to use older surveys, research in this tradition has found a natural way of incorporating past insights into current research, thus facilitating true accumulation of knowledge.

This chapter will continue this tradition by replicating and updating a well-known study on the Netherlands of this kind, conducted by De Graaf and Ganzeboom (1993). These authors combined data from 10 surveys held between 1970 and 1987 covering cohorts born between 1891 and 1960, thus firmly establishing the historical rise of educational mobility (i.e. downward trends in effects of parental status) for the Netherlands. In this replication, I will add data from another 33 surveys. These additional surveys add approximately 60,000 observations, and thus considerable more precision, but also contain information on more recent periods (adding cohorts born between 1960 and 1980), thus making it possible to study the trend for a longer period of time. The surveys used by De Graaf and Ganzeboom (1993) and in this replication are listed in the appendix to this chapter. The analysis will be guided by the following two questions:

> To what extent has there been a historical trend towards less inequality in educational opportunities and in educational outcomes between persons from different status backgrounds?
>
> To what extent do the conclusions by De Graaf and Ganzeboom (1993) hold when using more, and more recent data?

There are two reasons for choosing the study by De Graaf and Ganzeboom (1993) as a benchmark. First, it was part of a much-cited collection of studies of trends in inequality of educational attainment in 13 different countries (Shavit and Blossfeld, 1993) and stood out at the time because of its deviant results: the Netherlands, together with Sweden, was the only country that reported a substantial change towards less inequality of educational attainment. Second, it examined both the association between the highest achieved level of education and family background (Inequality of Educational Outcome, or IEOut) and the association between the probabilities of passing transitions between levels of education (Inequality of Educational Opportunity, or IEOpps), and found a trend towards more mobility in both, while many other studies tend to report only on one of these. IEOpp, which represents inequality during the process of attaining education, and IEOut, which represents inequality in the final outcome of the educational attainment process, are both of substantive interest and complement one another. While subsequent research (e.g. Ganzeboom and Luijkx, 2004b) has already examined the additional available data from the Netherlands in passing, there has not been a major update of the De Graaf and Ganzeboom findings since 1993.

This chapter will not only replicate De Graaf and Ganzeboom (1993) using more data, but it will also critique and improve some of the methods used by these authors. The criticism will come in two parts. First, the 1993 study contains some errors that can be easily rectified within the current context. These errors and their consequences will be discussed during the replication. Second, I will point out that the methods used by De Graaf & Ganzeboom — and replicated in this chapter — do not make the best use of the available information, and I will suggest five improvements. These five improvement require either the estimation of new models, or a substantial reevaluation of the interpretation of the existing models, and each will be discussed in a separate subsequent chapter in this dissertation. The nature of these possible improvements will be further introduced in the conclusions of this chapter.

This chapter will continue with a brief description of the structure of the Dutch educational system, followed by a review of a score of previous empirical studies on trends in inequality of educational attainment in the Netherlands, and in particular a detailed synopsis of De Graaf and Ganzeboom (1993), the benchmark study that will be replicated. Next, the design of the replication will be discussed by introducing the added data, followed by the results of the empirical analysis. This chapter will provide conclusions and the five suggestions for making better use of this type of data, and introduce the subsequent chapters of the dissertation.

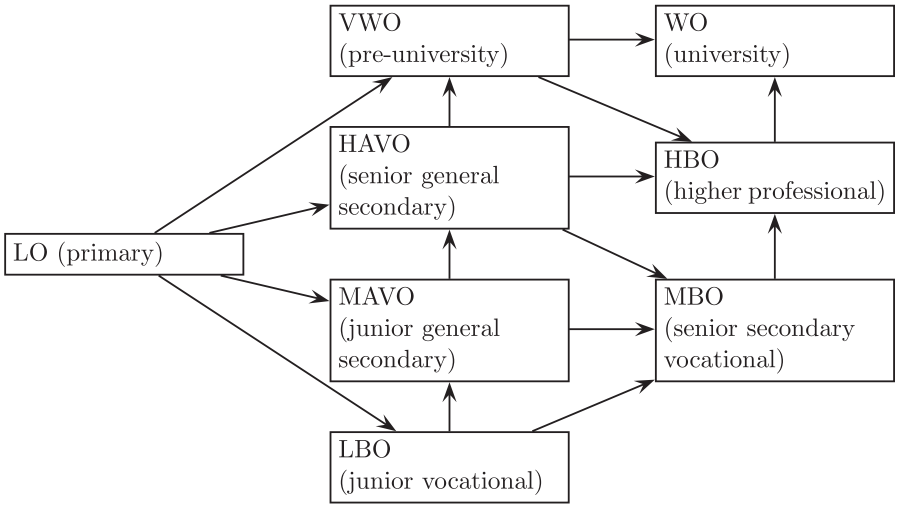
2.2 The Dutch education system

The Dutch education system has been subject to a number of developments and reforms. A uniquely important watershed was the introduction of the 'Mammoet Wet' or 'Mammoth Law' in 1968, that established the structure shown in Figure 3.1. This reform is important to most studies in this dissertation because it was implemented at about the middle of the observation period. This means that there are plenty of observations before and after this reform, so any effect it may have had should be clearly visible in these studies. It is convenient to choose this system as a reference and translate all other systems in terms of this reference. The basic structure of the system at that point can be sketched as follows. Primary education (LO) started at about age 6 and took 6 years. After finishing LO, a person must choose between four programmes at the secondary level: LBO (junior vocational education), MAVO (junior general secondary education), HAVO (senior general secondary education), and VWO (pre-university education). Then there are three pathways available if you wish to continue to more advanced levels of education. LBO and MAVO give access to MBO (senior secondary vocational education). HAVO gives access to HBO (higher vocational education). VWO gives access to WO (university). However, students can deviate from these three standard paths, for instance by choosing to 'move up' within their current column (LBO to MAVO, MBO to HBO, and so forth), or 'move down' in the next column (HAVO to MBO, and VWO to HBO).

It is important to note that the Mammoth Law left some features of Dutch education intact. In particular, it did not tinker with the age at which children move on from primary to secondary education. Throughout the period of study, the basic cut-off point in Dutch education has been at age 12, after 6 years of compulsory primary education[1]. This transition — which almost always implied, and still does imply, a transfer to a different school environment — has been a stable feature. By contrast,

[1] Throughout most of this period of study pre-primary education or kindergarten for children aged four and five was also quite common, but not compulsory. It became compulsory for childer aged five in 1985.

Figure 2.1: The Dutch education system after 1968



the Mammoth Law changed the existing structure in many other ways, some dramatic, others more cosmetic. One major reform was that the Mammoth Law encouraged schools to offer programmes at different levels (LBO, MAVO, HAVO, VWO) in the same institution and also to offer a common and comprehensive first year (the 'bridge year'), thus giving the opportunity of postponing the decision concerning which secondary level programme to enter by another year. Among the programmes, the HAVO level was new, although it resembled in some respects a programme that had been phased out in 1968 that was exclusively accessible to girls (MMS). The 6-year VWO programme assembled several previously existing older programmes (some lasting 5 years) that gave direct access to university (WO) at age 18. In addition to the comprehensive 'bridge year', moving between programs after the choice had been made was made easier.

