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# Microsimulation of Household and Marital Transitions Leading to Childlessness Among Dutch Women Born Between 1971 and 2000

**Michaël Boissonneault and Joop de Beer**

**ABSTRACT** After reaching historically low levels among the women born in the early 1940s, childlessness has been increasing in most Western countries among women born in the 1950s and 1960s. This increase took place as patterns of transition to adulthood have become increasingly late, protracted, and complex. Yet, it is precisely those women who enter a first relationship late, spend more time as single, and experience union instability who more often remain childless. This suggests that levels of childlessness will continue to increase as younger cohorts complete their childbearing histories. In this study, we use microsimulation to project the household and union formation histories of cohorts of Dutch women born between 1971 and 2000. Results suggest that childlessness will actually decrease among cohorts born between 1971 and 1983 and then increase among those born between 1984 and 2000. The decrease occurs as pathways of household and union formation become later, more protracted, and more complex, but also as cohabiting women start to exhibit a higher propensity to become mothers. The increase, on the other hand, occurs as pathways become somewhat less protracted and complex, but also as the propensity of cohabiting women to become mothers returns to previous levels and as age at leaving the parental home strongly rises. Childlessness levels appear to increasingly depend on the childbearing decisions of cohabiting couples and on age at leaving the parental home.

**KEYWORDS** Microsimulation • Population projection • Childlessness • Union formation • Transition to adulthood

## Introduction

Childlessness is the state of not being a parent of a child and it impacts societies through depressing total fertility, thereby contributing to population aging (Zeman et al. 2018). Older childless individuals are more at risk for adverse health and well-being outcomes because they are deprived of the care and support children traditionally provide (Bures et al. 2009; Dykstra and Hagestad 2007; Zhang and Hayward 2001). Female permanent biological childlessness (hereafter, levels of childlessness) can be computed as the proportion of women born in a given cohort who have not

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given birth to a child upon reaching the end of their reproductive life span, usually between ages 40 and 50 (te Velde et al. 2012). Estimated levels of childlessness in Western countries are currently available for cohorts born between the start of the twentieth century and the early 1970s. Trends in almost all countries have been following a U-shaped pattern, with prevalences of 20%–25% among cohorts born in the early 1900s, then decreasing to below 15% among those born in the 1940s, and increasing to 15%–20% among those born in the 1960s (Sobotka 2017).

The historically low levels of childlessness reached among women born in the 1940s coincided with the situation following the Second World War, when marriage occurred early and was nearly universal and the majority of births occurred within marriage (Van Bavel and Reher 2013). However, this situation dissipated in the 1970s as marital rates decreased and age at first marriage and nonmarital births increased (Sánchez-Barricarte 2018; Schellekens 2017), which coincided with increasing levels of childlessness among women who went through their reproductive years during this period. This new demographic regime led to the formulation of the second demographic transition theory (Lesthaeghe 2014; Lesthaeghe and Van de Kaa 1986), which predicted—in the context of secularization and the rise of postmodern values—a convergence among countries toward a situation in which household arrangements are more varied and less stable, and marriage is no longer necessary for childbearing.

Many of the facets predicted by the second demographic transition theory have received empirical support. According to data on women born between 1930 and 1979 in twenty-six European countries, Billari and Liefbroer (2010) identified a pattern of transition to adulthood that is increasingly late, protracted, and complex. It is late because young adults enter a first union at older ages, protracted because the time elapsed between leaving the parental home and establishing oneself in a specific household and union type has increased, and complex because it is composed of multiple and sometimes repeated transitions. There is also evidence that such a pattern of transition to adulthood results in higher levels of childlessness. Using the life course approach (Elder et al. 2003), studies have found that women who leave the parental home later, remain single, enter a first union later, and experience union disruptions are more likely to remain childless (Jalovaara and Fasang 2017; Keizer et al. 2008; Mynarska et al. 2015; Raab and Struffolino 2020; Saarela and Skirbekk 2020; Tanturri and Mencarini 2008). Thus, as partnerships are entered later and become less stable, levels of childlessness should increase among cohorts born from the 1970s onward.

