



*Demographic Research* a free, expedited, online journal  
of peer-reviewed research and commentary  
in the population sciences published by the  
Max Planck Institute for Demographic Research  
Konrad-Zuse Str. 1, D-18057 Rostock · GERMANY  
[www.demographic-research.org](http://www.demographic-research.org)

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## ***DEMOGRAPHIC RESEARCH***

**VOLUME 26, ARTICLE 8, PAGES 173-190**  
**PUBLISHED 09 MARCH 2012**

<http://www.demographic-research.org/Volumes/Vol26/8/>

DOI: 10.4054/DemRes.2012.26.8

*Research Article*

**Social mobility and demographic behavior:  
Long term perspectives**

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This publication is part of the Special Collection “Social Mobility and Demographic Behaviour: A Long-Term Perspective”, organized by Guest Editors Cameron Campbell, Jan Van Bavel, and Martin Dribe.

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## **Social mobility and demographic behavior: Long term perspectives**

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### **Abstract**

We introduce a collection of papers that examine interactions between demographic behavior and social mobility via analysis of historical and contemporary longitudinal, individual- and household-level socioeconomic and demographic data. The authors originally presented these papers at "The International Seminar on Social Mobility and Demographic Behavior: A Long Term Perspective" held at the California Center for Population Research at UCLA in December 2009, and organized on behalf of the IUSSP Scientific Panel on Historical Demography. We convened the meeting as a means of promoting the use of historical demographic data to address a topic of contemporary relevance that has been the subject of much attention lately: how the inter-generational transmission of socioeconomic status and socioeconomic differentials in demographic behavior interact to shape patterns of inequality over the long term. The papers here focus specifically on relationships among fertility, marriage, migration, and social mobility.

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## **1. Introduction**

Demographic behavior and social mobility interact. Such interactions occur across and within generations. Across generations, household demographic context and socioeconomic status jointly influence demographic outcomes and socioeconomic attainment chances in adulthood. Within generations, demographic behaviors such as marriage and childbearing affect attainment chances, and socioeconomic status affects demographic outcomes such as marriage, childbearing, and mortality. At the macro-level, socioeconomic differentials in demographic behavior and demographic differentials in socioeconomic attainment interact to shape long-term trends in population composition (Mare and Maralani 2006).

Among the relevant processes, demographic influences on socioeconomic attainment and the interactive influence of patterns of demographic and socioeconomic differentials on population composition have received the least attention. The influence of family socioeconomic status on the socioeconomic attainment of the next generation is a long-standing preoccupation in the study of social stratification. The influence of individual socioeconomic status on various demographic outcomes has been a long-standing interest in demography as well, but interest in the influence of family demographic context on socioeconomic attainment is more recent. Most reflect interest in the implications for attainment chances of recent increases in the diversity of family structures in developed countries (McLanahan and Percheski 2008). Studies of how socioeconomic differentials in demographic behavior and demographic differentials in socioeconomic attainment interact to shape trends in population composition are even more recent (Mare and Maralani 2006).

Along these lines, historical demography and historical social mobility as areas of inquiry have, until recently, been largely separate. They intersected only insofar as considering historical studies of the determinants of demographic outcomes such as marriage, reproduction and death included socioeconomic status as an explanatory variable. Thus, we have numerous studies of socioeconomic differentials in mortality and fertility; for example, Bengtsson, Campbell, and Lee (2004) and Tsuya et al. (2010). Historical studies of social mobility have largely focused on inter-generational mobility, especially the influence of parental socioeconomic status. To some extent, this separation reflected the fact that historical databases of the requisite size and detail were, until recently, not widely available.

New historical databases offer the prospect of integrating the study of social mobility and demography. Many of the longitudinal household- and individual-level population databases used in recent studies of historical demography are especially well-suited to the investigation of interactions between demographic behavior, social mobility, and population composition. The best of them provide much more time depth

than the retrospective or panel surveys that are the basis of studies in contemporary populations. They often provide complete life histories of individuals from birth to death, often in families linked across multiple generations. Because they follow individuals from birth forward, they permit the study of how childhood socioeconomic and demographic context interact to shape socioeconomic attainment in adulthood. They also allow for studies of the influence of demographic behavior in adulthood on socioeconomic attainment later in adulthood. Relevant longitudinal datasets have not only been constructed for a variety of historical Asian and European contexts, but in many cases they have also been released. Examples of the latter include the China Multi-generational Panel Dataset - Liaoning (CMGPD-LN) and the Historical Sample of the Netherlands (HSN).

