Diagonal reference models in longitudinal analyses of fertility and mortality

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Abstract

Diagonal reference models (DRM) are considered the only correct method of estimating an effect of social mobility that is distinct from origin and destination status. This method has become standard in analyses of other social phenomena as well. This study considers how diagonal reference models (DRM) may be applied to demographic processes (mortality and fertility) that are analyzed longitudinally and compares findings between a standard demographic approach and the DRM. Overall, the difference we see between the DRM and others is that DRM picks up weakly significant effects we otherwise do not see. This finding indicates that we gain social mobility effects rather than lose them when we use a DRM model, which means the standard demographic approach appears to run the risk of underestimating a mobility effect at worst.

Introduction

A discussion over how best to model the effects of inter and intragenerational social mobility has been on-going since the 1960s. Duncan (1966) began this methodological debate by arguing that the influence of social mobility cannot be estimated until we can separate the influence of the origin (past) and destination (current) statuses from the effect of mobility. His contribution to the debate resulted in the widespread use of the "square additive model", which allows separate and distinct effects of origin and destination status to be modeled. Later, Hope (1971, 1975) found fault with the square additive model because it assumes that the effect of the same class may be different depending on whether it is the origin or the destination class and claimed that a true mobility effect was still unidentifiable in the square-additive model. His proposition that a "diamond-additive model" better isolated a mobility effect is based on the use of one status parameter that represented the non-mobile's average status effect. But Sobel (1981, 1985) argued that Hope's model also failed to parametrize the status effect of the non-mobile, which is the key to accurately estimating an additional influence of mobility. He proposed the "diagonal mobility model", which has also been called the "diagonal reference model" (DRM) as the most suitable model.

Much of this debate was oriented specifically toward the study of how social mobility influenced fertility. However, research on social mobility and fertility appeared to have run its course by this time, as no further studies on this specific topic were later conducted. Even with his methodological developments, Sobel found only weak (1981) or non-existent (1985) effects of social mobility. Nevertheless, the DRM had been established as the best way to separate the distinct effects of origin class, destination class and social mobility. In the next decades, this model was used in a variety of topics to assess the independent influence of a difference in two statuses: whether the difference between husbands' and wives' educational attainment influences their fertility (Sorenson 1989), marital quality and stability (Eeckhaut et al. 2013), and culture participation (Van Berkel & De Graaf 1995); the effects of social mobility on political behavior (Weakliem 1992; Clifford & Heath 1993), life satisfaction (Marshall & Firth 1999), and psychological distress (Houle 2011; Houle & Martin 2011); the impact of migration on fertility (Liang et al. 2014); and whether the discrepancy between ideals and expectations related to education influence educational behavior (Vaisey 2010). Researchers also continued to analyze the appropriateness of the DRM for capturing mobility effects (Hendrickx et al. 1993, Clifford & Heath 1993; Eeckhaut et al. 2013).

We revisit the original question of whether social mobility influences fertility behavior, which Billingsley and Matysiak (2012) argued was never convincingly answered: Past research was hindered, among other things, by data that did not allow the order of events (social mobility and childbearing) to be known, which confounds the analysis of whether mobility is influential with the opposite influence of childbearing to mobility. We also extend the application of DRMs to the study of how social mobility influences mortality. Despite the vastness of the social mobility and mortality literature, no study has attempted to estimate the mobility effect using Sobel's specification of a DRM model. Demographic research on both fertility and mortality has demonstrated that both childbearing and mortality are best modeled as time-dependent processes, in which time-to-event is the key way to understand the intensity and occurrence of the event. In this tradition, time-changing circumstances can be carefully modeled that might otherwise confound the relationship of interest. To narrow the scope of this study and demonstrate the usefulness of different modeling strategies, we focus on intragenerational social mobility only, which includes changes within one's career over time. The implications will be relevant to research on intergenerational social mobility as well.

We first model the effect of intragenerational social mobility, along with origin and destination status, using an event history analysis regression approach with time-changing covariates (including destination status). This is the standard approach in both fertility and mortality research and will form the baseline of our analyses. We then discuss the limitations of this modeling approach in light of Sobel's (1981; 1985) arguments and propose an application of the DRM to this longitudinal research design, which has not yet been explored in the literature.