A somewhat cosmetic aspect of the Mammoth Law was that it changed the names of most of the programmes. Table 2.1 shows the programmes with their Mammoth names, together with the equivalent old names, the number of years of education they involve, their British-language equivalents, and their ISCED classification (UNESCO, 1997).

Table 2.1: Conversion of old educational levels into new educational levels and simplified educational levels

English name	before 1968	after 1968	duration[a]	ISCED
primary	LO	LO	6	1
extended primary	VGLO	-	7	1
junior vocational	LTS /ambachtschool	LBO	10	2C
junior vocational	LHNO / huishoudschool	LBO	10	2C
junior general secondary	ULO / MULO	MAVO	9 / 10	2B[b]
senior secondary vocational	MTS	MBO	14	3C
senior general secondary	MMS	HAVO	11	3B[b]
pre-university	HBS	VWO	12	3A[b]
pre-university	lyceum	VWO	12	3A
pre-university	gymnasium	VWO	12	3A
higher professional	HTS	HBO	15	5B
university	universiteit	WO	16	5A

[a] Years refer to the situation after 1968 except VGLO.

[b] These levels were originally intended to be terminal levels of education for most students (so 2C or 3C) but evolved into levels that primarily grant access to subsequent levels of education.

2.3 Previous research

A summary of the results of all studies assessing trends in inequality in educational attainment using a (pooled) cross-section design[2] in the Netherlands is shown in Table 2.2. The first to apply the cohort design in the Netherlands for the study of changes in educational inequality were Peschar et al. (1986) and Peschar (1987). These authors used data from a single survey (net82n, see the appendix to this chapter) and found no change over cohorts in the association between the highest achieved level of education and family background, the IEOut. The studies by Peschar and colleagues were followed by Ganzeboom and De Graaf (1989) and De Graaf and Ganzeboom (1990), who improved on the earlier work by assembling multiple surveys. As a consequence these studies contain much more observations and cover a long period of time. These two studies and all subsequent studies using a similar design have found a downward trend in IEOut, suggesting that Peschar's earlier finding of no trend was a matter of lack of statistical power.

A key feature of these early studies is that they examine the association between the highest achieved level of education and family background, in other words, they look at IEOut instead of IEOpp. This can be justified as it is the highest achieved level of education that influences later life chances, so it is inequality in the highest achieved level of education that ultimately influences inequality in other domains of life. However, the focus on final level completed has been criticized by Mare (1981) for not modelling the process through which education is attained. Mare argued that attaining a final educational level consists of a sequence of steps between levels, called transitions, and that the causal effects of parental background exert their influences at those transitions and not directly on the highest achieved level of education. Moreover, Mare (1981) showed that the IEOut is not a mere average of patterns of inequality at separate transitions, but that it is heavily influenced by the distribution of education. This is an important finding because over cohorts the educational distribution changes dramatically, so that any change in the effect of parental background on highest achieved

[2]The main alternative to this pooled cross-sections design is constituted by studies using panel data that follow a cohort of students through their educational career. Examples of this type of study are (Peschar, 1978; De Jong et al., 1982; Bakker et al., 1982; Meesters et al., 1983; Vrooman and Dronkers, 1986; Faasse et al., 1987; Dronkers and Bosma, 1990; Bakker and Schouten, 1991; Dronkers, 1993; Bakker and Cremers, 1994; Rijken et al., 2007). Unlike the studies using cross-sectional surveys the cohort-panel studies find at best mixed evidence for a declining trend in IEOpp at this transition. Panel studies have the advantage that one can study actual transitions between levels of education, and thus get better estimates of IEOpps than is possible using cross-sectional data. However, these data usually cover only the early part of the educational career, making them ill-suited for studying IEOut. In fact, most of these studies focus exclusively on the transition between primary and secondary education when students choose their initial secondary programme instead of the entire educational career. Moreover, they cover a relatively short period of historical time, and within this period the trend is usually estimated by comparing a small number of cohorts (often only two).

level of education could be due to changes in the distribution of education rather than by true causal changes of the inequality in the process of educational attainment. As a consequence, Mare proposed to model the effects of social background on the transition probabilities instead of on the highest achieved level. This model is known by a variety of names, including the sequential response model (Maddala, 1983), the continuation ratio logit (Agresti, 2002), the model for nested dichotomies (Fox, 1997), or simply the ’Mare’ model (Shavit and Blossfeld, 1993). This article will use the term ‘sequential logit model’ (Tutz, 1991) to emphasize that logistic regression is used to model the probabilities of passing transitions.

Those studies in Table 2.2 that use OLS, LISREL, scaled-association models and log-linear models measure IEOut, while studies using the sequential logit model estimate IEOpp. The findings of these studies can be summarized as strong evidence for a linearly declining trend in IEOut and a linearly declining trend in the IEOpp involving the choice of whether or not to continue after primary education, but only weak evidence for a negative trend in IEOpp involving the choice of further enrolment after completing lower levels of secondary education, and no evidence for a trend in IEOpp involving the choice to finish tertiary education.

Table 2.2: Results concerning trends in IEOpp and/or IEOut in the Netherlands from previous studies

study	parental background[a]	birth cohorts	method	trend	linear
Peschar et al. (1986)	fed	1925–1964	log-linear	no trend	
Peschar (1987)	fed	1925–1964	log-linear	no trend	
Ganzeboom and De Graaf (1989)	fed	1891–1960	log-linear	negative	
De Graaf and Ganzeboom (1990)	fed	1891–1960	log-linear	negative	yes
De Graaf and Ganzeboom (1993)	foc fed	1891–1960	OLS & sequential logit	mixed[b]	yes
De Graaf and Luijkx (1995)	foc	1917–1957	OLS	negative	yes
Ganzeboom et al. (1995)	foc fed	1908–1968	OLS	negative	
Ganzeboom (1996)	foc fed	1920–1965	OLS & sequential logit	mixed[c]	yes
Wolbers and de Graaf (1996)	foc fed med	1928–1967	sequential logit	no trend	
Rijken (1999)	foc	1900–1965	OLS & sequential logit	negative	
Korupp et al. (2000)	foc moc	1927–1975	LISREL	mixed[d]	
Sieben et al. (2001)	foc fed med	1925–1974	LISREL	mixed[e]	yes
Korupp et al. (2002)	foc fed moc med	1923–1962	OLS	negative	
Gesthuizen et al. (2005)	foc fed med	1923–1978	survival	negative	

[a] foc = father's occupational status, fed = father's education, moc = mother's occupational status, med = mother's education

[b] Negative for effect on highest achieved level of education and for the first transition, negative but not significant for the second transition, not negative for the third transition

[c] Negative trend for effects on highest achieved level of education and effect of father's occupation on transition from primary education versus more education and effect of father's education on transitions from primary education versus more education and lower secondary versus more education

[d] Significant difference in effect of father's occupation on daughter's education between cohorts 1927–1958 and 1959–1975, all other effects show no trend.