Historical demographic databases are uniquely suited to advancing research on the interactions between social mobility and demographic behavior. Contemporary data with the requisite life-course and generational span are rare because most large panel surveys are only a few decades old. Analysis of historical data not only illuminates how demographic and social mobility interacted during key periods of demographic and economic change (such as the Industrial Revolution and the Demographic Transition) but also yields insight into processes of contemporary interest and relevance.

To facilitate dialogue between demographers and stratification researchers and to promote the integrated study of social mobility and demographic behavior using recently constructed historical databases, we organized the “International Seminar on Social Mobility and Demographic Behavior: A Long Term Perspective” on behalf of the Scientific Panel on Historical Demography of the International Union for the Scientific Study of Population (IUSSP). Participants presented papers that used historical data to examine connections between social mobility, demographic behavior, and population composition. The meeting was held in December 2009 at the California Center for Population Research (CCPR) at the University of California, Los Angeles (UCLA). It received support from IUSSP, the UCLA International Institute and Division of the Social Sciences, CCPR, and the UCLA Department of Sociology.

Papers presented at the seminar considered relationships between social mobility and demographic behavior at the levels of the population and the individual. At the individual level, participants examined how household and individual demographic characteristics of children influenced their demographic behavior and educational and socioeconomic attainment in adulthood. At the population level, participants examined how inter-generational transmission of social status and socioeconomic differentials in demographic behavior interact to shape patterns of inequality. Such research reflects growing recognition that the evolution of inequality across generations depends not only on macro-level changes in the economy and the micro-level relationship between parents’ and children’s socioeconomic outcomes, but also on socioeconomic differences

in marriage, reproduction, and mortality. Aggregate patterns of upward and downward mobility, for example, may depend not only on the correlations of parent-child characteristics but also on socioeconomic differences in marriage and fertility that determine the composition of the population (Mare and Maralani 2006).

Presentations at the meeting represented a diverse array of datasets, disciplines, and methodological approaches, leading to a stimulating and fruitful interaction. Participants came from Asia, Europe, and America and included historians, anthropologists, economists, and sociologists. While many of the participants worked primarily with historical data, some worked with contemporary data while others worked with both contemporary and historical data. Data sets included historical population databases and contemporary panel and retrospective surveys. Methods included econometric techniques (instrumental variable regressions), demographic techniques [population renewal models (Mare and Maralani 2006)], and a variety of statistical techniques (event-history analysis, growth-curve modeling, and other extensions to basic regression).

The papers in this special collection focus primarily on the interaction of fertility, marriage, and migration with social mobility and social stratification. We organize the detailed introduction to the papers into two parts. The first part discusses the papers on fertility and social mobility. They mostly examine how family size in childhood affected socioeconomic attainment in adulthood and how childbearing in adulthood affects occupational trajectories and other aspects of inter-generational social mobility. The second part discusses the papers on marriage, migration, and social mobility. These papers examined how marriage timing, partner choice, and migration affected both intra-generational and inter-generational social mobility. Most of them focus on subsets of these factors; for example, marriage timing and partner choice versus migration and partner choice.

## **2. Fertility and social mobility**

Fertility matters for social mobility in two ways. First, childbearing may affect the intra-generational mobility of adults, especially women. Parents who have many children may have fewer chances of upward social mobility because the time, energy, and money they devote to their children is diverted from their work. This “luggage hypothesis” was first introduced in 1890 when the French social scientist, Arsène Dumont, wrote: “For people who want to go up, many children make inconvenient luggage” (Dumont 1890/1990:77, our translation). Second, fertility may also affect inter-generational social mobility. Children growing up in a larger family may have less favorable attainment chances than children growing up in a smaller family, even if the

socioeconomic statuses of their parents are equal. This argument is called the “resource dilution hypothesis” (Blake 1989): a large family size is expected to dilute parental resources and therefore hinder children’s climb up the social ladder. Parents with more children have less time, energy, and money to devote to the education of each child.

The papers in this special collection that deal with the relation between fertility and social mobility all address the resource dilution hypothesis (Bras, Kok, and Mandemakers 2010; Ferrari and Dalla Zuanna 2010; Kye 2011; Van Bavel et al. 2011). A study of Brazil (Marteletto 2010) was recently published in *Demographic Research* and also focuses on the resource dilution hypothesis but is not part of this special collection. Since Marteletto (2010) is so relevant to the themes of the meeting, and, by coincidence, appeared in *Demographic Research* around the same time as the Seminar, we discuss it here as well. These studies all apply advanced quantitative techniques to historical and contemporary data sets to examine how numbers of siblings in the family of origin affect attainment chances, net of the socioeconomic status of the family, and other characteristics.