The influence of social mobility on fertility and mortality

In both literatures that propose a relationship between social mobility and fertility / mortality, two hypotheses have often dominated research. In the first explanation, the outcomes of study—i.e., fertility and mortality—are argued to be determined by the same forces that cause mobility. This is referred to as "selection" or "joint determination", which can be understood in the following ways: 1) An individual with poor health endowment is more likely to be downwardly mobile than a healthy person, and this health endowment may determine both downward mobility and higher mortality. 2) An individual who is particularly interested in career advancement may not perceive having a child as helpful to career development or as satisfying, and this orientation may determine both upward mobility and lower fertility. The other explanation is that individuals carry with them characteristics of their past social class and are influenced by characteristics of their current social class, generating a combined outcome of the two classes: 1) The positive health environment and health behavior of a higher class will improve the mortality risk of an individual who came from a class characterized by a poorer health environment and behavior. 2) The lifestyle and culture surrounding childbearing in a lower class will moderate the past childbearing culture of a higher class. This argument forms the basis of the "null hypothesis" (Halaby & Sobel 1979) in mobility research because it supposes only an additive influence of past and social class, where mobility is not expected to contribute a unique effect. In the fertility literature (and occasionally in the mortality literature), the discussion has also included the idea that the experience of mobility may be influential beyond a selection effect or an averaging of the origin and destination class effects.

Specific to the fertility literature, the original focus was on upward mobility and the relationship was expected to be inverse: Westoff et al. (1961) claimed that status aspirations deter childbearing because they both require similar expenditures of energy, time and money. Empirical research grew over the next decades (e.g., Westoff et al. 1963; Blau and Duncan 1967; Hope 1971; Bean and Swicegood 1979; Stevens 1981; Sobel 1981; Kasarda and Billy 1985) in which scholars proposed many mechanisms and tested them in different contexts and with different methods. First, a *social disintegrative* effect was argued to arise when mobility disrupts family and social ties and creates a desire to compensate for the loss; alternatively, fertility may decline because of increased strain and stress. The second mechanism is *status enhancement*, by which families seek to maximize their resources—by limiting fertility—to obtain higher mobility, maintain their current status or avoid downward mobility. A third pathway is through a *relative economic effect* (Easterlin 1976) in which a negative evaluation of one's economic status based on aspirations developed in the past will induce fertility avoidance and vice versa. The alternative hypothesis to all these mechanisms is that individuals make fertility decisions simply on the basis of the behavior associated with either their origin or destination class (Duncan 1966; Stevens 1981).

In mortality research, the idea that mortality risk is influenced by socioeconomic position in a cumulative process has been supported (Hart et al. 1998; Bartley & Plewis 2007; Pollitt et al. 2005). Upwardly mobile individuals have better health than those in their origin class but worse health than those in their destination class, and the reverse relationship appears for downwardly mobile individuals (e.g., Cambois 2004; Boyle et al. 2009). These findings are interpreted as evidence for two mechanisms that link mobility and mortality. First, they may indicate a weak effect of social selection (Claussen et al. 2005): poor health or health behavior leads to downward mobility, whereas good health promotes upward mobility. Second, these findings may reflect social causation: individuals are exposed to health risks and benefits associated with the culture and environment of a class (Bartley & Plewis 2007; Chandola et al. 2003). In addition, downward mobility may influence health through stress-related factors as well as through lifestyle factors or loss of social networks (Rosvall et al. 2006). Burazeri et al. (2008) found an association between downward mobility and acute coronary syndrome after the collapse of widespread pyramid schemes in Albania. In another case where an exogenous shock generated downward mobility during the economic crises of the 1990s in Russia, Billingsley (2012) found a higher mortality risk after downward mobility among men, net of their previous health or health behavior.

The literature on both fertility and mortality suggest different pathways through which social mobility is influential, including selection processes, causation, and a moderation of the origin status effect by the destination status. These distinct arguments point to a need to carefully separate the effects of origin status, destination status and social mobility.

