Marital fertility decline in The Hague (Netherlands) 1870-1909: An age-period-cohort analysis

Jona Schellekens and Frans van Poppel

February 2008

*Jona Schellekens, Department of Sociology and Anthropology, Hebrew University, Mount Scopus, Jerusalem 91905, Israel; E-mail: jona@vms.huj.ac.il. Frans van Poppel, Netherlands Interdisciplinary Demographic Institute, The Hague, The Netherlands. The data on which this research is based were collected for a research project entitled 'Religion and Child Mortality in Holland 1860-1920'. Financial assistance from the Wellcome Trust is gratefully acknowledged. A previous version of this paper was presented at the annual meeting of the Social Science History Association, Minneapolis 2006.

Marital fertility decline in The Hague (Netherlands) 1870-1909: An age-period-cohort analysis

Abstract: The view of fertility decline as an adjustment states that fertility control is an adjustment to economic and social change. The view of the decline as a process of innovation, on the other hand, states that the adoption of fertility control represents new behavior due to attitudinal change. Cohort replacement has been suggested as a mechanism for attitudinal change. Using birth history data from population registers this study shows that marital fertility decline in The Hague, Holland, is not a cohort effect. The simultaneity of the onset of family limitation and a rise in living standards suggests that marital fertility decline was an adjustment to economic and social change with attitudinal change possibly determining the pace of decline.

Marital fertility decline in The Hague (Netherlands) 1870-1909: An age-period-cohort analysis

Carlsson (1966) published a highly influential paper that classified explanations of the fertility decline into two categories: adjustment and innovation. The view of fertility decline as an adjustment states that fertility control is an adjustment to economic and social change. The view of the decline as a process of innovation, on the other hand, states that the adoption of fertility control represents new behavior due to attitudinal change and, more specifically, changes in the acceptability of fertility control on moral grounds. Carlsson interpreted the Swedish evidence as supportive of the adjustment thesis. Most participants in Princeton's European Fertility Project (EFP), however, have found the adjustment thesis to provide a poor fit for what happened during the transition in Europe. They found correlations between marital fertility and the available social and economic measures to be weak. Their research indicated that the innovation thesis may provide a better guide to what happened (Knodel and van de Walle 1986; Cleland and Wilson 1987). But others view this conclusion as invalid because of serious reservations about the methods used in the EFP. The explanatory variables used in most EFP studies, for example, do not support meaningful tests of the role of social and economic change in the fertility transition (Brown and Guinnane 2002). Although their aim was to explain change, most EFP studies used statistical models that do not accurately differentiate cross-sectional from time-series changes. Richards (1977) and Galloway et al. (1994) have shown how conclusions can change when more appropriate statistical methods are used.

Some scholars went so far as to propose that innovation theory can substitute for adjustment theory (Cleland and Wilson 1987). Today, however, few would support a "pure" innovation model. The more common stance is that the two sets of explanations – adjustment and innovation – are complementary (Lesthaeghe 1983; Montgomery and Casterline 1996). Cleland (2001) refers to theories that combine the two explanations as "blended" models. In blended versions of innovation explanations, the fundamental cause of marital fertility decline is reduced demand for children. Once the structural conditions are right, marital fertility decline is inevitable but its timing may be lagged. The diffusion of innovative ideas subsequently conditions the speed and mechanisms of change.

A major problem in diffusion models is to understand who adopts the innovation, and how fast they do so (Palloni 2001, p. 70). According to Livi-Bacci (1986) attitudinal change was initiated by elites and gradually spread downward to the lower classes. Lesthaeghe and Surkyn (1988) argued that the major mechanism for attitudinal change is the demographic dynamic of cohort succession: when an older cohort dies out, it is replaced by a new cohort that holds different values reflecting its unique historical experience. Thus, the pace of cohort replacement determines how fast innovative ideas spread.

A central socio-psychological postulate is that cohorts tend to be marked for life by the ideas prevalent in their youth (Ryder 1965, p. 851). Evidence that attitudinal change is a cohort effect is accumulating (Sears and Valentino 1997). If value systems are likely to have crystallized by early adulthood and if fertility decline is due to attitudinal change, then there should be cohort influences in fertility decline (Raftery et al. 1995, p. 161).

There may also be period influences in fertility decline, but these are more likely to be associated with the adjustment hypothesis. Demand theory says that fertility decisions are determined by the costs and benefits faced by couples at the time when decisions are made implying that fertility decline is a period effect (Raftery et al. 1995, p. 161). Although a study of period and cohort influences may enrich our understanding of fertility declines, there are few age-period-cohort analyses of the fertility decline (e.g. Hsueh and Anderton 1990; Raftery et al. 1995).

The first aim of this paper is to try to determine the extent to which marital fertility decline in The Hague is a cohort effect. Using birth history data from population registers, a binary time-series-cross-section analysis of marital fertility shows that the decline there was a period effect, not a cohort effect. Thus, our empirical results seem to indicate that marital fertility decline in The Hague was not the delayed effect of a change in attitudes that occurred early in life in response to social and economic change in society at that time.

A second aim of this paper is to identify period influences on marital fertility. Variables that influence costs and benefits and that we were able to measure include childhood mortality and living standards. Controlling for social status, religion and migrant status, infant and early childhood mortality in The Hague do not seem to attenuate the period effects to any large extent.

In The Hague there was a delay between the timing of the onset of marital fertility decline and development as measured by a rise in living standards. There is no need to resort to the diffusion of ideas, however, to explain the delay. When a measure of family limitation – mean age at last birth – is substituted for that of marital fertility, there remains no evidence for a delayed response to development. If the simultaneity of an increase in living standards and the onset of family limitation is not a coincidence, then our results seem to suggest that attitudinal change did not cause a delay in the timing of the onset of marital fertility decline in The Hague.

Before turning to the data, methods, and an age-period-cohort analysis of the marital fertility decline in The Hague, we review cohort and period influences in theories of fertility decline.

Cohort and period effects in theories of fertility decline

There are few theories of fertility which have been explicitly formulated in a cohort mode. The best-known is Richard Easterlin's theory about the effect of relative cohort size. According to Easterlin, decisions about childbearing are made on the basis of income potential relative to an expected standard of living. The expected standard of living is determined through childhood economic socialization – the standard of living experienced in childhood and adolescence produces aspirations that are then compared to income potential in young adulthood, which is a function of relative cohort size. An increase in income potential relative to the expected standard of living is predicted to increase fertility (Pampel 1993, p. 496). Macunovich (2000) tested the Easterlin hypothesis and demonstrated how changes in relative cohort size appear to have triggered fertility declines.