The luggage and resource dilution hypotheses have a synchronic as well as diachronic relevance for demography. Synchronically, they say something about the expected association between family size and socioeconomic status in a specific time period and social setting. Diachronically, both hypotheses play a prominent role in explanations of the fertility transition in western societies; the secular decline of fertility that started in most European and North American countries in the second half of the nineteenth or early years of the twentieth century.

In this collection, Van Bavel et al. (2011) and Ferrari and Dalla Zuanna (2010) represent the synchronic approach. The first paper looks at the effect of family size of origin on inter-generational social mobility in a nineteenth century urban population in Antwerp, Belgium. The second paper looks at the same issue, but in a completely different historical context: France and Italy around the year 2000. The findings of both papers are consistent with the resource dilution hypothesis. Growing up in a large family tends to be associated with a lower attained socioeconomic status in adulthood. In the nineteenth century, this was reflected in occupational status. In the contemporary study, this was reflected in educational attainment.

A major challenge for studies in the synchronic tradition is to investigate whether correlations between family size and socioeconomic attainment actually represent causal relationships. From a counterfactual perspective, family size can only be said to have a causal effect on socioeconomic status if the latter would be different if family size also differed, all else equal (Morgan and Winship 2007). This will not be the case, for example, if family size and the social status attained by children are only correlated because both are caused by a third factor, such as the status anxiety of parents: “The level of ‘status anxiety’ for children may drive *both* the family size *and* the education of

each child” (Ferrari and Dalla Zuanna 2010). In this situation, family size and socioeconomic status are endogenous with respect to this third factor, and standard regression approaches that do not control for all such relevant but unobserved third factors will yield misleading estimates of the causal effect.

To discern the actual causal effect, Ferrari and Dalla Zuanna (2010) employ an instrumental variable approach. This approach yields unbiased estimates of the causal effect of X on Y if a variable Z can be exploited in the estimation process that does not have any direct effect on Y but does have a direct effect on X. Z is then called an instrument or instrumental variable (Morgan and Winship 2007). Ferrari and Dalla Zuanna (2010) argue that the sex composition of the two firstborn children can be considered a valid instrument (Z) to investigate the effect of final family size (X) on the educational attainment of children (Y). The motivation is that there is evidence that there is a preference in many European countries for a mixed-sex composition. Parents want a boy and a girl instead of boys only or girls only. Parents whose first two children are boys or girls only are more likely to have a third child, presumably in the hope to reach a mixed sex composition of their flock (Mills and Begall 2010). In the French and Italian data employed by Ferrari and Dalla Zuanna (2010), the effect of sex composition of the first two births (Z) on family size (X) is as predicted. Therefore, if the sex composition does not have any direct effect on the educational attainment of the children (Y), then the instrumental variable approach should yield an unbiased estimate of the causal effect of family size on educational attainment. With the instrumental variables approach, Ferrari and Dalla Zuanna (2010) find that the strength of the resource dilution effect weakens in Italy and disappears in France, which is in line with their hypothesis about the effects of different family policies endorsed in these two countries.

Instrumental variables are not a panacea. The instrument is supposed to randomly assign cases to a treatment group or to a control group. In this case, the treatment is larger family size, and the control is smaller family size. As is so often the case in analysis that involves instrumental variables, it is not clear that the assignment process is random with respect to the dependent variable. For example, parents who give priority to investing in the education of their children may care less about the sex composition of their flock. This would imply a correlation between an antecedent but unobserved factor and the assignment to family size groups through the instrument. In sum, the instrumental variables approach is potentially valuable as a means for identifying the causal effect of family size on socioeconomic status, but, as always, the choice of instrument may be controversial.

Much less empirical work has been done about the diachronic relationship between family size and socioeconomic attainment, even though the evolution of this relationship over time is considered very important in the theoretical literature about the



fertility transition (Van Bavel 2006; Dalla Zuanna 2007). The papers in this collection by Bras, Kok, and Mandemakers (2010) and Kye (2011) are exceptions, as is Marteleto (2010). All of these papers examine changes over time in the relationship between family size in childhood and socioeconomic attainment in adulthood.