However, other elements that characterize the new pattern of transition to adulthood could have the opposite effect. In countries where transitions out of the parental home occur earlier (Billari and Liefbroer 2010), more time is available for entering unions and starting a family. Meanwhile, the higher acceptability of nonmarital childbearing (Gubernskaya 2010; Pagnini and Rindfuss 1993) might allow for more fluid transitions into family formation. Importantly, levels of childlessness might increasingly depend on the family formation behaviors of cohabiting couples, the proportions of which have been increasing rapidly over the last decades (Kasearu and Kutsar 2011; Manning 2020).

This article aims to identify how household- and union-formation patterns are evolving among cohorts of Dutch women born between 1971 and 2000, and whether changes in these patterns will lead to lower or higher levels of childlessness. These aims will be pursued by estimating a Markov chain model that includes four household- and union-formation states and one family-formation state. Transitions between these states depend on parameters estimated from Dutch register data available for the period 1996–2017 and fed into a microsimulation model. To complete the partially observed household- and union-formation histories, parameters are projected into the past and future using state-of-the-art forecasting techniques (Bohk-Ewald et al. 2018; Myrskylä et al. 2013). The projected change in levels of childlessness is then analyzed by running alternate simulations, which allow us to isolate the effects of the changes in each transition in the model, artificially creating a context similar to a controlled experiment (Thomson et al. 2019; Thomson et al. 2012; Troitzsch et al. 1996).

In the next section, we rely on theory and empirical evidence to formulate hypotheses on how changes in household- and union-formation behavior might impact future levels of childlessness. Then, we describe the data, the estimation of the parametric models, the microsimulation procedure, and the projection method. The subsequent section presents the results from the microsimulation model and includes a description of household- and union-formation pathways for different cohorts, an overview of childlessness levels over the projection period, and an analysis of the impact of changes in household and union formation on intercohort levels of childlessness. In the final section, we discuss the results in view of the formulated hypotheses, some of their policy implications, and some of the limitations inherent to this study.

## Hypotheses

In this study, change concerning family formation is modeled by considering transitions between the states of living in the parental home, living alone, cohabiting with an unmarried partner, being married, and giving birth to a first child (see Figure 1).

We consider for convenience the transition between two demographic regimes. The first regime corresponds to the situation that prevailed until the 1960s in most Western countries, where marriage was early, was universal, and formed a prerequisite for family formation, and where levels of childlessness were low because married couples usually had children (Kirk 1996). In the Netherlands, this stage was reached among women born in the early 1940s, of which 95% were married and 90% gave birth to at least one child—the highest level ever recorded (Statistics Netherlands 2020b).

The second regime features high proportions of single women, a relatively low prevalence of marriage, and high rates of cohabitation. Unions are less stable, but marriage does not constitute a prerequisite for starting a family, and children are born in similar proportions to women who live alone or cohabit, either in a marital union or not. This situation would correspond more or less to the end stage of second demographic transitions (Lesthaeghe 2014). Important variation remains among countries as to where they stand with respect to this situation. In the Netherlands, ages at first marriage and at first birth increased substantially in the 1980s and 1990s (Fokkema et al. 2008); however, while marriage is increasingly forgone and cohabitation increasingly popular, first births continue to occur to a large degree inside of marriage, with very few occurring to single women (Andersson et al. 2017). In this respect, though the Netherlands has been considered a "model country" in the transition toward the demographic regime described by demographic transition theory (Sobotka 2008:121), it remains somewhat behind such countries as Sweden and Norway that themselves have not yet reached it in such a strict form (Zaidi and Morgan 2017). Thus, this second regime merely constitutes a hypothetical situation toward which we suppose countries—including the Netherlands—are converging.