Demographic Transition Theory emphasizes social and economic forces as the basic causes of fertility decline. These include a rise in education, new economic roles for women which are less compatible with child-rearing, a rise in the cost of child-rearing, a decline in the economic contribution by children, and a decline in infant and child mortality, among others (Hirschman 1994). Thus, Demographic Transition Theory predicts period as well as cohort influences. The level of education is largely determined by early adulthood remaining more or less constant for the rest of the life cycle. Hence, an increase in education and new economic roles for women which are less compatible with child-rearing will create cohort effects, to the extent that new economic roles are due to education, while a rise in the cost of child-rearing, a decline in the economic contribution by children, and a decline in infant and child mortality are more likely to create period effects.

Doubt was cast on the Demographic Transition Theory by the EFP, which showed that in much of Europe fertility started to decline at about the same time but under different social and economic circumstances. There were sharp differences across linguistic borders and religious barriers within the same country, suggesting the importance of non-economic factors. The fact that illegitimate fertility fell in parallel with marital fertility is considered to be the "single most telling piece of evidence to support the view that pregnancy prevention was indeed an innovation," because illegitimate births were surely unwanted and would have been prevented if pregnancy prevention were acceptable (Cleland 2001, p. 48; Knodel and van de Walle, 1986).[1] At about the same time, further doubts on Demographic Transition Theory were cast by studies of fertility decline in contemporary developing countries that used World Fertility Survey data.

Non-economic explanations stress the role of ideational change in the ethic, religious, and political realm. Hence, these explanations are now often referred to as ideational theory (Cleland and Wilson 1987). Most versions of ideational theory assume that the diffusion of ideas about appropriate family size and methods of birth control is a necessary condition for fertility decline. Less bald statements of the ideational change argument give equal or greater weight to ideas that influence the demand for children, such as ideas about the costs and benefits of children and the roles of women and children (Casterline 2001).

Caldwell's Theory of Intergenerational Wealth Flows combines aspects of both economic and ideational theories. In his theory there are only two stable fertility regimes. In traditional societies, children provide a positive net flow of resources to the parents, while in modern societies there is a reversal of the flow, parents contributing more to children. The destabilization of high-fertility regimes may be due to the diffusion of new cultural models by mass media and "mass schooling" (Caldwell 1982). If adolescents are more likely to be impressed by mass media and mass schooling than adults, then the Theory of Intergenerational Wealth Flows would predict cohort influences in the fertility decline.

The mechanism for attitudinal change, according to Lesthaeghe and Surkyn (1988), is the demographic dynamic of cohort succession: when an older generation dies out, it is replaced by a new cohort that holds different values reflecting its unique historical experience. In the social sciences there is a continuing debate between those who describe people as making choices "rationally" on the basis of available information and those who emphasize a wide variety of distorting psychological influences. One area of continuing empirical clash between these perspectives focuses on the long-term stability of attitudes. At one extreme is the view that basic attitudes are always susceptible to change given compelling evidence. At the other extreme is the view that basic attitudes are acquired early and persist throughout life. Much of the evidence for value systems to have crystallized by early adulthood comes from the study of political socialization. Several studies of political socialization suggest that people are highly vulnerable to shifts in attitudes during early adulthood. Attitude stability increases with age. This increase appears to occur immediately following early adulthood, and attitude stability appears to remain at a constant, high level for the remainder of the life cycle (Alwin and Krosnick 1991; Firebaugh and Chen 1995; Sears and Valentino 1997; Tilley 2002).

Lesthaeghe links attitudinal change with the process of secularization (Lesthaeghe and Surkyn 1988; Lesthaeghe and Wilson 1986). Empirical studies seem to indicate that religious commitment is largely determined in adolescence remaining more or less constant for the rest of the life cycle. Thus, the decline in religiosity appears to be mostly a cohort effect (Argue, Johnson and White 1999; Chaves 1989; Te Grotenhuis and Scheepers 2001; Tilley 2003; and Voas and Crockett 2005).

Changes in familial values have also been associated with fertility decline (Lesthaeghe and Surkyn 1988). Mason and Lu (1988) found that more of the change in women's and men's attitudes toward women's familial roles occurred within cohorts than through cohort replacement. Covering a longer period, however, more recent studies by Brewster and Padavic (2000), Ciabattari (2001), and Brooks and Bolzendahl (2004) found that changes in attitudes toward women's roles are brought about both by period influences as well as by cohort replacement.

Thus, there is a considerable body of evidence to suggest that attitudinal change is a cohort effect. If attitudinal change is a cohort effect and if fertility decline is due to attitudinal change, then there should be cohort influences in fertility decline.

Data and variables

In the second half of the nineteenth century, The Hague evolved from a provincial capital and a quiet residence into a big modern city. In 1850, the city had about 72,000 inhabitants. After 1870, when prosperity increased, the population grew steadily reaching 206,000 at the turn of the century. More than half of this growth was due to migration. The presence of the Royal Court, Parliament and government offices attracted large numbers into the service sector. In 1850, this sector made up 42 per cent of the labour force. Another 34 per cent were employed in industry, mostly in the construction sector, and the clothing and shoe industries. By 1900 the service sector had declined to less than 37 per cent, while almost 36 per cent were employed in industry (Stokvis 1987, pp. 88 and 149).

We used the marriage registration as a sampling frame. A random sample was drawn from the records of civil marriages contracted in 1859-1902. Many couples that married in The Hague did not settle there after their marriage. Other couples simply could not be located in the population registers for technical reasons. We have excluded second marriages from the analysis. A few more cases were lost due to data inconsistencies and missing values. Older cohorts are underrepresented in early periods, while younger cohorts are underrepresented in later periods. Hence, birth histories were left-censored at the beginning of 1870 and right-censored at the end of 1909. Thus, the analysis is based on 2,337 women, resulting in 33,814 years of exposure.

Next, socio-economic and demographic information on the couples was extracted from the population registers. Continuous population registers in the sense of bound documents with non-removable pages were prescribed in The Netherlands by Royal Decree of December 22, 1849. The registers had to record the population residing within the municipality. The returns from the census of 1849 were copied into the population register, and from then on all changes occurring in the population during the following decades were recorded in the register. For each individual, date and place of birth, relation to the head of the household, sex, marital status, occupation, and religion were recorded.

For the town of Tilburg, Janssens (1994) checked the quality of the population registers in recording demographic events by checking the registration of births in the population register against the birth registers. She found that at most 0.2 per cent of births were not entered in the population register, all such cases being children dying soon after birth. The omission of less than one percent of births should not affect our conclusions to any large extent.

The occupation attributed to each household is the first occupation of the husband listed in the population registers. We used a new international social classification scheme for occupational data – the Social Power (SOCPO) scheme – developed by Van de Putte and Miles (2005). The fundamental organizational principle of their scheme is the potential to influence one's destiny through control of resources. The categories are:

1. Unskilled workers;
2. Semi-skilled workers and the micro-scale self-employed;
3. Manual skilled workers; and supervisors of semi- and unskilled workers;
4. Manual super-skilled and non-manual skilled workers; supervisors of skilled workers; and local businessmen;
5. Non-manual super-skilled workers; supra-local businessmen; executives and those with general policy tasks; and nobility;
6. Without occupation; and unknown.