[e] Significant negative trend in effect father's education, no significant trend in father's occupation or mother's education

2.3.1 Results from the study by De Graaf and Ganzeboom (1993) and the design of the replication

De Graaf and Ganzeboom (1993) looked at the changes in effect of father's education and father's occupation on the offspring's highest achieved level of education (IEOut) and the probabilities passing three transitions (IEOpps). The transitions De Graaf and Ganzeboom (1993) analysed were: 1) from no diploma to any diploma in secondary education (LBO, MAVO, HAVO, MBO, and VWO) or higher, 2) from any diploma in lower secondary education (LBO, MAVO) to any diploma in higher secondary (HAVO, MBO, and VWO) or tertiary education, 3) from any diploma in higher secondary education to completed tertiary education (HBO, and WO). The historical trends were assessed by comparing seven ten-year wide cohorts that were born in 1891–1960. To evaluate trends, the authors tested whether differences between cohorts can best be summarized by a single linear trend instead of a separate estimate for each cohort. The findings can be summarized as follows:

1. Inequality of Educational Outcomes
   (a) The data are better described by a linear main effect of cohort and by linear trends in the effect of the father's education and the father's occupational status than by separate estimates for every ten-year wide cohort.
   (b) The effects of father's education and father's occupational status both decrease over time.
   (c) Father's education has a stronger impact than father's occupational status, and the effect of the father's occupational status declines faster than the effect of father's education. As a consequence, the effect of father's education increases relative to father's occupational status.
2. Inequality of Educational Opportunities
   (a) There has been a negative linear trend for both the effects of the father's education and the effect of the father's occupational status on success at the first transition, between primary and secondary education.
   (b) There has also been a negative linear trend for both the effects of father's education and the effect of father's occupational status on the second transition, from lower-level secondary programmes to completing higher-level secondary programmes that give access to programmes at the tertiary level. However, this trend is non-significant, except for the effect of father's education for men.

(c) There is no trend in the effects of the father's education and the father's occupational status on the third transition.

The data to be used in this replication have been taken from 55 surveys held in the Netherlands that were harmonized as part of the International Stratification and Mobility File [ISMF] (Ganzeboom and Treiman, 2009). All ISMF surveys contain information on gender, age (year of birth), the highest achieved level of education and the occupational status of the father (foc). Some of these surveys also contain additional information about mother's occupational status (moc), and father's and mother's highest achieved level of education (fed and med). The appendix to this chapter reports for each survey the year in which it was held, the birth cohorts covered by the survey, the number of respondents, which additional variables are available, and whether or not it was used by De Graaf and Ganzeboom (1993). In order to replicate the analysis by De Graaf and Ganzeboom (1993) only the ISMF surveys that also contain information about the father's education will be used. The number of such surveys available in the ISMF has increased from 10 in the 1993 study to 43 in this replication. The number of respondents has increased from 6,128 men and 5,116 women to 35,846 men and 34,022 women. This replication also covers more recent birth cohorts: 1891–1980 instead of 1891–1960.

In order to replicate the approach followed by De Graaf and Ganzeboom (1993), only respondents who were older than 25 at the time of the interview were used in the analysis, but no upper age limit was imposed. The lower limit ensures that the respondents have finished their full-time education and so their final highest achieved level of education is known. The absence of an upper age limit makes it possible to include the earliest cohort, 1891–1900, whose members were at least 62 when they were interviewed in 1958, when the earliest ISMF survey for the Netherlands was held. A concern might be that including data from older respondents can cause selection on the dependent variable, as higher educated people are more likely to live longer than lower educated people. Such a selection on the dependent variable can lead to biased estimates of the effect of explanatory variables (Breen, 1996). For this reason the earliest cohort is excluded from the analysis in the subsequent chapters. However, in order to match the design of De Graaf and Ganzeboom (1993), this cohort will be included in this chapter.

Education of parents and respondents were measured in four categories: primary education (LO), lower secondary education (LBO and MAVO), higher secondary education (HAVO, MBO, and VWO), and tertiary education (HBO and WO). Notice that the second transition groups together two very different choices: HAVO and VWO are immediately chosen after primary education, while MBO can only be chosen after having finished lower secondary education. Also HAVO and VWO are not intended as terminal levels of education, while MBO is a terminal level of education. However, these levels were grouped together because not all surveys distinguished between them. In concordance with the study by De Graaf and Ganzeboom (1993), the four levels were given the numerical values 1 to 4. Using these quantifications, the distribution of the respondent's highest achieved level of education over cohort and gender is displayed in Figure 2.2. It shows that people who were born more recently are more likely to have completed higher secondary or tertiary education and much less likely to have completed only primary education. This increase in average level of education across cohorts is found in many — if not all — countries, and is usually referred to as 'educational expansion' (Hout and DiPrete, 2006). Figure 2.2 shows that educational expansion in the Netherlands occurred later for women than for men. Both the initial disadvantaged position of women and the decline, or even reversal, of this disadvantage are also features commonly found in other countries (Hout and DiPrete, 2006).

Figure 2.2: Distribution of highest achieved level of education

Father's occupational status was measured according to the father's score on the International Socio-Economic Index of occupational status [ISEI] (Ganzeboom and Treiman, 2003) which was originally measured on a continuous scale from 10 (low status) to 90 (high status), but has been rescaled here to a range between 0 and 8.

2.4 Results

2.4.1 Inequality of Educational Outcome

To model Inequality of Educational Outcome, a linear regression of highest achieved level of education was estimated separately for men and women. The effects of the father's occupation and the father's education capture the IEOut. These effects are allowed to vary over cohorts by adding interactions with either a set of dummy variables for the birth cohorts (to capture a non-linear trend) or a single metric variable (to constrain the trend in IEOut to be linear). This results in a set of nested models, which are presented in panel (a) of Table 2.3 together with their R^2. These models are compared using nested F-tests. These F-tests compare two models, a larger and a smaller model, in the situation that the smaller model can be obtained by imposing a linear constraint on the larger model. The R^2s of the two models being compared and the F-statistic are related to one another according to the following formula:

$$F = \frac{(R_u^2 - R_c^2)/df_{num}}{(1 - R_u^2)/df_{denom}} \tag{2.1}$$

R_u^2 stands for the R^2 of the larger (unconstrained) model, R_c^2 represents the R^2 of the smaller (constrained) model, df_{num} represents the numerator degrees of freedom or the number of linear constraints, and df_{denom} the denominator degrees of freedom or the number of observations minus the number of parameters in the larger model[3].