Data

The data on which these analyses are based come from administrative registers that are collected by Statistics Sweden: The Longitudinal Database for Health Insurance and Labor Market Studies and The Structure of Earnings Survey (Lönestrukturstatistiken). This data is of very high quality and covers the entire population of Sweden. It contains some family background information as well as life course biographies, including detailed histories of working life and children born. Most histories are available from 1968, but annual observation of occupations only begins in 1996 and is covered until 2007.

The coverage of the occupation register is not complete. All individuals working in public institutions or firms with 500+ employees in Sweden are included, but firms with less than 500 employees are randomly sampled each year, where the likelihood of being sampled decreases with the size of the firm. When individuals' occupational information is missing due to lack of coverage, they are assigned to a missing category. Using the sample for the fertility analyses (men and women who had a first child June 1997 or later), only 38% of the person/years have occupational information in the raw data. Thirteen per cent of the person/years were enrolled in education during those years. This leaves 49% of all person/years with missing information. Some occupational information was therefore imputed. When there was information available from the previous year and income was similar (less than a 10% difference), the same occupation was assumed. Similarly, occupational information was held constant when a woman or man recently had a child and there is evidence of social benefits being a main source of income for that year. About 16 per cent of missing information appeared to be related to being on leave during the period occupational information was collected. In addition, some individuals have more than one occupation recorded each year. The occupation with the highest class was chosen to represent the class standing of a given year.

The occupational information available comes in the form of Swedish-specific occupational codes, which are translated into three digit ISCO88 codes and then categorized into the European Socioeconomic Classification according to the protocol established by Rose and Harrison (2006). This classification is based on the EGP schema and has been validated for comparative purposes. At heart, it differentiates positions in society in terms of employment relations, which involve how the work fits into systems of authority and control, economic security and prospects for advancement. The schema consists of 4 classes, which corresponds to the original 5 class schema, but excludes one class because the register does not provide occupational information for those who are self-employed or small employers.

Table 1. Four-class schema

	Type of occupation
1	Large employers; professional, administrative and managerial occupations; higher grade technician and supervisory occupations
2	Intermediate occupations, lower supervisory and lower technician occupations

3	Lower services, sales and clerical occupations
4	Lower technical occupations, routine occupations

Operationalizing intragenerational mobility

To simplify the empirical exercise in this study, we focus on only one form of social mobility: intragenerational mobility. This means we capture changes in occupational class within one's own career. Both inter and intragenerational mobility have been used in past studies of both fertility and mortality, as well as DRM investigations. The choice to use intragenerational mobility reflects our assumption that the importance of origin status would always outweigh the importance of destination status if origin status measured childhood class status (as in the case of intergenerational mobility) and this exercise may be more informative if the weight of each factor potentially varied more.

The samples are restricted to only those who have an occupational class status in their first year of observation (described below in the separate sections for mortality and fertility). Origin status is held constant from that point on, whereas "destination" status is the occupational class of each consecutive year. Because of changes in labor market activity, a class may not always be assigned. For example, individuals may be studying or not participating in either the labor market (no earnings) or education. These two states are treated as separate categories. An additional category contains those with missing information that year: those who have income from an employer, but for whom we do not have information about their occupation (due to sampling issues mentioned above).

The intragenerational mobility variable is coded in the following way: When the origin status is higher than the destination status, the spells are coded as downward mobility; conversely, a destination status that is higher than an origin status is coded as upward mobility. When origin and destination status are the same, the spell is coded as no mobility. Men and women are at risk of being mobile only when there is information about their current occupation. This means that when respondents are unemployed, inactive or there is missing information they are not categorized for mobility, but rather are classified into an "other" category and these separate states are indicated in the destination status variable.

Mortality analyses

The sample is restricted to men and women who were born in Sweden and who had an occupational class status in 1996 (the first year this information was available). This means that only those who were working and had employment information recorded in 1996 are included in the analysis. The employment information is no longer available after 2007, but we continue to observe men and women until 2012, after which point we have no information about timing of death. They are also censored if they have emigrated. We do not censor them if they retire, rather they are classified as no longer working or at risk of social mobility. We use Cox proportional hazard model, where age is designated as the time scale. The control variables that are included are all time-varying and indicate whether men and women 1) reside in one of Sweden's metropolitan areas (Gothenburg, Malmo or Stockholm); 2) are married, unmarried, or previously married; 3) are enrolled in education or have finished with a low (two years of secondary education or less), medium (three years of post-secondary education or less) or high level (more than three years of post-secondary education); 4) origin status; and 5) destination status. In total, there are 1024142 women and 747532 men in the sample and 80382 deaths observed.