The religion of the head of the household was used to divide couples into three religious groups: Dutch Reformed, Roman Catholics, and others. We included the following demographic variables in the analysis: age of the woman; marital duration; a dummy variable indicating the first year of marriage; infant mortality and a measure of childhood mortality; and length of the birth interval. Most couples will not have a child in the first calendar year of their marriage because they will have married too late and exposure to intercourse in the months preceding marriage is relatively low. We have added a dummy variable indicating the first year of marriage to take this into account. The death of an infant to a breastfeeding mother will shorten the post-partum infecundable period. To control for this physiological effect, we included a variable indicating whether an infant death occurred in the previous year. Childhood mortality may increase fertility through the 'replacement' of children who have died and 'insurance' against high mortality. To capture these effects we included a variable measuring the percentage of children in the family that died before reaching age ten. Like infant mortality, this variable is measured in the previous year.

Our analysis only includes women who married in The Hague. It has been shown that migrant status is related to fertility control in urban settings (Alter 1988, p. 193). Hence, we included two dummy variables indicating birth in The Hague or Scheveningen, one for the woman and one for her husband.

Statistical methods

A discrete-time multi-level hazard model is used to assess the effects of the independent variables on the probability of giving birth (Barber et al 2000). On the first level we have years and on the second women. We estimated discrete-time hazard models using logistic regression (Efron 1988). This approach allows considerable flexibility in handling time-varying covariates, such as age and marital status, and censored observations (Allison 1982).

Event history models were initially developed in the health sciences. There, the canonical study is one of mortality. By contrast, the nature of fertility is that births are repeatable events. Because the focus of the present study is not any specific birth interval but rather fertility levels in general, birth intervals were pooled, turning the model into a repeated-events duration model (Box-Steffensmeier and Zorn 2002). The use of logistic regression to estimate the repeated events history model effectively turns our analysis into a binary time-series-cross-section analysis, in which we pool binary time-series for women. This type of analysis is a convenient way to model age, period and cohort effects (Raftery et al. 1995). Researchers typically analyze time-series-cross-section data with a binary dependent variable assuming temporal independence. However, observations in a time-series are likely to be temporally dependent, and ignoring this may have misleading results. Following Beck et al. (1998) the solution adopted here is to add the number of years since the previous event (length of the birth interval). Random effects were added to control for unobserved heterogeneity between women (Amemiya 1985, pp. 348-352; Yamaguchi 1986). MIXNO was used to estimate the coefficients (Hedeker 1999).

Since we do not censor intervals – after five years, for example – but follow all married women, including infertile ones, until the end of their marriage, age fifty, or the end of the period (1910), whatever comes first, last intervals can be quite long. Moreover, unlike deaths, births cannot occur every month. Hence, we opted for annual intervals rather than monthly intervals. The model, therefore, assumes that the hazard for a birth is constant within annual intervals, but is otherwise unconstrained. There is some chance that a woman will have two births in a calendar year. However, we counted less than 0.5 per cent of second and higher-order births during the same calendar year as the previous birth. Another problem is the inclusion of women who never gave birth or 'long-term survivors'. McDonald and Rosina (2001) proposed the use of mixture models to solve this problem. In historical populations, however, this problem is likely to be much less severe, because the number of years contributed by these women is much smaller than in modern populations. The dependent variable in the model is the log odds of a woman giving birth in a specific calendar year.

Disentangling the distinct effects of age, period and cohort involves a methodological problem, because the three are perfectly correlated. Mason et al. (1973) point out that the identification problem can be solved by imposing equality constraints on categories of age, period and/or cohort. One criticism of this method is that estimates of model effect coefficients are sensitive to the arbitrary choice of the identifying constraint. Another solution is to parameterize the effect of age on the dependent variables as a quadratic or cubic function (Raftery et al. 1995). The use of a polynomial also has its drawbacks, however. It may lessen the rigorousness of the control for the age effects on cohort differences (O'Brien 2000, p. 125). In order to minimize this problem, we used a third-degree polynomial of age to model the relation between age and marital fertility. We did not find examples of the representation of age as a cubic function in age-period-cohort models of fertility, but this solution has been used before in epidemiological research (e.g. Rosén and Haglund 2006). A comparison of goodness of fit statistics for a model that includes age as a cubic function with those for a model that uses equality constraints on categories of age, period and cohort indicates that replacing age categories with a third-degree polynomial of age does not lessen the rigorousness of the control for the age effects on cohort differences to any large extent (result not shown).

Period effects are measured by seven five-year period dummies indicating whether the current year is in the period 1870-74, 1875-79, 1885-89, 1890-94, 1895-99, 1900-04 or 1905-09 – 1880-84 being the reference category. Cohort effects are measured by nine cohort dummies indicating whether the woman was born in 1840-44, 1845-49, 1850-54, 1855-59, 1860-64, 1865-69, 1870-74, 1875-79, or after 1879 – the pre-1840 birth cohort being the reference category.

Results

Figure 1 presents the total marital fertility rate (TMFR) above age 20 – the sum of the age-specific marital fertility rates per 1000 women, multiplied by five and divided by 1000, when age is given in five-year age groups – for each five year period. Marital fertility in The Hague seems to have started its decline in the 1890s. As the statistical models below will show marital fertility in 1890-94 was significantly lower than that in the 1880s.

[Figure 1 about here]

Table 2 presents three models of the decline in marital fertility. Coefficients are presented as odds ratios or exponents of the raw logistic coefficients. The odds ratios are multiplicative effects on the odds of giving birth in any one-year interval. A coefficient of 1.00 represents no effect, a coefficient greater than 1.00 represents a positive effect, and a coefficient less than 1.00 represents a negative effect on the odds. Table 1 presents descriptive statistics of the variables used in the analysis.

[Tables 1 and 2 about here]

The first model is an age-period model. The period effects show that marital fertility reached its highest level in the 1880s and started its decline in the first half of the 1890s. If cohorts tend to be marked for life by the ideas prevalent in their youth and if fertility decline were due to attitudinal change then there should be cohort influences. In an age-cohort model women born after 1860 have a significantly lower level of fertility than earlier cohorts (result not shown). The second model adds cohort dummies to determine the extent to which they attenuate the period effects. In the age-period-cohort model, however, only two cohort effects – 1845-49 and 1860-64 – remain that are significant at five percent in a one-sided test. Moreover, cohort dummies only attenuate the period effects to a limited extent. Marital fertility decline is mostly a period effect. Thus we reject the hypothesis that marital fertility decline in The Hague is the *delayed* effect of a change in attitudes that occurred in adolescence or early adulthood. Previous empirical studies suggest that secularization is most likely a cohort effect. If this conclusion is valid then secularization is unlikely to have been a major driving force in marital fertility decline in The Hague.