There are two aims to these comparisons. The first aim is to assess whether trends in the effects of father's occupation and education are linear. This is based on the comparison of the models in which cohort is represented by a set of dummy variables with the models in which cohort is represented by a linear trend. The second aim is to assess whether there has been any trend at all. This conclusion can be made by comparing the models without a trend interaction term with models with a linear trend. A problem with the approach by De Graaf and Ganzeboom (1993) is that they started their analysis by imposing the constraint that the main effect of cohort is linear. Once the main effect of cohort is constrained to be linear, this can influence the linearity of the interaction terms (the trends in the effects of father's education and occupation). This would be unfortunate since it is these latter trends that are of primary interest; they are the trends in IEOut we are testing. It is safer to leave the trend in the intercept free to vary, while testing the trends in the effects. This appears to matter, as the original sequence of tests by De Graaf and Ganzeboom (1993) leads to a linear effect of father's education for women and non-linear trends in all other effects, while in

[3] De Graaf and Ganzeboom (1993) erroneously state that the denominator degrees of freedom equals the number of observations minus the number of parameters in the smaller model.

the sequence preferred here only the effect of father's education for men is non-linear. However, a graphical comparison of the estimates using separate cohorts and a linear trend as in Figure 2.3 shows that in all cases the linear trend provides a reasonable summary of the changes over cohorts.

Table 2.3: Test for trends in Inequality of Educational Outcome

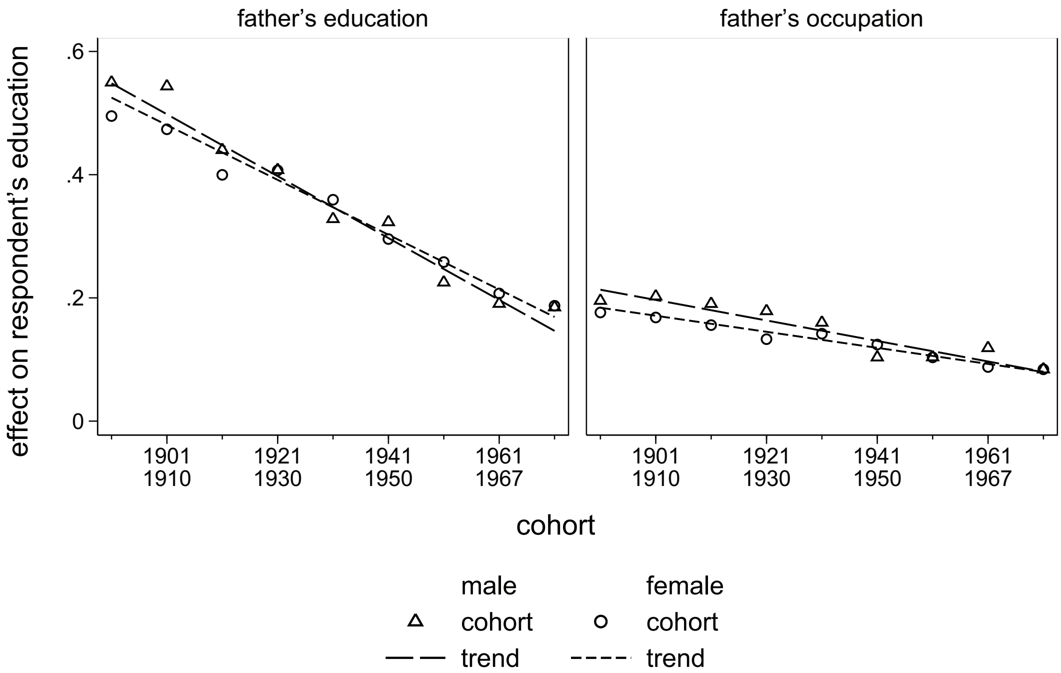
(a) Fit statistics

model	constraints father's education	father's occupation	Intercept	number of parameters	R^2 men	women
sequence of models as used by De Graaf and Ganzeboom (1993)						
1	dummies	dummies	dummies	26	0.277	0.366
2	dummies	dummies	trend	19	0.276	0.365
3	trend	dummies	trend	12	0.276	0.365
4	trend	trend	trend	5	0.275	0.363
5	trend	constant	trend	4	0.274	0.362
6	constant	trend	trend	4	0.270	0.360
7	trend	trend	constant	4	0.240	0.319
preferred sequence of models						
8	trend	dummies	dummies	19	0.277	0.365
9	trend	trend	dummies	12	0.276	0.365
10	trend	constant	dummies	11	0.275	0.365
11	constant	trend	dummies	11	0.272	0.362

(b) Tests

		men			women		
contrast	df_{num}	df_{denom}	F	p	df_{denom}	F	p
sequence of models as used by De Graaf and Ganzeboom (1993)							
2 - 1	7	35813	7.066	0.000	33999	5.499	0.000
3 - 2	7	35820	2.763	0.007	34006	0.978	0.445
4 - 3	7	35827	3.262	0.002	34013	13.840	0.000
5 - 4	1	35834	59.733	0.000	34020	40.670	0.000
6 -4	1	35834	260.915	0.000	34020	142.971	0.000
7 - 4	1	35834	1743.814	0.000	34020	2355.229	0.000
preferred sequence of models							
8 - 1	7	35813	1.940	0.059	33999	0.647	0.717
9 - 8	7	35820	4.177	0.000	34006	1.048	0.395
10 - 9	1	35827	58.644	0.000	34013	42.788	0.000
11 - 9	1	35827	186.240	0.000	34013	179.970	0.000

Figure 2.3: Inequality of Educational Outcome (unstandardized coefficients)



The parameter estimates of models 4 and 9 are presented in Table 2.4. The difference between these models is that in model 4 the trend in the intercept is linear, while in model 9 it is left free to vary across cohorts. The main effects of the father's education and the father's occupation represent the IEOut in the earliest observed cohort, 1891–1900. As in De Graaf and Ganzeboom (1993), these effects are not standardized, so the effect of father's education is the effect of an increase in father's education by one level, while the effect of father's occupation is the effect of an increase in father's occupational status by $1/8^{th}$ of the range of the occupational status scale. The trend parameters are changes in these effects per decade. One way to get a sense of the size of the trend is to extrapolate when the IEOut will have completely disappeared if the trend continues unchanged. According to model 9, the effect of father's education will have completely disappeared for the cohort that will be born in 2009[4] and 2017 for men and women respectively. Similarly, the effect of father's occupation will have disappeared for the cohort born in 2025 and 2041 for men and women respectively.

De Graaf and Ganzeboom (1993) also claim to have found that, in relative terms, the effect of father's education has become more important than father's occupation.