Fertility analyses

In contrast to past research on social mobility, we do not analyze completed childbearing (at a specific age or at the time of a survey), which would not allow the social mobility event to be properly placed in time. Rather, we focus on one parity transition, specifically the transition to second births. Childbearing is mostly universal in the context of Sweden, which means studying the transition to the first birth would mostly capture differences in timing, which has not been argued to be as theoretically relevant to social mobility as family size. Higher parity births are therefore more relevant, and for the purpose of this paper analyzing one transition is sufficient.

We begin observing men and women from the year they have their first child. Occupational information is gathered in the Fall of each year, which means the earliest first births we can observe take place in the summer of 1997. Our sample therefore is women and men who had their first child between June 1997 and 2007 and they are censored at the next conception, emigration, death, when women turn 45 and men turn 55, or the end of 2007. The sample again contains only those who were born in Sweden. Only those men and women who have occupational information recorded the year of the first birth (or the year before) are kept in the sample. A discrete hazard model is implemented to analyse the time-varying determinants of each conception. The same control variable in the mortality analysis are included in the fertiltiy analysis, with the addition of age and the number of years since first birth. In total, there are 282412 women and 232669 men in the analysis of second conceptions and 282344 conceptions observed.

Methodological considerations

The unique Swedish register data provide the opportunity to observe occupational changes annually in the entire population for recent years. The tradition of research in Sweden on social mobility and mortality has nevertheless relied on data from cohort studies, using information from two or three time points spread over many decades of the life course, or from past censuses that were administered up until 1990 and provide data for points in time that vary between five or ten years apart. Specifically, intragenerational mobility effects for mortality have been studied in Malmö, where adult occupation was measured at least three separate times between 1960 and 1990 (Nilsson et al., 2005); in Stockholm, where occupation was measured in individuals' late 20s and early 50s (Hallqvist et al., 2004); and in Scania, where occupation was measured in individual's early 30s and 40s (Rosvall et al. 2006). In these studies, social mobility was modeled using categories that represent trajectories (e.g., stable high status, stable low, upward mobility, downward mobility) and occupational class was usually reduced to only two categories. This strategy aims to contrast those who experienced social mobility with those who did not. However, it ignores the issues that DRM models aim to address because the individual effects of origin and destination are not separated from each other and because it does not address the possible independent effects of experiencing social mobility. One exception in the Swedish literature is the study by Tiikkaja et al. (2012) in which parental class in 1960, own class in 1990, and an interaction of the two were included in a model to capture the effect of social mobility on premature cardiovascular-related mortality. This modeling is similar to the square additive model, which was criticized by Sobel (1981; 1985). These studies all share a research design in which origin and destination status are measured at only one point in time each and mortality is observed in a follow-up period, where the probability of death was sometimes considered a time-dependent process and sometimes not.

Yamaguchi (1991) isolates four limitations of a simple cross-sectional approach to modeling an event outcome. All four are related to the loss of information that occurs when measuring an outcome at only one moment in time and the possibility that the particular moment may not be perfectly random. First, we lose potentially important information on when an event happened before or after the moment of measurement. Second, an event happening before measurement may result in that particular observation being excluded from the sample; likewise, a process under observation for a shorter period of time may not yet have resulted in an event, which limits comparability. Third, the impact of covariates may be sensitive to the timing of measurement, which means that a strong short-term influence of a specific covariate may be missed if the moment of measurement occurs later in the process and vice versa. Finally, static measurement design misses variation in the value of covariates over time that may be related to the outcome.