According to Livi-Bacci (1986) attitudinal change was often initiated by the elite. Hence, we experimented with interactions between social status and the period dummies to test the hypothesis that the elite were social-group forerunners. None of the interactions, however, was significant (results not shown). Livi-Bacci (1986) also argued that Jewish communities may have been forerunners of fertility control. Schellekens and Van Poppel (2006), however, have already shown that Jews in The Hague were not forerunners.

Since very few people in the nineteenth century would have received any education beyond adolescence, the level of education would have been mostly fixed by early adulthood. Hence, a rise in education is likely to be a cohort effect (Alwin 1996, p. 189). Since the age-period-cohort model shows that marital fertility decline is not a cohort effect, education of the mother is unlikely to have been a major driving force in marital fertility decline in The Hague.

The third model investigates to what extent marital fertility decline is due to structural change and mortality decline as measured at the household level. Both mortality variables have the expected positive effect. As expected Catholics have a significantly higher level of fertility. The social status variable shows the expected gradient, fertility declining as social status increases.

In general, studies of migration to urban areas in developing countries show that migrants tend to have higher fertility than natives (Kulu 2005). At least one study reported a similar finding for a historical population. Thus, Alter (1988) reports that migrants to the town of Verviers in Belgium show less evidence of fertility control than natives. After controlling for social status and mortality migrants to The Hague, however, seem to have lower fertility then non-migrants. A similar finding has been reported in a developing country. Macisco et al. (1970) found that migrants to metropolitan areas of Puerto Rico have lower fertility than do the urban natives. Controlling for the effects of educational attainment and occupational characteristics did not reduce substantially the difference in fertility between in-migrants and non-migrants in Puerto Rico. They speculated that migrants are more likely to view children as an obstacle to upward social mobility.

Although mortality, migrant status, social status and religion all have a significant effect on marital fertility, they do not attenuate the period effects to any large extent. Thus, the individual-level variables mostly explain the variance between households and only a small part of the marital fertility decline. A graphical comparison of the period effects in the first and third model makes the contribution of the explanatory variables to fertility decline more apparent. Figure 2 shows the limited extent to which these variables attenuate the period effects.

[Figure 2 about here]

If cohort replacement, structural change and mortality decline only attenuate period effects to a limited extent, what caused fertility to decline in The Hague? The timing of the onset of decline in 1890-94 may provide a clue. We searched in vain, however, for changes that occurred in 1890-94 that could account for the timing of the onset of marital fertility decline. A pre-decline rise in marital fertility, however, may obscure the timing of the onset of fertility control. At about the same time as the use of contraceptive methods becomes more widespread breastfeeding may decline

(Dyson and Murphy 1985). Thus, fertility control in The Hague may have started before the 1890s but this decline may be obscured by a simultaneous decline in breastfeeding, for example. To investigate this issue, we estimated a measure of fertility control – the singulate mean age at last birth (SMALB) – from proportions of women who had stopped childbearing by age in each period using a method borrowed from Hajnal (1953).[2] Figure 3 presents estimates of SMALB and compares them with TMFR above age 20. If SMALB is any indication, then fertility control in The Hague started about a decade before marital fertility decline, in 1880-84. Initially, trends in both series diverge, but after a decade, starting in 1890-94, trends in both series are almost indistinguishable.

[Figure 3 about here]

In the 1880s there was a large increase in the standards of living in the Netherlands. Standards of living may influence marital fertility in different ways, depending on the proximate determinant. On the one hand, an increase in living standards may cause a decline in breastfeeding, for example, as living standards may have improved parents' ability to acquire breast-milk substitutes (Schellekens 2001). On the other hand, an increase in living standards may lead to family limitation. Figure 1 compares trends in TMFR with those in an estimate of real income per capita at the national level. Real income per capita and marital fertility both increased in the 1880s. Thus the pre-decline rise in marital fertility could be due to the increasing ability of parents to acquire breast-milk substitutes. Figure 4 compares SMALB with real income per capita and shows that both changed at about the same time suggesting that the timing of the onset of marital fertility decline is somehow linked to the increase in living standards.

[Figure 4 about here]

Conclusion and discussion

Using macro-level data from Germany Richards (1977), Galloway et al. (1994) and Brown and Guinnane (2002) have shown that the EJP downplayed the role of social and economic development. Thus, they reject pure versions of the innovation model. Blended models often assume a delay between social and economic change and marital fertility decline. Once the structural conditions are right, marital fertility decline is inevitable but its timing may be lagged due to the pace of attitudinal change. Lesthaeghe and Surkyn (1988) proposed cohort replacement as a possible determinant of the pace of attitudinal change. Using individual-level data from the Netherlands the empirical results of this study suggest that marital fertility decline in The Hague was a period effect and not a cohort effect, provided that the time period we used – 1870-1909 – is long enough. One of the few previous studies to present an age-period-cohort model of marital fertility decline reported a similar finding for a developing country (Raftery et al. 1995). Of course, the absence of cohort influences does not necessarily imply that marital fertility decline was simply an adjustment to social and economic change and not due to attitudinal change. It does seem to indicate, however, that marital fertility decline in The Hague was not the *delayed* effect of a change in attitudes that occurred early in life in response to social and economic change in society at that time.

The literature on ideational theory relates innovative thinking about childbearing to secularization. In classical statements of ideational theory, "both the idea of marital birth control and its material manifestations encounter resistance of a largely cultural or religious nature that condition the timing and speed of adoption" (Cleland 2001, p. 46). If secularization is indeed a cohort effect, as recent research seems to suggest, then the role of secularization needs rethinking and greater weight ought perhaps to be given to attitudinal change that is more likely to be a period effect, such as a change in ideas about the costs and benefits of children.

Age-period-cohort models may also provide an indirect test of other kinds of cohort influences. If the level of education is largely determined by early adulthood remaining more or less constant for the rest of the life cycle, then the absence of significant cohort effects suggests that an increase in the education of the mother does not explain the change in their reproductive behaviour. Neither do several other variables that are emphasized by Demographic Transition Theory as basic causes of fertility decline seem to have contributed much. Infant and childhood mortality and socio-economic status as measured at the household level do not attenuate the effects of the period dummies to any large extent.

Galloway et al. (1994) count a reduction in infant mortality and an improvement in education among the forces that drove fertility decline in nineteenth-century Prussia. Our results are not necessarily inconsistent with theirs. First, even if an improvement in the education of women does not account for marital fertility decline to any large extent, this does not exclude the possibility of the education of children influencing the reproductive behaviour of their parents. Second, infant mortality measured at the level of the Prussian *Kreis* may be a proxy for social and economic change. The near simultaneity of the timing of the onset of family limitation and a rise in living standards suggests that marital fertility decline in The Hague was a response to social and economic change.

These were the days of the second Industrial Revolution, which is usually dated between 1870 and 1914. Trends in the standard of living in Holland and elsewhere in Western Europe had risen before in the past, mostly, without triggering a marital fertility decline. It was only after 1870, however, that the standard of living in the industrialized parts of Western Europe for the first time rose noticeably above the relatively high late-medieval levels (Allen 2001).