Hypotheses are formulated concerning the intercohort changes in household- and union-formation patterns (sets 1 and 2) and concerning the impact of these changes on levels of childlessness (sets 3 and 4). We assume that changes across cohorts in household- and union-formation patterns and the resulting changes in levels of childlessness are the product of the transition between the two demographic regimes described earlier. We further assume that changes across cohorts in such patterns follow the increasingly late, protracted, and complex pattern of transition to adulthood identified by Billari and Liefbroer (2010). The underlying causes of these changes are the shift toward secularism, the pursuit of greater autonomy, and the increasing importance of self-realization (Lesthaeghe 2014).

Our first set of hypotheses concerns the age at leaving the parental home and at first union formation. From a life course perspective, these two events show a strong interconnection: entry into a first union necessarily follows leaving the parental home (Esteve et al. 2020). Age at leaving the parental home has been shown to increase during economic recessions (Aassve 2013). The literature also has paid attention to the effect of globalization and financial insecurity on age at leaving the parental home and propensity to return to it (Sironi and Furstenberg 2012; South and Lei 2015; Stone et al. 2014). Billari and Liefbroer (2010), on the other hand, assume that intercohort changes in the ages at leaving the parental home and at first union are mostly driven by the younger generation's growing desire for autonomy. This leads younger cohorts to leave the parental home early and enter a first union late. The natural consequence of these two evolutions is an increase in the time spent living alone. This corresponds to a late and protracted pattern of transition to adulthood, from which our first three hypotheses are inspired:

*Hypothesis 1a* (H1a): Ages at leaving the parental home and returning to it stay constant or decrease across cohorts, reducing the total time spent at the parental home.

*Hypothesis 1b* (H1b): Age at first union stays constant or increases across cohorts.

*Hypothesis 1c* (H1c): Time spent living alone increases across cohorts.

As societies become increasingly secular, marriage no longer forms a social obligation and is instead seen as a personal preference (Manting 1996). As a result of the decline of marriage, cohabiting unions become more prevalent; however, these are also less stable and result in increased union instability (Liefbroer and Dourleijn 2006). Union instability causes pathways to be more complex in the sense that the states of living at the parental home, living alone, and cohabiting are visited more often (Elzinga and Liefbroer 2007; Studer et al. 2018). This leads to our second set of hypotheses:

*Hypothesis 2a* (H2a): The share of people who marry before the birth of a first child decreases across cohorts.

*Hypothesis 2b* (H2b): Union instability—as evidenced by increases in the numbers of times that people visit the same states—increases across cohorts.

Our first set of hypotheses thus assumes increasingly late and protracted pathways of transition to adulthood, while our second set assumes increasingly complex ones. Each aspect of this new pattern of transition to adulthood is expected to have its own impact on levels of childlessness. First, later and more protracted pathways are assumed to lead to higher levels of childlessness. This is explained by the fact that fertility is biologically constrained among women and that capacity to conceive starts declining from around age 30 onward (te Velde et al. 2012). If women wait until older ages before they enter a first union, they run a greater risk of remaining childless owing to an inability to conceive, leading to the following hypothesis:

*Hypothesis 3a* (H3a): Late and protracted pathways lead to higher levels of childlessness.

Second, more complex transitions to adulthood entail more union disruptions. Union disruptions reduce the length of each cohabitation, effectively reducing opportunities to start a family (Bélanger et al. 2010). Furthermore, union disruption may point to a lack of commitment to a partnership, which is also important for starting a family (Hiekel and Castro-Martín 2014). In sum, it is expected that a more complex transition to adulthood—as evidenced by increases in the numbers of times people visit the same states—will lead to an increase in levels of childlessness:

*Hypothesis 3b* (H3b): Complex pathways lead to higher levels of childlessness.