Here we apply a strict longitudinal perspective. Longitudinal data and data analysis have become the standard in demographic research and for both fertility and mortality studies time-to-event regression has become the most common tool of analysis. Time-to-event regression comes in various different flavors. In fertility research, time-to-event regression is often called event-history-analysis, while in mortality research the terms survival analysis or hazard regression are most common. All terms refer to the same statistical method, with slight variations in model specification. Most variations in the specifications are due to differences in the assumptions on the shape of the basic time-to-event process, sometimes called the baseline hazard. In fertility research the baseline hazard is often assumed to follow a piece-wise constant hazard, which allows for a flexible shape and gives estimates on the absolute risk to experience a birth. In mortality research the baseline is often assumed to follow the well-known exponential increase of mortality over time or age. Here, we will use a time-to-event regression that is often applied when data is available only annually: discrete time event-history-analysis (Yamaguchi 1991). Discrete time event-history analysis is suitable for all types of binary outcomes and is able to capture the basic time-to-event processes for both fertility and mortality. The method ensures the best possible comparability between the standard demographic models and the proposed DRM models, as both can incorporate the same independent variables and are based on the same logit specification.

Then, the remaining distinction between the standard demographic methods and the DRM is the treatment of the origin (O), destination (D), as well as the indicators for upward and downward mobility. In the standard models O and D are included as two categorical variables with 5 levels each, and the D categorical variable can include other states when an individual is not employed at a given time. In addition social mobility is included as categorical variable with 3 levels, indicating upward mobility, downward mobility or no social mobility. The basic time-to-event process is captured by dummy variables. For the fertility question (transition to second birth) we include a dummy variable for each year since first birth and for the mortality question we include dummy variables for each age.

Diagonal Reference Models

The diagonal reference model, proposed by Sobel (1981, 1985), treats origin, destination, and the indicators for upward and downward mobility differently. This model is designed for contingency tables classified by factors with the same levels. The cell means are modelled as a function of the diagonal effects, i.e., the mean responses of the `diagonal' cells in which the levels of the row and column factors are the same.

Consider a two-way square arrangement defined by the four types of occupation given in Table 1. If we denote the mean response in cell (i, j) by μ_{ij}, it may be reasonable on subjects matter grounds to suppose that

$$\mu_{ij} = \omega\mu_{ii} + (1-\omega)\mu_{jj} \,.$$

Following Cox (1990), the notion is that ‘individuals’ in cell (i, i) and (j, j) represent “pure” i and j individuals, respectively, whereas individuals in cells (i, j) have moved from i to j and represent some intermediate category. In more complicated versions, ω depends on further features such as additional explanatory variables.

According to Turner and Firth (2015) a diagonal reference term comprises an additive component for each factor. The component for factor *f* is given by

$$\omega_f \gamma_l$$

for an observation with level *l* of factor *f*, where ω_f is the weight for factor *f* and γ_l is the 'diagonal effect' for level *l*.

The weights are constrained to be nonnegative and to sum to one so that a 'diagonal effect', say γ_l, is the value of the diagonal reference term for data points with level l across the factors. Dref specifies the constraints on the weights by defining them as

$$w_f = \frac{exp(\delta_f)}{\sum_i exp(\delta_i)}$$

where the δ_f are the parameters to be estimated. Thus, in a diagonal reference model for a contingency table classified by the row factor O (say origin) and the column factor D (say destination), the mean response in cell (i, j) is given by

$$\mu_{od} = \omega_1\gamma_o + \omega_2\gamma_d = \left(\frac{exp(\delta_1)}{exp(\delta_1)+exp(\delta_2)}\right)\gamma_o + \left(\frac{exp(\delta_2)}{exp(\delta_1)+exp(\delta_2)}\right)\gamma_d.$$

In the presence of an explanatory variable x_i the diagonal reference model may be extended to (Turner and Firth; 2015):

$$\mu_{odi} = \beta x_i + \left(\frac{exp(\delta_{01} + \delta_{11}x_i)}{exp(\delta_{01} + \delta_{11}x_i) + exp(\delta_{02} + \delta_{12}x_i)}\right)\gamma_o + \left(\frac{exp(\delta_{02} + \delta_{12}x_i)}{exp(\delta_{01} + \delta_{11}x_i) + exp(\delta_{02} + \delta_{12}x_i)}\right)\gamma_d$$