In a large number of countries the relationship between development and the timing of the onset of fertility declines deviates substantially from what would be the case if fertility and development were closely linked (Bongaarts and Watkins 1996). In The Hague there was also a delay between the timing of the onset of marital fertility decline and development as measured by a rise in living standards. There is no need to resort to the diffusion of ideas, however, to explain the delay. When a measure for family limitation is substituted for that of marital fertility, there remains no evidence for a delayed response to development. We suspect that a simultaneous decline in breastfeeding initially obscured the effect of family limitation on marital fertility.

The conventional wisdom until fairly recently was that cohort measures of fertility are superior to period measures because they tap the life experiences of a real group that lives through a particular era of history together. Much fertility research, however, has tended to rely on period measures, such as the total fertility rate, because of the nature of the available data (Hirschman 1994). Bongaarts and Feeney (1998) proposed to solve this dilemma by the development of an adjusted version of the total fertility rate that is free of so-called tempo effects – distortions due to changes in the timing of births. But not all agree with the conventional wisdom concerning the relative value of cohort and period measures. Ní Bhrolcháin (1992) has questioned the value of the cohort approach in fertility studies. A key purpose of fertility measures is to describe change over time in fertility and to examine the causes of such change. So far, empirical studies of fertility decline, including this one, indicate that period influences tend to be more powerful than cohort influences, suggesting that when examining the causes of fertility decline, period measures may be more informative (Pullum 1980; Foster 1990; Hsueh and Anderton 1990; Raftery et al. 1995; Krull 2000).

Notes

1. If most illegitimate births were the result of a pregnancy in the anticipation of marriage, then these could only have been prevented by an abortion. The results of an analysis of the decline in nineteenth-century England suggest that a change in the knowledge and acceptability of contraception is not among the major explanations of illegitimate fertility decline (Schellekens 1995).
2. The sample does not contain any women born after 1890. Hence, our analysis of marital fertility ends in 1909. Married women in the sample, however, were followed until 1939 enabling us to compute age at last birth even for the youngest woman. Due to migration and death of the woman or that of her husband before she reached age 50 we lost more than a third of the woman-years in our sample. Women who never gave birth were also excluded leaving only 18,814 woman-years or 56 percent of the sample for the computation of SMALB. In an age-period-cohort model of age at last birth in a sample of 777 women there were no significant period or cohort effects (result not shown).

References

Allen, Robert C. 2001. The Great Divergence in European Wages and Prices from the Middle Ages to the First World War, *Explorations in Economic History* 38**:** 411–447.

Allison, Paul D. 1982. Discrete-time methods for the analysis of event histories, *Sociological Methodology* 13: 61-98.

Alter, George. 1988. *Family and the Female Life Course: The Women of Verviers, Belgium, 1849-1880*. Madison: The University of Wisconsin Press.

Alwin, Duane F., and Jon A. Krosnick. 1991. Aging, cohorts, and the stability of sociopolitical orientations over the life span, *The American Journal of Sociology* 97 (1): 169-195.

Alwin, Duane F. 1996. From childbearing to childrearing: The link between declines in fertility and changes in the socialization of children, *Population and Development Review*, 22 (Supplement: Fertility in the United States: New Patterns, New Theories): 176-196.

Amemiya, Takeshi. 1985. *Advanced Econometrics*. Cambridge, MA: Harvard University Press.

Argue, Amy, David R. Johnson and Lynn K. White. 1999. Age and religiosity: evidence from a three-wave panel analysis, *Journal for the Scientific Study of Religion* 38 (3): 423-435.

Barber, Jennifer S., Susan A. Murphy, William G. Axinn, and Jerry Maples. 2000. Discrete-time multilevel hazard analysis, *Sociological Methodology* 30: 201-235.

Beck, Nathaniel, Jonathan N. Katz, and Richard Tucker. 1998. Taking time seriously: Time-series-cross-section analysis with a binary dependent variable, *American Journal of Political Science* 42 (4): 1260-1288.

Bongaarts, John, and Griffith Feeney. 1998. On the quantum and tempo of fertility, *Population and Development Review* 24 (2): 271-291.

Bongaarts, John, and Susan Cotts Watkins. 1996. Social interactions and contemporary fertility transitions, *Population and Development Review* 22 (4): 639-682.

Box-Steffensmeier, Janet M., and Christopher Zorn. 2002. Duration models for repeated events, *The Journal of Politics* 64 (4): 1069-1094.

Brewster, Karin L., and Irene Padavic. 2000. Change in gender-ideology, 1977–1996: The contributions of intracohort change and population turnover, *Journal of Marriage and Family* 62 (2): 477-487.

Brinkman, H. J., J. W. Drukker and B. Slot. 1988. Height and income: A new method for the estimation of historical national account series. *Explorations in Economic History* 25: 227-264.

Brooks, Clem, and Catherine Bolzendahl. 2004. The transformation of US gender role attitudes: cohort replacement, social-structural change, and ideological learning, *Social Science Research* 33: 106-133.

Brown, John C., and Timothy W. Guinnane. 2002. Fertility transition in a rural, Catholic population: Bavaria, 1880-1910, *Population Studies* 56 (1): 35-50.

Caldwell, J. C. 1982. *Theory of Fertility Decline*. London: Academic Press.

Carlsson, G. 1966. The decline of fertility: Innovation or adjustment process? *Population Studies* 20 (2): 149-174.

Casterline, John B. 2001. Diffusion processes and fertility transition: Introduction, in John B. Casterline (ed.), *Diffusion Processes and Fertility Decline: Selected Perspectives*. Washington, D. C.: National Academy Press, pp. 1-38.

Chaves, Mark. 1989. Secularization *and* religious revival: Evidence from U.S. church attendance rates, 1972-1986, *Journal for the Scientific Study of Religion* 28 (4): 464-477.

Ciabattari, Teresa. 2001. Changes in men's conservative gender ideologies, *Gender and Society* 15 (4): 574-591.

Cleland, J. 2001. Potatoes and pills: An overview of innovation-diffusion contributions to explanations of fertility decline, in John B. Casterline (ed.), *Diffusion Processes and Fertility Decline: Selected Perspectives*. Washington, D. C.: National Academy Press, pp. 39-65.

Cleland, John, and Chris Wilson. 1987. Demand theories of the fertility transition: An iconoclastic view, *Population Studies* 41 (1): 5-30.

Dyson, Tim, and Mike Murphy. 1985. The onset of fertility transition, *Population and Development Review* 11 (3): 399-440.

Efron, Bradley. 1988. Logistic regression, survival analysis, and the Kaplan-Meier curve, *Journal of the American Statistical Association* 83 (402): 414-425.