Thus, the later, more protracted, and more complex the pattern of transition to adulthood is, the higher the level of childlessness will be, in general. This prediction focuses on household- and union-formation dynamics. Another important aspect is the childbearing decisions made among single women and couples. Childbearing outside of marriage has become widely accepted, and the Netherlands can be seen as a forerunner in this regard (Fokkema et al. 2008; Sobotka 2008). However, relationship stability is still seen as a prerequisite for family formation (Hiekel and Castro-Martín 2014). Also, children continue to be more likely to be born to women in cohabiting unions than to those who are single or living apart from their partner (Andersson et al. 2017; Kennedy and Bumpass 2008). Cohabiting couples who have children are more likely than those without children to marry at some point in their relationship (Perelli-Harris et al. 2012). This could be because of the fact that the decisions to marry and to start a family are both determined by the degree of commitment to a relationship (Baizán et al. 2003). In other words, a decrease in the popularity of marriage will not necessarily lead to a decrease in transitions to first birth if couples continue to be equally committed to each other (Sobotka and Toulemon 2008). The meaning that couples give to cohabitation is crucial (Hiekel et al. 2014). If couples tend to increasingly see cohabitation as a prelude to family formation (and eventually to marriage), then transitions to first births might increase. Conversely, if couples increasingly see cohabitation as a trial for subsequent family formation, then transitions to first births might decrease. While it remains unclear how couples' feelings about cohabitation might change, in light of the preceding discussion, we hypothesize that childbearing decisions among cohabiting couples will become increasingly important determinants of levels of childlessness:

*Hypothesis 4* (H4): Levels of childlessness depend increasingly on the decision of cohabiting women to start a family.

That is, given the increasingly late, protracted, and complex transition to adulthood, levels of childlessness will increase unless first-time childbearing among cohabiting women increases. Alternatively, if Hypotheses 1 and 2 do not hold true and transitions to first births become more prevalent among cohabiting women, levels of childlessness may decrease.

## Materials and Methods

### Data

To estimate transition probabilities between household and union statuses, we use Dutch register data supplied by Statistics Netherlands (van Duin et al. 2018). One advantage of these data is that their coverage of the Dutch population is excellent (higher than 98%, see Prins 2016), including among immigrants. The data contain aggregate numbers of persons living in the Netherlands between 1996 and 2017 broken down by age, year, and household and marital status; they also contain transition probabilities between each status. Household statuses include living at the parental home, living alone, cohabiting with a partner but without children, cohabiting with a partner and at least one child, cohabiting with at least one child but no partner, living in another type of household, and living in an institutional setting. Marital statuses include never married, married, widowed, and divorced. Probabilities correspond to the number of events of interest during a calendar year divided by the population at risk on the 31st of December of the preceding year, inside of each year of age.

### The Model

We estimate our model using a reduced number of states for parsimony. New transition probabilities were calculated by merging categories in the original database. Our specification includes living at the parental home (state 1), living alone and not married (state 2), cohabiting without children and not married (state 3), and married and living in any type of household without children (state 4) (Figure 1). Transitions into parenthood are measured on the basis of transitions into any household with a child (state 5) as the data do not include information on actual births. Transition rates into any household with a child compare well with transition rates to first birth at younger ages but tend to overestimate first births at older ages (i.e., above 35 years old or so), probably because transition rates into any household with a child capture older childless women who move in with a partner who has children from a previous union. To avoid overestimating births at older ages, we assume that the probability of making a transition from any state to state 5 tends toward zero past the modal age. This was realized by supposing that the probability of moving into a household with a child is equal to zero above age 40 when estimating the parametric models that describe the age-related probability of making a transition to first birth. This age was chosen as a threshold because it provides estimates of fertility that compare the best to those of vital statistics (Statistics Netherlands 2020a). The parametric models are elaborated upon in the next section. The correspondences between the states in the original data set and the states in our model are shown in Table A1 of the online Appendix 1.