Changes over time in the relationship between family size and socioeconomic attainment have been suggested as an explanation for fertility decline because an increase in the adverse effect of larger family size could motivate couples to reduce their number of children. In a closed society in which status was highly heritable and determined largely by parentage rather than parental investments, family size should not affect the attainment chances of offspring. Couples have no incentive to limit family size. They may even have an incentive to maximize it, thereby increasing the chances that at least one of their offspring survives to adulthood. In contrast, in societies with a more open stratification system in which parental investments also affect socioeconomic attainment of children, parents who have aspirations for the upward mobility of their offspring have a strong incentive to limit fertility. Transitioning from a closed to an open system should accordingly trigger a reduction in fertility.

The basic hypothesis is that, before the demographic transition, high fertility of parents did not adversely affect the chances for upward mobility of their children. The adverse effect of large family size on the attainment chances of children is supposed to have emerged only in the course of the demographic transition. This basic hypothesis would be rejected if there was a negative effect of family size on intergenerational social mobility already before the demographic transition. In contrast, if there was no negative effect of a large family size on upward social mobility before the transition, but a pronounced negative effect during and after, the emergence of such an adverse effect may well be a crucial piece in the puzzle of the fertility transition (Van Bavel 2006).

Investigating changes in the relationship between fertility and social mobility over the course of the demographic transition has, until recently, been very difficult. The main reason for this is the lack of appropriate data. A proper study requires individual-level data with indicators of social status and fertility that also spans the fertility decline. Marteleto (2010) compared the association between family size and socioeconomic status in Brazil in 1977 and 1997, before and after a substantial decline in fertility. Consistent with the theoretical expectations, she concludes that children born after the demographic transition suffer a greater disadvantage from being born in a large family than children born in the earlier time period.

Bras, Kok, and Mandemakers (2010) make use of a data set for the Netherlands that spans an even longer time period: the Historical Sample of the Netherlands (HSN). They examine the adult outcomes of children born in marriages contracted between 1840 and 1925. In addition to exploiting a very rich data base, they also discuss the

theoretical reasons for expecting a weaker or even positive relation between family size and social status before the demographic transition. First, in contexts and social groups where children become economically productive from an early age onwards, additional children may increase the resources available to the household, not dilute them. Second, a premise of the resource dilution hypothesis is that resources are finite and provided entirely by parents. In some contexts, a lack of resources in the household may be offset by social ties outside the nuclear family, such as support offered to child-rich families by the community or the kin network.

The findings of Bras, Kok, and Mandemakers (2010) indeed show that the relationship between family size and socioeconomic status greatly depends on the social and historical context. For example, growing up in a large family did not have a negative impact on the adult socioeconomic status of farmers' children. Similarly, in areas with high proportions of co-residing kin, the impact of a larger family size on socioeconomic status was found to be positive rather than negative. Finally, and most relevant to the fertility transition, the association between family size of origin and social status in adulthood changed over time. During the period when fertility started to decline, resource dilution appeared to become a more important issue for families. As time went on, children from larger families experienced an increasing disadvantage.

Kye (2011) examines the macro-level implications for population composition of fertility differentials by socioeconomic status. By applying a population renewal model (Mare and Maralani 2006) to combined census, birth registration, and survey data from contemporary South Korea, Kye (2011) investigates whether educational differentials in fertility and intergenerational transmission of educational status affected trends in the educational distribution of the population. He finds that differential fertility by level of education has not substantially affected the aggregate educational distribution in the population. While educational mobility and differential fertility are interdependent processes that jointly determine population replacement by level of education, the fertility gap between education groups would have to be unrealistically large to be influential for the educational distribution in the Korean population, due to the extraordinarily high educational mobility in South Korea. The population renewal models that he applies are an ideal tool for investigating the implications for population composition of changing relationships between family size and socioeconomic attainment during fertility decline and would be an ideal follow-up to analyses similar to those by Bras, Kok, and Mandemakers (2010) and Marteleto (2010).

Schulz and Maas (2010) also present a methodology for the study of occupational trajectories in historical data that should be useful in future research on the luggage hypothesis. Their paper studies the implications of marriage for trajectories in socioeconomic status during adulthood by applying techniques of multi-level growth curve modeling. While their analysis did not include the childbearing experiences of

women, it should be possible to do so in future applications of this technique. This would allow for examination of the influence of childbearing on occupational trajectories. To our knowledge, there is no study in historical demography that has done this, even though the relevant theoretical argument plays an important role in the literature.