Firebaugh, Glenn, and Kevin Chen. 1995. Vote turnout of nineteenth amendment women: The enduring effect of disenfranchisement, *The American Journal of Sociology* 100 (4): 972-996.

Foster, Andrew. 1990. Cohort analysis and demographic translation: A comparative study of recent trends in age specific fertility rates from Europe and North America, *Population Studies* 44 (2): 287-315.

Galloway, Patrick R., Eugene A. Hammel and Ronald D. Lee. 1994. Fertility decline in Prussia, 1875-1910: A pooled cross-section time series analysis, *Population Studies* 48 (1): 135-158.

Hacker, J. David. 1999. Child naming, religion, and the decline of marital fertility in nineteenth-century America, *The History of the Family* 4 (3): 339-365.

Hajnal, John. 1953. Age at marriage and proportions marrying, *Population Studies*, 7 (2): 111-136.

Hedeker, Donald. 1999. MIXNO: A computer program for mixed-effects nominal logistic regression, *Journal of Statistical Software* 4(5): 1-92.

Hirschman, Charles. 1994. Why fertility declines? *Annual Review of Sociology* 20: 203-233.

Hobcraft, John, Jane Menken and Samuel Preston. 1992. Age, period, and cohort effects in demography: A review, *Population Index* 48 (1): 4-43.

Hsueh, Yung-Chang, and Douglas L. Anderton. 1990. Temporal dimensions of the fertility transition: An age-period-cohort analysis of frontier fertility, *Sociological Perspectives* 33 (4): 447-464.

Janssens, Jacqueline. 1994. *Family and Social Change: The Household as a Process in an Industrializing Community*. Cambridge: Cambridge University Press.

Knodel, John, and Etienne van de Walle. 1986. Lessons from the past: Policy implications of historical fertility studies, in Ansley J. Coale and Susan Cotts Watkins (eds.), *The Decline of Fertility in Europe*. Princeton: Princeton University Press, pp 390-419.

Krull, C. 2000. Fertility change in Quebec: 1931-1991, *Canadian Studies in Population* 27: 159-181.

Kulu, Hill. 2005. Migration and fertility: Competing hypotheses re-examined, *European Journal of Population* 21 (1): 51-87.

Lesthaeghe, Ron. 1983. A century of demographic and cultural change in Western Europe: An explanation of underlying dimensions. *Population and Development Review* 9 (3): 411–35.

Lesthaeghe, Ron, and Johan Surkyn. 1988. Cultural dynamics and economic theories of fertility change, *Population and Development Review* 14 (1): 1-45.

Lesthaeghe, Ron, and Chris Wilson. 1986. Modes of production, secularization, and the pace of the fertility decline in Western Europe, 1870-1930, in Ansley J. Coale and Susan Cotts Watkins (eds.), *The Decline of Fertility in Europe*. Princeton: Princeton University Press, pp 261-292.

Livi-Bacci, Massimo. 1986. Social-group forerunners of fertility control in Europe, in Ansley J. Coale and Susan Cotts Watkins (eds.), *The Decline of Fertility in Europe*. Princeton: Princeton University Press, pp. 182-200.

Macisco, John J., Leon F. Bouvier, and Robert H. Weller. 1970. The effect of labor force participation on the relation between migration status and fertility in San Juan, Puerto Rico, *The Milbank Memorial Fund Quarterly* 48 (1): 51-70.

Macunovich, Diane J. 2000. Relative cohort size: Source of a unifying theory of global fertility transition? *Population and Development Review* 26 (2): 235-61.

Mason, Karen Oppenheim, and Yu-Hsia Lu. 1988. Women's familial roles: Changes in the United States, 1977-1985, *Gender and Society* 2 (1): 39-57.

Mason, Karen O., W. M. Mason, H. H. Winsborough and W. Kenneth Poole. 1973. Some methodological issues in cohort analysis of archival data, *American Sociological Review* 38 (2): 242-258.

McDonald, John W., and Alessandro Rosina. 2001. Mixture modelling of recurrent event times with long-term survivors: Analysis of Hutterite birth intervals, *Statistical Methods and Applications* 10: 257-272.

McKeown, Thomas, and R. G. Record. 1962. Reasons for the decline of mortality in England and Wales during the nineteenth century, *Population Studies* 16 (2): 94-122.

Montgomery, M. R., and J. B. Casterline. 1996. Social learning, social influence and new models of fertility, *Population and Development Review* 22: S151-S175.

Ní Bhrolcháin, Máire. 1992. Period paramount? A critique of the cohort approach to fertility, *Population and Development Review* 18 (4): 599-629.

O'Brien, Robert M. 2000. Age period cohort characteristic models, *Social Science Research* 29: 123-139.

Palloni, Alberto. 2001. Diffusion in sociological analysis, in John B. Casterline (ed.), *Diffusion Processes and Fertility Decline: Selected Perspectives*. Washington, D. C.: National Academy Press, pp. 66-114.

Pampel, Fred C. 1993. Relative cohort size and fertility: The socio-political context of the Easterlin effect, *American Sociological Review* 58 (4): 496-514.

Pullum, Thomas W. 1980. Separating age, period, and cohort effects in White U.S. fertility, 1920-1970, *Social Science Research* 9 (3): 225-244.

Raftery, Adrian E., Steven M. Lewis, and Akbar Aghajanian. 1995. Demand or ideation? Evidence from the Iranian marital fertility decline, *Demography* 32 (2): 159-82.

Richards, Toni. 1977. Fertility decline in Germany: An econometric appraisal, *Population Studies* 31 (3): 537-553.

Rosén, Måns, and& Bengt Haglund. 2006. Trends in alcohol-related mortality in Sweden 1969-2002: An age-period-cohort analysis, *Addiction* 101 (6): 835-840.

Ryder, Norman B. 1965. The cohort as a concept in the study of social change, *American Sociological Review* 30 (6): 843-861.

Schellekens, Jona. 1995. Illegitimate fertility decline in England, 1851-1911, *Journal of Family History* 20 (4): 365-377.

Schellekens, Jona. 2001. Economic change and infant mortality in England, 1580-1837, *Journal of Interdisciplinary History* 32 (1): 1-13.

Schellekens, Jona, and Frans van Poppel. 2006. Religious differentials in marital fertility in The Hague (Netherlands) 1860-1909, *Population Studies* 60 (1): 23-38.

Sears, David O., and Nicholas A. Valentino. 1997. Politics matters: Political events as catalysts for preadult socialization. *The American Political Science Review* 91 (1): 45-65.

Stokvis, P. R. D. 1987. *De Wording van Modern Den Haag: De Stad en Haar Bevolking van de Franse Tijd tot de Eerste Wereldoorlog*. Zwolle: Uitgeverij Waanders.

Te Grotenhuis, Manfred, and Peer Scheepers. 2001. Churches in Dutch: Causes of religious disaffiliation in the Netherlands, 1937-1995, *Journal for the Scientific Study of Religion* 40 (4): 591-606.