[4]The effect of father's education for men in model 9 is .547 - .050 $\times$ t, this will be zero at t= -.547/-.050 = 10.94 decades after 1900, that is in 2009

Table 2.4: Estimates of IEOut and trend in IEOut

	men		women	
	model 4	model 9	model 4	model 9
effect father's education	0.578	0.547	0.491	0.525
	(29.94)	(27.05)	(27.45)	(28.26)
trend in effect father's education	-0.056	-0.050	-0.038	-0.045
	(-16.15)	(-13.65)	(-11.96)	(-13.42)
effect father's occupation	0.214	0.213	0.182	0.184
	(18.14)	(18.07)	(16.63)	(16.82)
trend in effect father's occupation	-0.017	-0.017	-0.013	-0.013
	(-7.73)	(-7.66)	(-6.38)	(-6.54)

t statistics in parentheses

The intercept and the dummies for the different cohorts are not reported

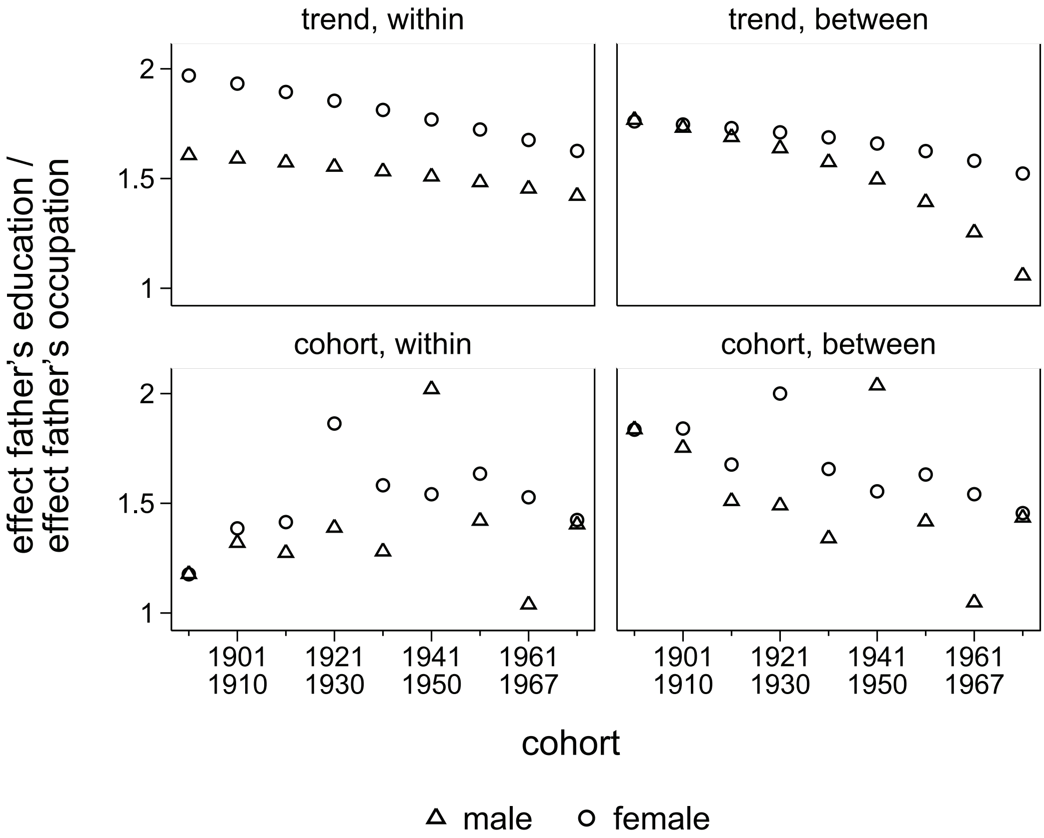
They explained this finding by assuming that father's occupation corresponds more closely to the economic resources available in a family while the father's education correspond more closely to the cultural resources in the family. The decrease in the influence of economic resources would be in line with modernization theory, while cultural reproduction theory would predict an enduring influence of the cultural resources of the parents on especially secondary and tertiary education.

However, their analysis of this issue is problematic for two reasons. A first concern arises because they make the effects of father's education and occupational status comparable by standardizing within each cohort, and provide no justification for this choice. This method of standardization implies that the value of the respondent's education changes as the distribution of the respondent's education changes, and that the values (in terms of being able to influence their offspring's education) of the father's education and occupational status change as the distributions of these variables change. The first idea is common, and is often referred to as diploma inflation. However, the parameterization chosen by De Graaf and Ganzeboom overlooks the fact that the value of a level of education is not only determined by how many people have a certain diploma, but also by the demand for people with that diploma. For this reason, the simpler parameterisation of standardizing between cohorts is preferred here, i.e. standardizing using the overall standard deviations of the variables instead of using the cohort-specific standard deviations.

A second, and more serious, concern is that De Graaf and Ganzeboom use the model with linear trends in the effects of father's education and occupation to compute the ratios of these effects. The assumption of linear trends implies changing ratios unless there is no trend in both effects or when both effects are 0 at cohort 0. So this model is clearly not appropriate for studying changes in the relative sizes of two effects. The appropriate model is to estimate separate effects for each cohort without imposing a linear change over time (model 1 in Table 2.3). Figure 2.4 shows how these ratios change over cohorts according to the different models and standardizations. The preferred ratios are those based on coefficients that were standardized between cohorts in model 1, the bottom right graph of Figure 2.4.

Unlike the conclusions of De Graaf and Ganzeboom (1993), the size of the effect of the father's education relative to the father's occupation seems to actually decline, instead of rise. There is however one feature of this trend that is hard to explain, and that is the sudden spike in the ratio for men from the cohort 1941–1950. In other data, such a spike would be attributed to outlying observations, or — as this dataset consists of multiple surveys — an outlying survey. However, this cohort happens to be the largest cohort containing the largest number of observations and surveys, so that no single observation or survey can have a major influence. This feature thus remains unexplained.

Figure 2.4: The effect of the father's education relative to the father's occupation in model 1



2.4.2 Inequality of Educational Opportunity

As in De Graaf and Ganzeboom (1993), the IEOpps are defined as the association between father's occupational and educational status and the probabilities of passing three transitions: 1) from a diploma in primary education to any diploma in secondary or tertiary education, 2) from a diploma in lower secondary education to any diploma in higher secondary or tertiary education, 3) from any diploma in higher secondary education to completed tertiary education. These IEOpps were measured using the sequential logit model as proposed by Mare (1981). Separate logit models were estimated for each transition, conditional on having passed the previous transition. As with the analysis of IEOut, the analysis of IEOpp will consist of two parts: a sequence of tests on the trends in the effects of the family background variables, and a comparison of the effects of father's education and father's occupation by computing the ratios of standardized coefficients. The concerns with the approach taken by De Graaf and Ganzeboom discussed when analysing IEOut also apply here: (A) it is better not to constrain the trend in intercept to be linear before testing whether the trend in the effects of family background variables is linear; (B) when standardizing, it is better to standardize between cohorts and not within cohorts, and (C) when comparing ratios of effects across cohorts, it is better to base those ratios on a model that allows the effects to change freely across cohorts.

Tables 2.5, and 2.6 represent the tests for the trend in IEOpp equivalent to the tests performed on the trend in IEOut. Instead of comparing the models using the F-test, the models are compared using the likelihood ratio test, as the F-test is only available for models that are estimated using ordinary least squares. The difference between the F-test and the likelihood ratio test is that the F-test takes into account the fact that it is based on a finite sample (through the denominator degrees of freedom) while the likelihood ratio test assumes an infinitively large sample (Long, 1997). Since the sample size is very large, the distinction is negligible in this case. The test statistic of the likelihood ratio test is twice the absolute value of the difference in log likelihood of the two models that are compared, and is χ^2 distributed if the null hypothesis is true.