DRM modeling of longitudinal processes

To enable the comparison with the standard longitudinal demographic approaches, DRM models need to be fitted in a longitudinal framework as well. This presents new challenges because fitting a DRM requires the origin and destination variables to be symmetrical: for the weights to be accurately estimated, they must be constructed in the exact same way (i.e., same categories and hierarchical ordering). In a longitudinal design such as ours, origin status is time-constant and contains only occupational classes as categories because only individuals that could be identified within a specific class during the first moment of observation were included in the sample. In contrast, destination status is time-varying, where individuals contribute to the exposure time of different destination statuses over the period of observation. Also unlike origin status, individuals are not identified in a specific class when they stepped out of the labor market, took a leave of absence, became unemployed or had missing information during that year. These states are alternatives to the occupational classes and are called non-symmetrical destination statuses hereafter. Potentially, they are related to our outcomes of interest and therefore important pieces to address Yamaguchi's 4th limitation of simple cross-sectional approaches to modeling.

At any given moment when origin and destination statuses are not symmetrical, the question of what to do with these spells when estimating a DRM is raised. One potential solution to non-symmetrical destination statuses could be to simply exclude these observations, as done in previous studies with cross--sectional data. As we have already discussed, these alternative states are important to model, particularly when non-symmetrical destination statuses may be related to the outcome of interest. For example, if an individual becomes ill, he/she may be more likely to not have an occupational class (whether due to inactivity or taking a leave of absence) as well have a higher mortality risk due to illness. Likewise, even though most women and men go on parental leave for some amount of time, observations during which an individual does not have an occupational class after entering parenthood due to leave or inactivity may be more prevalent for individuals who are more likely to have another child. By simply excluding these observations as done in previous research, these potential relationships would clearly generate non-random selectivity into the sample, which can change how all covariates are related to the outcome of interest and, thus, create bias.

We have considered two other approaches to dealing with non-symmetrical destination statuses. Both require including three dummy variables to represent the non-symmetrical destination statuses: studying, not employed or missing information. The distinct influence of these non-symmetrical destination activities should be therefore picked up by the dummy variables introduced. In approach A, we set the destination status variable to the same value as the origin status when it would otherwise be non-symmetrical. This approach increases the collinearity of origin and destination statuses by duplicating the origin status exposures in the destination status. An adjustment such as this does not change whether an individual is categorized as non-mobile, upwardly or downwardly mobile, however. When in a non-symmetrical destination status, individuals are not considered at risk of mobility: only observations in which an origin and destination class status can be identified are assigned as non-mobile, downwardly mobile, or upwardly mobile. All other observations are assigned a missing status for the mobility variable. This means that any approach for dealing with non-symmetrical destination statuses does not change the observations contributing to the composition of the non-mobile, upwardly mobile or downwardly mobile observations.

In approach B, we set the destination status variable to the last observed destination status when it would otherwise be non-symmetrical. This approach has the advantage of somewhat lessening collinearity between origin and destination status and giving more relevant information for that time period by reflecting the most recent class status in the destination status variable. See the table below for an example of how the different approaches appear in the data.

		Standard demographic approach			**Alternatives that meet DRM symmetry requirements**				
								Approach A	Approach B
ID	Year	Origin	Destination	Social mobility	Studying	Not employed	Missing info	Destination	Destination
1	1997	3	3	none	0	0	0	3	3
1	1998	3	2	upward	0	0	0	2	2
1	1999	3	**not emp.**	missing	0	1	0	**3**	**2**
1	2000	3	2	upward	0	0	0	2	2
1	2001	3	**not emp.**	missing	0	1	0	**3**	**2**
1	2002	3	2	upward	0	0	0	2	2
1	2003	3	2	upward	0	0	0	2	2
1	2004	3	2	upward	0	0	0	2	2
1	2005	3	**missing**	missing	0	0	1	**3**	**2**
1	2006	3	2	upward	0	0	0	2	2
1	2007	3	2	upward	0	0	0	2	2

Results

In this section, we make three points of comparison between DRM models and the others (Standard, Approach A and Approach B). First and foremost, we compare the effect of social mobility (coefficient and significance). Second, we compare the effect of O and D (coefficient and significance) in non-DRM models with the O and D “weights” in DRM models. These two comparisons give us substantive differences to talk about, which may lead to different conclusions on the usefulness of DRM models. The third comparison is based on model fit, which allows us to situate our findings among the other papers that compare different models.