States 1 to 4 are transient, while state 5 is absorbing. Our model has a total of 13 possible transitions. Transitions are allowed between all transient states and from

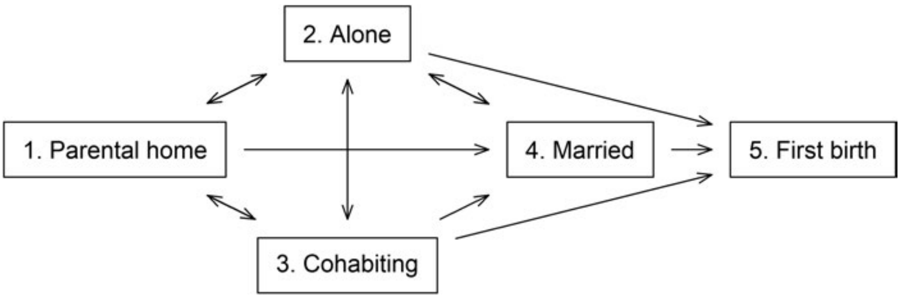


**Fig. 1** State space of household- and union-formation transitions leading to the birth of a first child. States 1 to 4 are transient, and state 5 is absorbing.

each transient state to first birth, except from married to cohabiting or living at the parental home and from living at the parental home to first birth, as these occur only rarely in the data and excluding them did not affect the results. Women enter the model at age 15 living at their parental home and exit upon giving birth for the first time or reaching age 42 childless. The lower age limit was chosen as very few events of interest occur before that age, while the upper one was chosen as less than 1% of all first births occur beyond that age (Sobotka 2017).

## Calculations

First, we parameterize the age-related change in transition probabilities following one of the three models (whichever fit the data best) proposed by Peristera and Kostaki to describe the heterogeneity of fertility schedules across Western countries (Peristera and Kostaki 2007). Models can be interpreted with regard to the modal age $\mu$ (i.e., the age at which the transition rate is the highest), the base level of the transition curve $c$ (i.e., the intensity of the transition), and the spread of the distribution $\sigma$. Models may include each of these terms twice to accommodate humps in the age-schedules, lending them the flexibility to fit not only fertility, but also such other age-related processes as household- and union-formation transitions. Separate models are fit to each year and transition's specific age-schedule. We estimate optimal fits using nonlinear, least-squares models employing a Gauss–Newton optimization algorithm (Bates and Watts 1987). Starting parameters are entered manually and kept constant throughout all years inside of each transition. To help models converge, the data are smoothed using loess regression with age as a predictor and a span of 0.12 (Cleveland and Devlin 1988).

Next, yearly change in the parameters obtained from the Peristera–Kostaki models is estimated inside of each transition following linear spline functions with knots at calendar time values 2001 and 2013 (Rogers 1986). These values correspond to five years after the first year covered by the data and five years before the last year covered by the data, respectively. This choice flows out from the projection method discussed in the next section. All calculations were performed in the R environment (R Core Team 2013). The online Appendix 2 provides a full definition of the Peristera–Kostaki and linear spline models, while Appendix 3 provides a complete overview of the estimated parameters.

## Projection

Transitions between states follow functions that depend on both age and calendar time and are determined by the Peristera–Kostaki and linear splines models described earlier. Parameters of the Peristera–Kostaki models before 1996 and after 2017 are determined by extrapolating until 1991 (“backcast”) and 2022 (forecast) the values predicted by the linear spline functions and by keeping them constant beyond those years. Parameters are thus projected five years into the future (or into the past concerning the backcast) on the basis of the last five years of observation (or first five years concerning the backcast). This “baseline” method is preferred as it has been shown to provide equally good or better predictions than other forecasting methods of cohort fertility (Bohk-Ewald et al. 2018; Myrskylä et al. 2013). We nevertheless assess the results’ sensitivity by relying on two other projection methods. The first consists of keeping the parameters’ values at their 2018 levels from this year onward (i.e., “freeze” method), while the second consists in extrapolating the values predicted by the linear spline function until the last year of projection (i.e., “unlimited” method). In addition, we supplement our results with the projection made by Statistics Netherlands, which is based on a continuation (and eventual stabilization) of the current fertility intensity and mean age at first birth (Stoeldraijer et al. 2017). In sum, parameters are fitted to data observed during a 22-year period (including the years 1996–2017) and extended 10 years into the past and 25 years into the future. Thus, the whole estimation period comprises the years 1986–2042, which are the years in which the 1971 cohort turned 15 years old and the 2000 cohort will turn 42, respectively. The projection is based on the observed trends in age-specific transition probabilities across years of calendar time (rather than across years of birth), which allows us to make a more optimal use of the data (see Lexis diagram in Figure 2).