Despite the enormously expanded database, the results are very similar to the ones found by De Graaf and Ganzeboom (1993), as can be seen in Table 2.7 and Figure 2.5. There is a clearly declining trend in IEOpp for the first transition, and there is still mixed evidence for a trend in IEOpp for the second transition. The trend at the third transition is more complex: the effect of father's education for men is significantly declining, while the effect of father's occupational status for women is significantly increasing. The latter increase in inequality could be due to the fact that the group of women at risk of entering tertiary education has become a lot less selective over the period that is being studied, meaning that there is more room in the recent cohorts for an effect of family background. Also the IEOpps are highest in the first transition, and lowest in the last transition. This pattern has been identified by De Graaf and Ganzeboom (1993) and in many other countries (Hout and DiPrete, 2006), and two explanations have been put forward by Mare (1980). First, the higher transitions are usually made when the person is older, and older persons are less dependent on their family than younger persons. Second, there is only a selected sub-sample at risk of making the higher transitions - those who passed the previous transitions - and this selection causes a negative correlation between unobserved and observed variables, leading to an underestimation of the effects of the observed variables. Using pooled cross-section data from a single country, little can be said about the relative merits of these two explanations (but see Rijken, 1999).

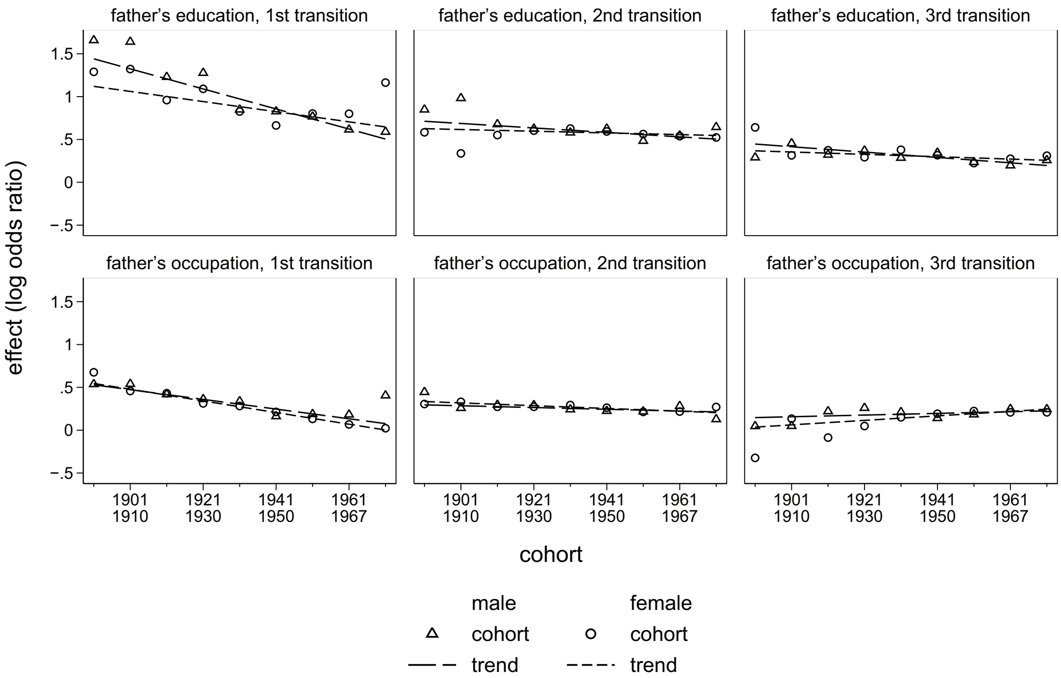
Table 2.5: Tests for trend in Inequality of Educational Opportunity, fit statistics

model	constraints father's education	father's occupation	Intercept	number of parameters	log likelihood Transition 1 men	women	Transition 2 men	women	Transition 3 men	women
sequence of models as used by De Graaf and Ganzeboom (1993)										
1	cohort	cohort	cohort	26	-11459.63	-11466.26	-17627.82	-15974.66	-13113.89	-10400.2
2	cohort	cohort	trend	19	-11466.91	-11474.63	-17637.98	-16005.31	-13131.26	-10402.6
3	trend	cohort	trend	12	-11472.44	-11480.77	-17643.93	-16007.09	-13137.93	-10405.32
4	trend	trend	trend	5	-11481.91	-11498.8	-17654.31	-16125.8	-13160.26	-10428.09
5	trend	constant	trend	4	-11502.24	-11534.05	-17655.57	-16136.99	-13161.88	-10434.22
6	constant	trend	trend	4	-11496.98	-11503.68	-17655.87	-16126.16	-13170.69	-10428.98
7	trend	trend	constant	4	-11789.77	-11974.58	-17705.37	-16268.52	-13160.43	-10428.27
preferred sequence of models										
8	trend	cohort	cohort	19	-11463.52	-11477.02	-17633.94	-15977.43	-13116.76	-10403.12
9	trend	trend	cohort	12	-11473.47	-11478.73	-17641.29	-15980.9	-13124.52	-10408.33
10	trend	constant	cohort	11	-11493.79	-11509.3	-17642.48	-15983.47	-13125.37	-10413.23
11	constant	trend	cohort	11	-11488.98	-11484.27	-17643.89	-15981.32	-13128.64	-10408.98

Table 2.6: Tests for trend in Inequality of Educational Opportunity, Tests

		Transition 1				Transition 2				Transition 3			
		men		women		men		women		men		women	
contrast	df	χ^2	p	χ^2	p	χ^2	p	χ^2	p	χ^2	p	χ^2	p
sequence of models as used by De Graaf and Ganzeboom (1993)													
2 - 1	7	14.543	0.042	16.740	0.019	20.319	0.005	61.285	0.000	34.748	0.000	4.801	0.684
3 - 2	7	11.060	0.136	12.273	0.092	11.892	0.104	3.574	0.827	13.328	0.065	5.435	0.607
4 - 3	7	18.955	0.008	36.066	0.000	20.753	0.004	237.417	0.000	44.674	0.000	45.546	0.000
5 - 4	1	40.659	0.000	70.495	0.000	2.532	0.112	22.371	0.000	3.231	0.072	12.252	0.000
6 -4	1	30.133	0.000	9.754	0.002	3.118	0.077	0.719	0.396	20.861	0.000	1.784	0.182
7 - 4	1	615.704	0.000	951.552	0.000	102.121	0.000	285.432	0.000	0.342	0.559	0.350	0.554
preferred sequence of models													
8 - 1	7	7.779	0.353	21.508	0.003	12.242	0.093	5.527	0.596	5.743	0.570	5.838	0.559
9 - 8	7	19.895	0.006	3.435	0.842	14.690	0.040	6.936	0.436	15.527	0.030	10.423	0.166
10 - 9	1	40.648	0.000	61.130	0.000	2.390	0.122	5.147	0.023	1.691	0.193	9.803	0.002
11 - 9	1	31.024	0.000	11.064	0.001	5.206	0.023	0.857	0.355	8.230	0.004	1.294	0.255

Figure 2.5: Inequality of Educational Opportunity



The relative sizes of the effects of father's occupation and father's education can be studied by computing the ratio of the standardized coefficients of these two variables. The results are shown in Figure 2.6. A striking feature of these graphs is the large degree of variability of some of these estimates, so much so that one of these estimates (the youngest cohort for women in the first transition) needed to be truncated in order to obtain interpretable graphs. This degree of uncertainty is understandable: there is very little information present in the data because either there are very few people at risk of passing (transition 3), or virtually everybody passes that transition (transition 1). For this reason there is also little evidence for a trend in the ratio of the effects of father's education and father's occupation.