### **3. Marriage, migration, and social mobility**

Marriage may have long-term implications for individual social mobility, as reflected in earnings and employment. For example, in contemporary Western contexts, married men have often been shown to earn more than unmarried men (Hill 1979; Nakosteen and Zimmer 1997; Korenman and Neumark 1991; Nakosteen, Westerlund, and Zimmer 2004). Even though this “marriage premium” has declined since the 1960s it still amounts to about 10 percent, and sometimes even more (Gray 1997; Blackburn and Korenman 1994). For women, the association between marital status and earnings is weaker. In fact, women often seem to experience a marriage penalty which may be connected to the luggage hypothesis. Specifically, this may reflect adverse effects of childbearing on earnings (Hill 1979; Korenman and Neumark 1992; Loughran and Zissimopoulos 2009) or labor force participation (Angrist and Evans 1998). The extent to which the marriage premium for men is related to selection processes into marriage or to real productivity differences between married and unmarried men is still under debate, despite considerable attention being devoted to this issue in previous research (Akerlof 1998; Chun and Lee 2001; Dougherty 2006; Nakosteen and Zimmer 2001; Nakosteen, Westerlund, and Zimmer 2004; Ginther and Zavodny 2001; Loughran and Zissimopoulos 2009; Krashinsky 2004).

The case for causal effects of marriage on earnings in contemporary society is based on two different arguments. According to the specialization model proposed by Becker (e.g., 1981), spouses allocate time by specializing according to their comparative advantages in home production and market production respectively. Especially in a traditional one-earner (male-breadwinner) model this usually assumes that the man specializes in market work while the woman specializes in domestic production. The opportunity for married men to specialize in market work implies that they have an advantage over unmarried men in market production and may earn higher wages. The second argument is that the marriage premium is a result of discrimination. The reasoning follows that employers give their married workers an advantage because they believe married employees are more productive, being more dependent on their salary to support their family and therefore more afraid of losing their job (Bartlett and Callahan 1984). Married life might also contribute to a more healthy lifestyle for men

which in turn would also increase their labor productivity relative to that of unmarried men.

We can expect similar associations between marriage and socioeconomic attainment and mobility in historical populations. That marriage and socioeconomic attainment were related is apparent in the segregation of the labor market according to marital status. Married men typically attained different positions than those who were unmarried (see Dribe and Lundh 2010). A prime example of this is the custom in historical Western Europe of men and women living and working in other households while unmarried only to set up an independent household upon marriage (e.g. Laslett 1977; Mitterauer 1988). The division of labor was also crucial in this respect as occupations and tasks were highly gender segregated (e.g. Tilly and Scott 1989).

The article by Schulz and Maas (2010) examines the consequences of marriage for occupational trajectories by applying multilevel growth models to study occupational careers in the Netherlands between 1865 and 1940. Besides an important effect of socioeconomic origin (father's occupation) on occupational attainment early in a career, they also demonstrate a clear effect of marriage on both men and women. Marriage shifted an individual's occupational trajectory upward, but did not affect its slope. In other words, it had no effect on the rate of change in occupational standing. For men this result is expected from theory. For women, it is unexpected. The problem, however, is that marriage for women often meant leaving the labor market altogether and women who did not follow this rule might have been positively selected in terms of occupational status. Thus, looking only at women who remained employed after marriage will most likely over-estimate the positive effect of marriage on women.

It is not only marriage itself that might have an impact on the socioeconomic attainment but also the characteristics of the partner. From this perspective, the choice of partner may well have long-term effects on career development and earnings. For contemporary Europe, some studies have found a positive effect of wife's education on husband's income, which could be a result of support and better understanding to help the man in his career (Benham 1974; Bernasco, de Graaf, and Ultee 1998; Duvander 2000; Jepsen 2005). For women, the results are more mixed. Husband's education, occupational status, or labor market experience may have a positive or negative effect on the labor market status of women, depending on the gender and welfare regime of the specific country (Bernardi 1999; Bernasco, de Graaf, and Ultee 1998; Blossfeld and Drobnic 2001).