Tilley, James R. 2002. Political generations and partisanship in the UK, 1964-1997, *Journal of the Royal Statistical Society A* 165 (1): 121-135.

Tilley, James R. 2003. Secularization and aging in Britain: Does family formation cause greater religiosity? *Journal for the Scientific Study of Religion* 42 (2): 269-278.

Van de Putte, Bart, and Andrew Miles. A social classification scheme for historical occupational data: Partner selection and industrialism in Belgium and England, 1800-1918, *Historical Methods* 38 (2): 61-91.

Voas, David, and Alasdair Crockett. 2005. Religion in Britain: Neither believing nor belonging, *Sociology* 39 (1): 11-28.

Watkins, Susan Cotts. 1987. The Fertility Transition: Europe and the Third World compared, *Sociological Forum* 2 (4): 645-673.

Yamaguchi, Kazuo. 1986. Alternative approaches to unobserved heterogeneity in the analysis of repeatable events, *Sociological Methodology* 16: 213-49.

Table 1. Descriptive statistics for variables used in the analysis.

Variable	Mean*	Stand. Dev.
Birth in year *t*	0.227	-
Age (years)	34.98	7.37
Age squared / 100	12.79	5.23
Age cubed / 1000	48.56	28.92
First year of marriage	0.057	-
Marital duration (years)	9.47	6.76
Birth interval		
First year	0.227	-
Second year	0.184	-
Third year	0.097	-
Fourth year	0.065	-
Fifth year	0.051	-
Period		
1870-74	0.063	-
1875-79	0.096	-
1880-84 (ref.)	0.120	-
1885-89	0.138	-
1890-94	0.151	-
1895-99	0.152	-
1900-04	0.153	-
1905-09	0.127	-
Cohort		
<1840 (ref.)	0.087	-
1840-44	0.085	-
1845-49	0.113	-
1850-54	0.131	-
1855-59	0.136	-
1860-64	0.173	-
1865-69	0.129	-
1870-74	0.090	-
1875-79	0.048	-
1880+	0.008	-
Mortality		
Infant death in *t*-1	0.039	-
Child mortality in *t*-1	0.148	-
Place of birth		
Woman from The Hague	0.598	-
Husband from The Hague	0.600	-
SOCPO		
1 (ref.)	0.084	-
2	0.194	-
3	0.370	-
4	0.203	-
5	0.038	-
Unknown	0.111	-
Religion		
Dutch reformed (ref.)	0.626	-
Catholic	0.320	-
Other	0.054	-
Number of women	2,337	
Woman years	33,814	

Note: * means of woman-years.

Table 2. Discrete-time event history analysis of births.

Variable	Model 1		Model 2		Model 3	
	e^b	*p*-value	e^b	*p*-value	e^b	*p*-value
Age	0.438	0.000	0.432	0.000	0.437	0.000
Age squared / 100	13.386	0.000	13.738	0.000	13.451	0.000
Age cubed / 1000	0.743	0.000	0.740	0.000	0.743	0.000
First year of marriage	0.284	0.000	0.285	0.000	0.287	0.000
Marital duration	0.964	0.000	0.966	0.000	0.950	0.000
Birth interval						
First year	0.458	0.000	0.457	0.000	0.383	0.000
Second year	2.050	0.000	2.043	0.000	1.860	0.000
Third year	1.878	0.000	1.871	0.000	1.806	0.000
Fourth year	1.051	0.528	1.049	0.548	1.018	0.825
Fifth year	0.883	0.199	0.882	0.199	0.862	0.129
Period						
1870-74	0.785	0.001	0.717	0.006	0.710	0.004
1875-79	0.761	0.000	0.727	0.000	0.726	0.000
1880-84	1.000	-	1.000	-	1.000	-
1885-89	1.049	0.419	1.097	0.221	1.076	0.332
1890-94	0.860	0.013	0.927	0.492	0.905	0.365
1895-99	0.725	0.000	0.791	0.130	0.781	0.110
1900-04	0.639	0.000	0.700	0.076	0.697	0.072
1905-09	0.504	0.000	0.558	0.018	0.569	0.023
Cohort						
<1840			1.000	-	1.000	-
1840-44			0.834	0.264	0.923	0.615
1845-49			0.738	0.088	0.772	0.141
1850-54			0.831	0.381	0.936	0.749
1855-59			0.703	0.152	0.781	0.315
1860-64			0.613	0.084	0.717	0.239
1865-69			0.668	0.218	0.819	0.540
1870-74			0.795	0.538	0.916	0.811
1875-79			0.807	0.608	0.960	0.921
1880+			0.601	0.337	0.642	0.397
Mortality						
Infant death in *t*-1					2.845	0.000
Child mortality					1.786	0.000
Place of birth						
Woman from The Hague					1.188	0.005
Husband from The Hague					1.180	0.007
SOCPO						
5					0.412	0.000
4					0.586	0.000
3					0.794	0.042
2					0.819	0.102
1					1.000	-
Unknown					0.377	0.000
Religion						
Dutch Reformed					1.000	-
Catholic					1.230	0.001
Other					0.660	0.000
Intercept	7837.303	0.000	12813.313	0.000	10032.348	0.000
S. D. random effect	1.166	0.000	1.161	0.000	1.089	0.000
-2Log likelihood	-14,806.954		-14,799.675		-14,570.451	

Figure 1. Total marital fertility rate (TMFR) above age 20 in The Hague and real income per capita in The Netherlands in 1900/10 Guilders.

Note: Scale of real income per capita is reversed.

Source: Sample from population registers; real income per capita from Brinkman et al. (1988).