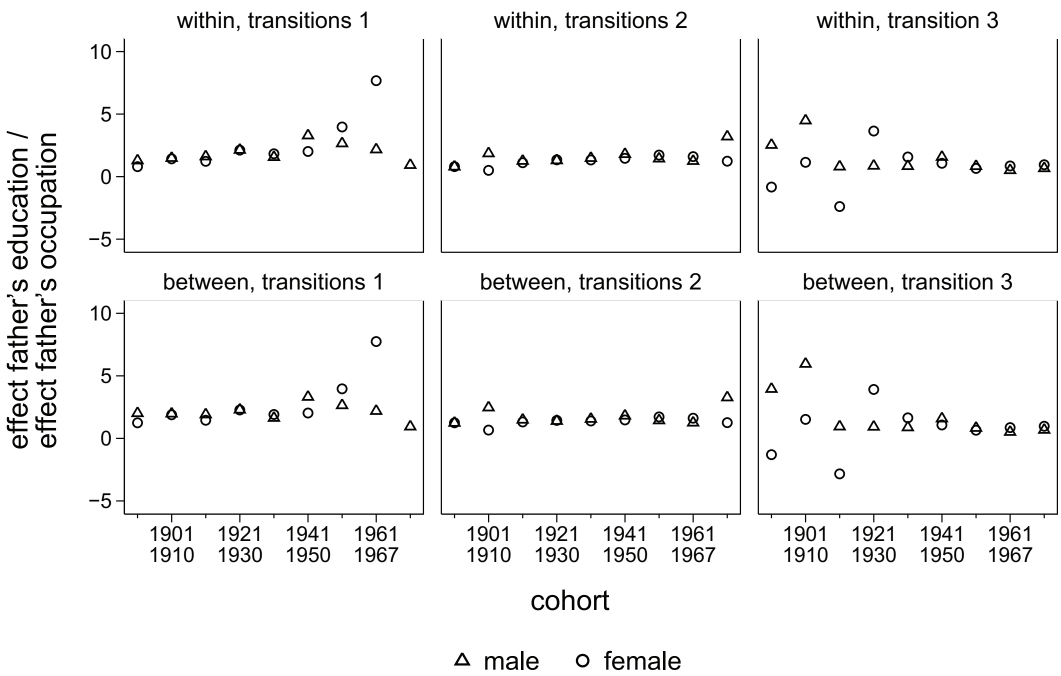
Table 2.7: Estimates of IEOpp and trend in IEOpp

	men		women	
	model 4	model 9	model 4	model 9
Transition 1				
effect father's education	1.407	1.440	1.104	1.121
	(13.64)	(13.26)	(13.10)	(13.11)
trend in effect father's education	-0.109	-0.117	-0.054	-0.059
	(-5.50)	(-5.50)	(-3.12)	(-3.31)
effect father's occupation	0.530	0.530	0.572	0.545
	(13.23)	(13.20)	(14.56)	(14.04)
trend in effect father's occupation	-0.056	-0.057	-0.073	-0.068
	(-6.39)	(-6.38)	(-8.45)	(-7.85)
Transition 2				
effect father's education	0.676	0.710	0.532	0.628
	(11.50)	(11.59)	(8.91)	(10.33)
trend in effect father's education	-0.019	-0.026	0.009	-0.010
	(-1.77)	(-2.28)	(0.85)	(-0.92)
effect father's occupation	0.297	0.296	0.431	0.335
	(8.34)	(8.21)	(10.84)	(8.45)
trend in effect father's occupation	-0.010	-0.010	-0.033	-0.016
	(-1.59)	(-1.55)	(-4.73)	(-2.27)
Transition 3				
effect father's education	0.536	0.446	0.376	0.367
	(8.80)	(7.20)	(5.29)	(5.08)
trend in effect father's education	-0.049	-0.031	-0.016	-0.014
	(-4.56)	(-2.86)	(-1.33)	(-1.14)
effect father's occupation	0.125	0.148	0.018	0.034
	(2.95)	(3.47)	(0.35)	(0.66)
trend in effect father's occupation	0.013	0.010	0.029	0.027
	(1.80)	(1.30)	(3.50)	(3.13)

z statistics in parentheses

The intercept and the dummies for the different cohorts are not reported

Figure 2.6: The effect of the father's education relative to the father's occupation in model 1



2.5 Summary and discussion

2.5.1 Summary

When studying the effect of parental background on educational attainment, one has to distinguish between two types of effects: the effect on the highest achieved level of education, and the effect on the probabilities of passing the transition between the levels of education that make up the educational system. The former represents the inequality in the end result of the educational process, while the latter represents inequality during the process of attaining education. For this reason they are called Inequality of Educational Outcome (IEOut) and Inequality of Educational Opportunity (IEOpp), respectively. This chapter examined long-term trends in IEOut and IEOpp in the Netherlands by replicating a study by De Graaf and Ganzeboom (1993) using more data and more recent data. This study was chosen as a benchmark as it is much cited and provides estimates of both IEOpp and IEOut. The aim of this replication was to answer the following two questions: (A) To what extent has a trend toward less inequality in educational opportunities and in educational outcomes between persons from different family backgrounds occurred in the Netherlands? (B) To what extent do the conclusions by De Graaf and Ganzeboom (1993) hold when using more and more recent data?

Despite the fact that this replication used a little more than five times as many respondents and covered 20 additional years, the results were largely the same as in the benchmark study: negative trends in IEOut, and in IEOpp for the transition whether or not to continue after primary education, mixed evidence for a negative trend in IEOpp for the choice of track during secondary education, and mixed evidence for trends in IEOpp for the transition whether or not to finish tertiary education. The major deviation from the findings in the benchmark study involved the relative impact of the father's education compared to the father's occupational status. Due to an error in their method, De Graaf and Ganzeboom (1993) concluded that the father's education had become relatively more important, while this replication, using the correct method, found no such trend.