## Analyses

We estimate cohort-specific childlessness levels using microsimulation. This technique allows us to easily assess the sensitivity of the results to alternate specifications, a feature that we exploit when assessing the impact of changes in household- and union-formation patterns over time on intercohort changes in levels of childlessness. Models are estimated using the R package MicSim, a continuous-time microsimulation model designed for modeling demographic events (Zinn 2014). This package was chosen because it is freely available and its use does not require high prior knowledge or skills. The model takes as input a transition matrix, where each transition in the matrix follows previously defined parametric models. These parametric models are, in turn, allowed to depend on age, calendar time, and duration, or on any combination thereof. As explained earlier and because of our use of aggregate data, we specify each transition along age and calendar time only.

Results are computed with respect to birth cohort. Birth cohorts are randomly assigned inside the specified interval to each simulated individual. Separate simulations were run based on each projection scenario (baseline, freeze, and unlimited). Further simulations were run to assess the impact of change over time in each transition on intercohort change in levels of childlessness. More specifically, let the transition matrix $\mathbf{A}_{ij}$ capture all 13 possible transitions in the model. These transitions depend on

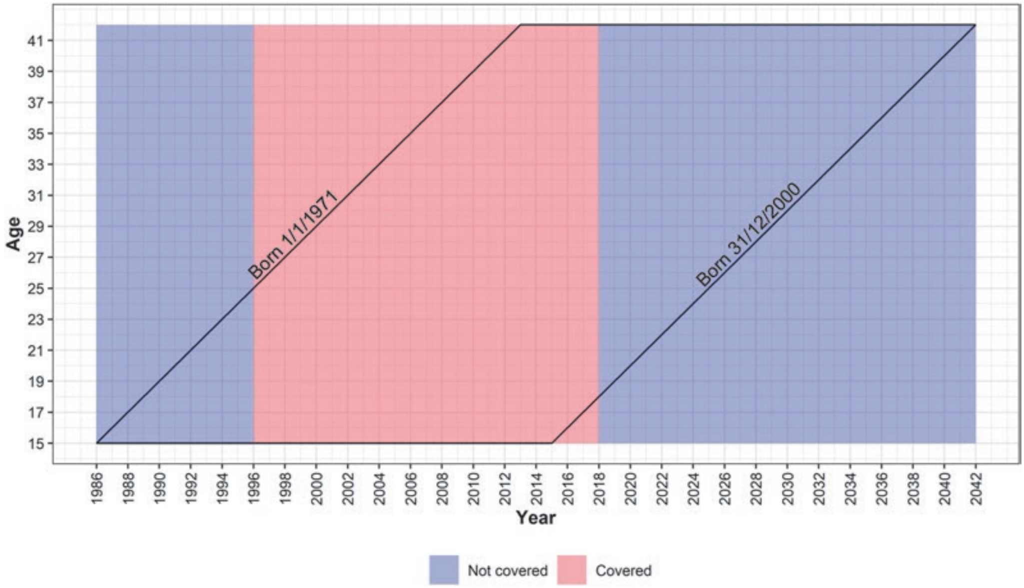


**Fig. 2** Lexis diagram showing the years covered by the data and the cohorts of interest, which fall within the parallelogram delimited by black lines

continuous measures of age $x$ and calendar time $t$, where $x$ takes any value between 15 and 42, and $t$ takes any value between 1986 and 2042. For each transition of interest $ij$, an alternate simulation is performed where $t = 1971 + x$ for this specific transition, while all other transitions are simply defined along $t$. In other words, transition $ij$ describes the life course of the 1971 cohort, while all other transitions describe the life course of each successive cohort. We interpret the difference in cohort-specific levels of childlessness between the baseline projection and each alternate projection as the effect of change over time in each transition on intercohort change in levels of childlessness.