In historical populations, choice of partner should also have influenced individual socioeconomic attainment. As argued by Dribe and Lundh (2010), one important way of accessing economic resources, networks, or social prestige in the absence of inherited assets was through the marriage market. Many studies have indicated the prevalence of socioeconomic homogamy in pre-industrial societies, especially among

landholding farmers (e.g. Arrizabalaga 2005; Bras and Kok 2005; Bull 2005; Dribe and Lundh 2005; Van Leeuwen and Maas 2002). At least to some extent this could be viewed as an indication of the strategic and instrumental nature of pre-industrial marriages (cf. Mitterauer and Sieder 1982:Ch. 6; Shorter 1977:Ch. 2; Stone 1977:Ch. 7).

By finding a spouse from a higher status origin, individuals increased their chances of upward social mobility. Conversely, marrying downward also increased the risks of negative social mobility. Compared to being homogamously married, Dribe and Lundh (2010) show that hypergamy (marrying up) in nineteenth-century southern Sweden had a positive effect on socioeconomic status for both men and women. Hypogamous marriage (marrying down), however, had a negative effect on socioeconomic attainment for both sexes. The magnitude of the effects also suggest that hypergamy was more important for upward mobility than hypogamy was for downward mobility.

Breschi, Manfredini, and Mazzoni (2010) look at the possible effect of individual health on partner selection in nineteenth-century Sardinia, Italy (Alghero). They employ military data to assess the health status of young men which are then used to predict the chance of marrying a literate woman, a proxy for high social status. The results clearly indicate that, for men, poor health and physical defects lowered the chances of marrying a high-status woman. Adverse health conditions may have affected socioeconomic attainment and mobility indirectly through partner selection as well as directly through productivity.

The age and geographic origin of partners may also affect the prospects for socioeconomic mobility. In their study of southern Sweden, Dribe and Lundh (2010) find that men who married younger women attained higher socioeconomic status than men who married women of the same age. Marrying older women had a negative effect and reduced socioeconomic attainment. One possible explanation could be that such unions had fewer assets related to productivity, such as land.

Maas and Zijdeman (2010) look at the evolution of geographical exogamy over time. Specifically, they examine whether the emergence of mass communication and mass transportation contributed to spatial enlargement of marriage markets. In the Dutch province of Overijssel in the late nineteenth to early twentieth century, marriage markets grew in size over time. Higher proportions of people married exogamously and the average distance between the places of birth for spouses increased. While better mass communication (measured by presence of post offices) clearly contributed to this development, the expansion of mass transportation (trains and trams) appears to have been largely unrelated to the increased geographical exogamy. The degree of exogamy, as measured by the distance between the spouses' places of birth, depended on socioeconomic status, so that people from higher-status backgrounds also married spouses from further afield.

Linking geographic exogamy to socioeconomic attainment, Dribe and Lundh (2010) mostly find only small and statistically insignificant effects. The primary exception is that exogamously-married women born outside the area under study experienced lower attainment than endogamously-married women. On the other hand, almost all types of geographic exogamy increased the probability of downward socioeconomic mobility. This may be linked to deficient access to local networks and exclusion of migrants in general. However, they also find a positive effect of exogamy where both spouses came from outside the area on upward mobility, which might have been related to positive selection of migrants (see, e.g., Ferrie 1999; Long 2005; but see also Stewart 2006).

Finally, the paper by Helgertz (2011) analyzes the long term impact of international migration on intra-generational occupational mobility in contemporary Sweden. Though not a clear case for a glass-ceiling effect, the disadvantaged position of many immigrant groups for occupational mobility in the labor market across the occupational hierarchy is clearly evident. To a large extent, this inferior position seems to be related to language barriers operating across the occupational distribution.

#### **4. Conclusion**

The papers in this special collection highlight the potential for the application of contemporary methods to historical data to illuminate interactions of demography and social mobility of general interest. Analysis of historical demographic data has much to contribute to our understanding of stratification processes and their relationship to demographic processes. Historical demographic data often provide entire life histories, recording demographic behavior and socioeconomic status from birth to death. In many cases, they follow families for multiple generations. Through additional linkage, they can provide details on geographic context. In contrast, most contemporary data recorded only a portion of the life course. If they provide information on circumstances at birth, such information is typically retrospective, reconstructed from the recall of the interviewee.

The papers also show that, to realize the potential of historical data in the study of demography and social mobility, it is necessary to apply methods developed for the analysis of contemporary data. Until now, techniques such as growth curve modeling have rarely been applied to historical data. Indeed, the papers in this collection may represent the first applications of such techniques to historical data. Population renewal models like the ones employed in Kye (2011) have not yet been applied to any historical data. Clearly, application of these advanced techniques to historical data has much to offer.

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