Summary tables for social mobility effect

Fertility	Women		Men	
	Downward	Upward	Downward	Upward
Standard demographic approach	NS .014(.02)	Neg -.059(.02)	NS .008(.02)	Pos .081(.02)
Approach A	NS -.025(.03)	NS -.019(.03)	NS .050(.03)	NS .027(.03)
Approach B	NS .012(.03)	Neg -.061(.03)	NS .039(.03)	NS .040(.03)
DRM with Approach A	NS -.013(.03)	NS -.033(.03)	Weak pos .04(.023)	Weak pos .04(.022)
DRM with Approach B	NS .018 (.027)	Strong Neg -.066(.026)	NS .037(.023)	Pos .044(.021)

Note: NS=Not statistically significant, Neg=negative coefficient, Pos=positive coefficient; Coefficients given below with standard errors in parentheses

Mortality	Women		Men	
	Downward	Upward	Downward	Upward
Standard demographic approach	Pos .187(.04)	NS -.058(.04)	Pos .097(.04)	Neg -.165(.04)
Approach A	Weak pos .120(.07)	NS .030(.07)	NS .026(.06)	NS -.076(.06)
Approach B	Pos .175(.05)	NS -.026(.04)	NS .013(.04)	NS -.055(.04)
DRM with Approach A	pos .167(.051)	NS -.024(.046)	NS .028(.052)	NS -.058(.051)
DRM with Approach B	pos .184(.043)	NS -.037(.037)	NS .032(.042)	NS -.053(.039)

Note: NS=Not statistically significant, Neg=negative coefficient, Pos=positive coefficient; Coefficients given below with standard errors in parentheses

Of approaches A and B, Approach B seems to come nearest to the standard approach, in terms of coefficient size, direction and standard error of the social mobility effect (as well as the effect of the destination status variable). But we still lose the effect of upward mobility on men’s fertility and both the upward and downward mobility effect on men’s mortality, which means no alternative model is perfectly comparable to a DRM model.

Overall, the difference we see between the DRM and others is that DRM picks up weakly significant effects we otherwise do not see. This finding indicates that we gain social mobility effects rather than lose them when we use a DRM model, which means the standard demographic approach appears to run the risk of underestimating a mobility effect at worst.

Summary tables for comparing the effect of origin and destination statuses with origin and destination weights

Fertility	Origin coeffs		Destination coeffs		Origin weight	Destination weight
Standard demographic approach						
Men						
high prof/mngrs	0.28	***	-0.02			
intermediate/low superv	0.20	***	-0.02			
white collar workers	1		1			
blue collar workers	0.07	***	-0.01			
Women						
high prof/mngrs	0.08	***	0.18	***		
intermediate/low superv	0.03	*	0.14	***		
white collar workers	1		1			
blue collar workers	-0.06	***	-0.01			
Approach A						
Men					0.71	0.29
high prof/mngrs	0.19	***	0.08	*		
intermediate/low superv	0.14	***	0.06	*		
white collar workers	1		1			
blue collar workers	0.07	*	0.00			
Women						
high prof/mngrs	0.12	**	0.07		0.59	0.41
intermediate/low superv	0.06	*	0.05	+		
white collar workers	1		1			
blue collar workers	-0.07	*	0.01			
Approach B						
Men					0.74	0.26
high prof/mngrs	0.20	***	0.07	*		
intermediate/low superv	0.15	***	0.06	*		
white collar workers	1		1			
blue collar workers	0.07	**	0.01			
Women					0.31	0.69
high prof/mngrs	0.06	+	0.14	***		
intermediate/low superv	0.03		0.08	***		

white collar workers	1	1
blue collar workers	-0.04	-0.02

Mortality	Origin coeffs		Destination coeffs		Origin weight	Destination weight
Standard demographic approach						
Men						
high prof/mngrs	-0.25	***	0.02			
intermediate/low superv	-0.16	***	0.07			
white collar workers	1		1			
blue collar workers	0.00		0.03			
Women						
high prof/mngrs	-0.09	***	0.06	*		
intermediate/low superv	-0.07	***	0.08	**		
white collar workers	1		1			
blue collar workers	0.08	***	0.14	***		
Approach A						
Men					0.13	0.87
high prof/mngrs	-0.10		-0.15	*		
intermediate/low superv	-0.03		-0.12	*		
white collar workers	1		1			
blue collar workers	-0.01		0.02			
Women					0.28	0.72
high prof/mngrs	0.06		-0.14			
intermediate/low superv	0.04		-0.09			
white collar workers	1		1			
blue collar workers	0.04		0.07			
Approach B						
Men					0.11	0.89
high prof/mngrs	-0.09	*	-0.16	***		
intermediate/low superv	-0.06		-0.09	*		
white collar workers	1		1			
blue collar workers	-0.02		0.04			
Women					0.53	0.47