2.5.2 Discussion: how the remaining chapters can improve on this study

The design in this study contain five problems, each of which will be discussed in a subsequent chapter in this dissertation. The first problem is that values need to be assigned to each level of education in order to study IEOut, and the scale of education used in this study is rather crude and arbitrary: 1 for only primary education, 2 for lower secondary education, 3 for higher secondary education, and 4 for tertiary education. More sophisticated *a priori* scales of education exist, mostly based on the institutional number of years assigned to each level. In either case, the value of each level of education is assumed to remain constant over time. This assumption can be questioned as the large increase in the number of people with a higher level of education can be assumed to have led to a decrease in the value of higher levels of education. In Chapter 3 I will empirically estimate a scale of education in order to examine this hypothesis, and to compare the resulting scale with *a priori* scales, including the crude measure used here.

The second problem refers to the way trends in effects are estimated. Two extreme methods were used to test for trends. On the one hand the trend is constrained to be linear, while on the other hand completely separate effects are estimated for each cohort. An intermediate solution is to estimate the trend as a smooth curve. This also allows one to estimate at which point in time such a trend changed. This will be done in Chapter 4 using local polynomial regression. In the other chapters, trends will be estimated using restricted cubic splines, which are more convenient to estimate but less suitable for exactly pinpointing when the trend changed, as the restricted cubic spline model imposes constraints on the change in trend near the beginning and the end of the period under study (Harrell, 2001).

The third problem refers to the informal way in which the hypothesis concerning changes in the relative influence of father's education and father's occupational status were tested. In Chapter 5 I will propose a model that can be used to explicitly test whether the relative contributions of parental education and parental occupational status has remained constant or not. Moreover, this chapter will also investigate whether relative influences of the father and the mother have remained constant or not.

The fourth problem is that the estimates of IEOut and IEOpp are treated separately, while in fact the two are related, since IEOut represents inequality in the end result of the educational process and IEOpp inequality during the educational process. Chapter 6 will explore the way in which these two types of inequality complement one another. IEOut will be shown to be a weighted sum of IEOpps, such that an IEOpp receives more weight if: 1) the proportion of people 'at risk' of making that transition increases; 2) the proportion passing that transition is closer to 50%, that is, passing or failing that transition cannot be described as 'almost universal'; and 3) the difference in expected level of education between those who pass and those who fail to make the transition increases, that is, the expected gain achieved by passing increases. Educational expansion would thus condition the role of IEOpps to predict IEOut by making some transitions become more important, for instance because more people have become at risk of passing that transition, while other transitions have become less important, for instance because virtually everybody passes that transition.

The fifth problem is that the estimates of IEOpp are potentially sensitive to the exclusion of (unobserved) variables, like ability or motivation of the respondent. Excluding these variables from the model will change the results even if these variables are uncorrelated with the variables in the model at the first transition. This means that the estimates of IEOpp are likely to be biased even in the best possible case, when none of the omitted variables are confounding variables. This potential influence is the result of two mechanisms: The first mechanism is that leaving a variable out means that the probabilities will be averaged over these unobserved variables. This will influence the estimates of IEOpp as the IEOpp is a non-linear transformation of these probabilities (it is the logarithm of the ratios of odds). In Chapter 7 I will call this the averaging mechanism. The second mechanism is that the IEOpps at later transitions are based on a selected sample: only those students who are at risk of passing these transitions. This selection can cause a negative correlation between the observed and unobserved variables. I will call this the selection mechanism. Finding a solution to this problem is difficult as such an analysis has two contradictory aims: on the one hand one wants to perform an empirical analysis while on the other hand one wants to control for variation that has not been observed. Chapter 7 proposes one possible solution: estimate the IEOut given a scenario specified by the researcher concerning the unobserved variable. By presenting results of multiple scenarios one can give an indication of the range of plausible values of IEOpp.

Appendix: Description of data sources

Table 2.8: Description of surveys on the Netherlands that are part of the International Stratification and Mobility File (Ganzeboom and Treiman, 2009)

study[a]	year	cohorts	N	additional variables[b]
net58	1958	1891–1933	987	
net67	1967	1896–1942	1162	
net67t	1967	1927–1942	387	
net70[c,d]	1970	1891–1945	1569	fed med
net71c[d]	1971	1898–1944	1223	fed
net71[c,d]	1971	1891–1946	1507	fed
net74p[c,d]	1974	1891–1949	852	fed med
net76j[c,d]	1976	1900–1951	689	fed
net77[c,d]	1977	1891–1952	3116	fed med moc
net77e[c,d]	1977	1891–1952	1339	fed
net79p[c,d]	1979	1891–1954	1344	fed med
net81e[d]	1981	1891–1956	1697	fed
net82e[d]	1982	1891–1957	1184	fed
net82n[c,d]	1982	1917–1957	1783	fed med
net82u[c,d]	1982	1917–1957	621	fed moc
net85o[c,d]	1985	1904–1960	3372	fed med
net86e[d]	1986	1893–1961	1266	fed
net86l[d]	1986	1907–1961	3094	fed med
net87i	1987	1907–1962	1335	
net87j[c,d]	1987	1897–1962	715	fed
net87s	1987	1915–1962	730	moc
net88o[d]	1988	1912–1963	3644	fed
net90[d]	1990	1920–1965	1894	fed
net90o[d]	1990	1913–1965	3471	fed
net91j	1991	1909–1966	736	
net92f[d]	1992	1915–1968	1644	fed med moc
net92o[d]	1992	1911–1967	3690	fed
net92t[d]	1992	1903–1967	1753	fed med moc
net94e[d]	1994	1905–1969	1445	fed med moc
net94h[d]	1994	1913–1969	913	fed med moc

(Continued on next page)

Table 2.8 – continued from previous page

study[a]	year	cohorts	N	additional variables[b]
net94o[d]	1994	1911–1969	3512	fed
net95h[d]	1995	1916–1970	1716	fed med moc
net95s[d]	1995	1925–1970	1688	fed med
net95y[d]	1995	1944–1970	1187	fed med moc
net96[d]	1996	1909–1971	697	fed med moc
net96c[d]	1996	1901–1971	1148	fed med moc
net96o[d]	1996	1911–1971	3823	fed
net96y[d]	1996	1962–1971	271	fed med moc
net98[d]	1998	1902–1973	737	fed med moc
net98e[d]	1998	1908–1973	1314	fed med moc
net98f[d]	1998	1915–1973	1856	fed med moc
net98o[d]	1998	1911–1973	4041	fed med
net99[d]	1999	1906–1974	2150	fed med moc
net99a[d]	1999	1904–1974	7671	fed med moc
net99i[d]	1999	1916–1974	1188	fed med
net00f	2000	1916–1975	1450	
net00s[d]	2000	1930–1975	888	fed med
net02e[d]	2002	1907–1978	1888	fed med moc
net03f	2003	1924–1978	1835	
net03n[d]	2003	1923–1979	7520	fed med moc
net04e[d]	2004	1910–1980	1593	fed med moc
net04i[d]	2005	1912–1980	1540	fed med moc
net06e[d]	2006	1912–1981	1560	fed med moc
net06i[d]	2006	1907–1981	1729	fed med moc

[a] Codes refer to the data references

[b] moc is the mother's occupational status; med is the mother's education; fed is the father's education

[c] used in (De Graaf and Ganzeboom, 1993)

[d] used in replication