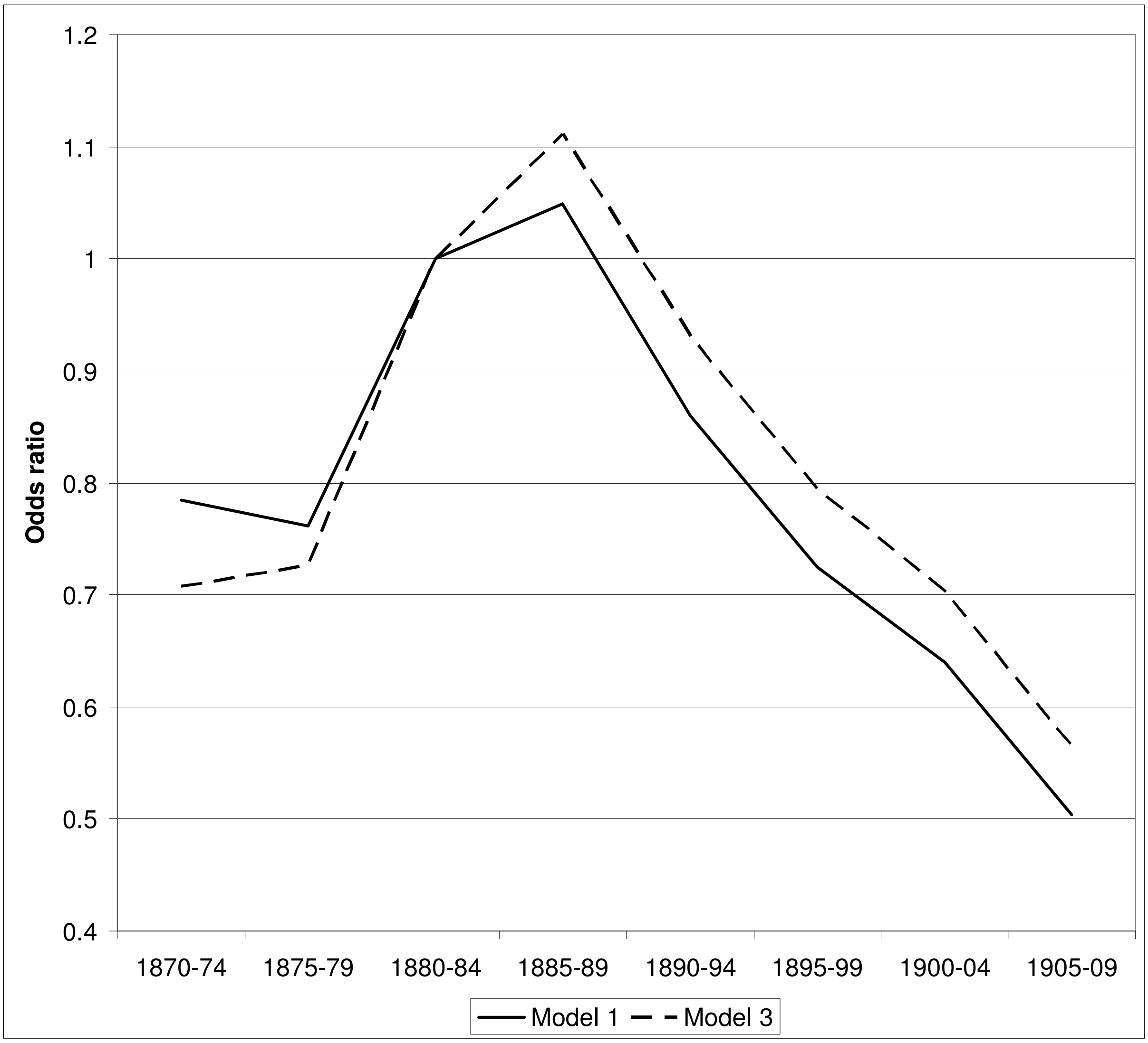

Figure 2. Odds ratios for period effects.

Source: Table 2.

Figure 3. Total marital fertility rate (TMFR) above age 20 and the singulate mean age at last birth (SMALB) in The Hague.

Source: Sample from population registers.

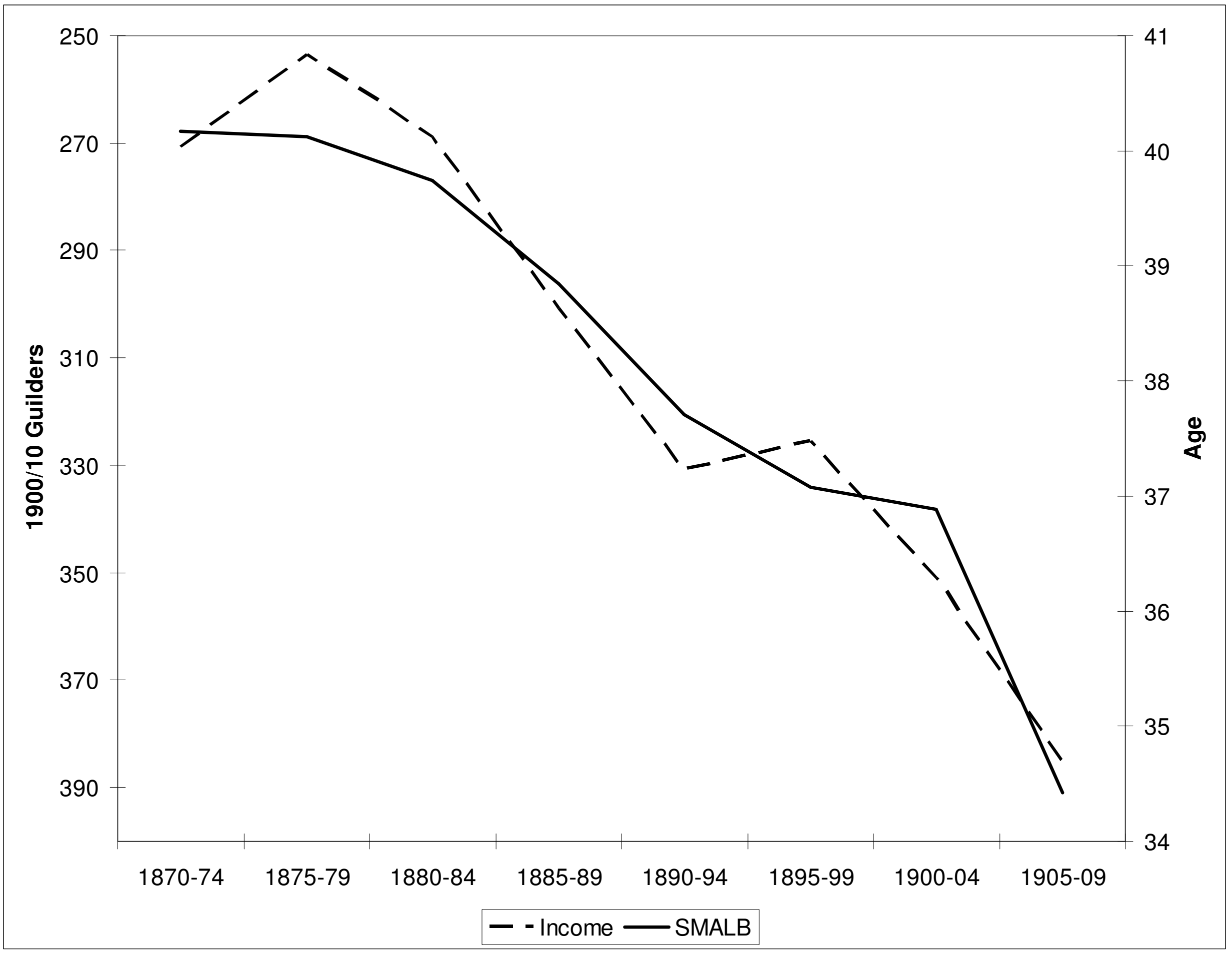

Figure 4. Singulate mean age at last birth (SMALB) in The Hague and real income per capita in The Netherlands in 1900/10 Guilders.

Note: Scale of real income per capita is reversed.

Source: Sample from population registers; real income per capita from Brinkman et al. (1988).