high prof/mngrs	-0.02		-0.04
intermediate/low superv	-0.01		-0.04
white collar workers	1		1
blue collar workers	0.08	*	0.04

In general, whichever status (origin or destination) has the stronger weight, we usually see that the coefficients for that status are larger and more likely to be statistically significant in the standard model. This is particularly true for the fertility results. Approach A for men shows a weight for origin status of .71 and 0.29 for destination status; likewise, the coefficients for origin status are larger than for destination status. For women, the weights are somewhat more balanced and the coefficients for origin status less pronounced. We see similar correspondence for Approach B, but in this case the weight of origin status is not more important for women as it in the case of men. As we might expect, the coefficients for destination status are more important than origin status to women's fertility. These similarities are pretty straightforward and easy to interpret, even if weights and coefficients are not measuring exactly the same thing (the latter is an association of different class levels with the outcome and the former is how much the socially mobile resemble the origin or destination class). The mortality findings are similar, but slightly less clear (for example, a stronger origin status coefficient usually accompanies a stronger origin status weight).

Conclusions

Forthcoming

Appendix

Forthcoming

References

Boyle, P. J., Norman, P., Popham, F. (2009), Social mobility: Evidence that it can widen health inequalities. *Social Science and Medicine* **68**, 1835-1842

Clifford, P., and Heath, A. F. (1993), The Political Consequences of Social Mobility. *Journal of the Royal Statistical Society – Series A* **156**, 51-61.

Cox, D. R. (1990), Role of Models in Statistical Analysis. *Statistical Science* **5**, 169-174.

Duncan, O. D. (1966), Methodological Issues in the Analysis of Social Mobility. Pp. 51-97 in Smelser,, N. J., and Lipset, M. S. (Eds.), *Social Structure and Mobility in Economic Development*. Chicago: Aldine.

Eeckhaut, M. C. W., Van de Putte, B., Gerris, J. R. M., Vermuslt, A. A. (2013), Analysing the Effect of Educational Differences between Partners: A Methodological/Theoretical Comparison. *European Sociological Review* **29**, 60-73.

Halaby, C. N., and Sobel, M. E. (1979), Mobility Effects in the Workplace. *American Journal of Sociology* **85**, 385-416.

Hendrickx, J., De Graaf, N. D., Lammers, J., and Ultee, W. (1993), Models for status inconsistency and mobility: A comparison of the approaches by Hope and Sobel with the mainstream square additive model. *Quality and Quantity* **27**, 335-352.

Hope, K. (1971), Social Mobility and Fertility. *American Sociological Review* **36**, 1019-1032.

Hope, K. (1975), Models of Status Inconsistency and Social Mobility Effects. *American Sociological Review* **40**, 322-343.

Sobel, M. E. (1981), Diagonal Mobility Models: A Substantively Motivated Class of Designs for the Analysis of Mobility Effects. *American Sociological Review* **46**, 893-906.

Sobel, M. E. (1985), Social Mobility and Fertility Revisited: Some New Models for the Analysis of the Mobility Effects Hypothesis. *American Sociological Review* **50**, 699-712.

Turner, H., and Firth, D. (2015), Package 'gnm' (Generalized Nonlinear Models) – Version 1.0-7 (20 Feb. 2015). *The Comprehensive R Archive Network Project* (https://cran.r-project.org/)

Van der Slik, F. W. P., De Graaf, N. D., and Gerris, J. R. M. (2002), Conformity to Parental Rules: Asymmetric Influences of Father's and Mother's Levels of Education. *European Sociological Review* **18**, 489-502.

Weakliem, D. (1992), Does social mobility affect political behavior? *European Sociological Review* **8**, 153-165.