To assess the variance associated with the Monte Carlo component of the microsimulation model, we perform separate simulations with each time for 100,000 simulated individuals. Results are computed additively and compared across samples with increasing sizes, until the point where the total number of simulated individuals reaches three million. The difference between each additional run in the proportion of childless women is computed for each cohort. This difference remained below 0.001 for all cohorts from the nineteenth run onward—that is, after the number of simulated individuals had reached 1.9 million. Using three million simulated cases should thus prove robust against random fluctuations.

## Results

This section concentrates on the results from the microsimulation model; for information on the parameters estimated from the Peristera–Kostaki and linear splines models, see the online Appendix 3.

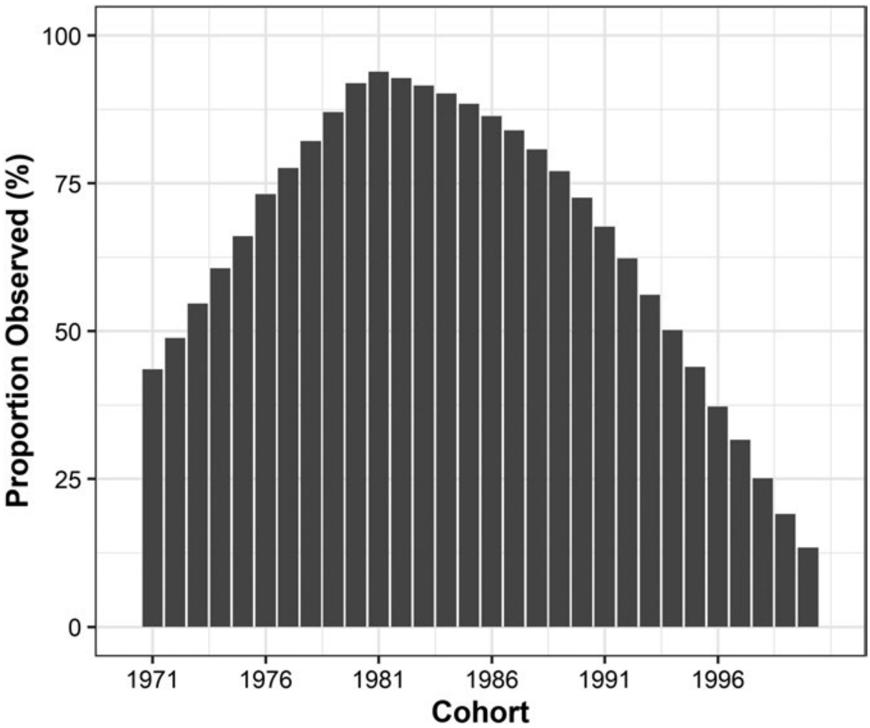


**Fig. 3** Percentage of simulated life courses that take place during the years covered by the data. Percentages are calculated as the number of person-years that are simulated during the period covered divided by the total number of simulated person-years.

## Model Coverage and Fit

Figure 3 shows for each simulated cohort the percentage of the simulated life course that develops during the period for which data are available—that is, the proportion that is "observed" rather than projected. Proportions are calculated as the number of years between age 15 and first birth or age 42 that take place in the simulation between the 1st of January 1996 and the 31st of December 2017, divided by the total number of simulated person-years, inside of each cohort.

Proportions observed are above 90% among the cohorts born in the early 1980s. These cohorts enter the model around 1996 (i.e., when the data start being available) and exit mostly before 2018 (i.e., when the data stop being available). Proportions observed are lower among the cohorts born earlier, making "backcasting" necessary for completing the part of their life course before 1996. On the other hand, the simulation increasingly relies on forecasting for the cohorts born in later years, as proportions observed decline gradually to reach 12% among the cohort born in 2000. That is, only the first few years of the life course of the 2000 cohort are based on observed data past age 15.

To evaluate the reliability of the microsimulation model, we compare the estimated proportions of women still childless in our model with the ones observed in vital statistics (Stoeldraijer et al. 2017), as far as data are available. Figure 4 presents

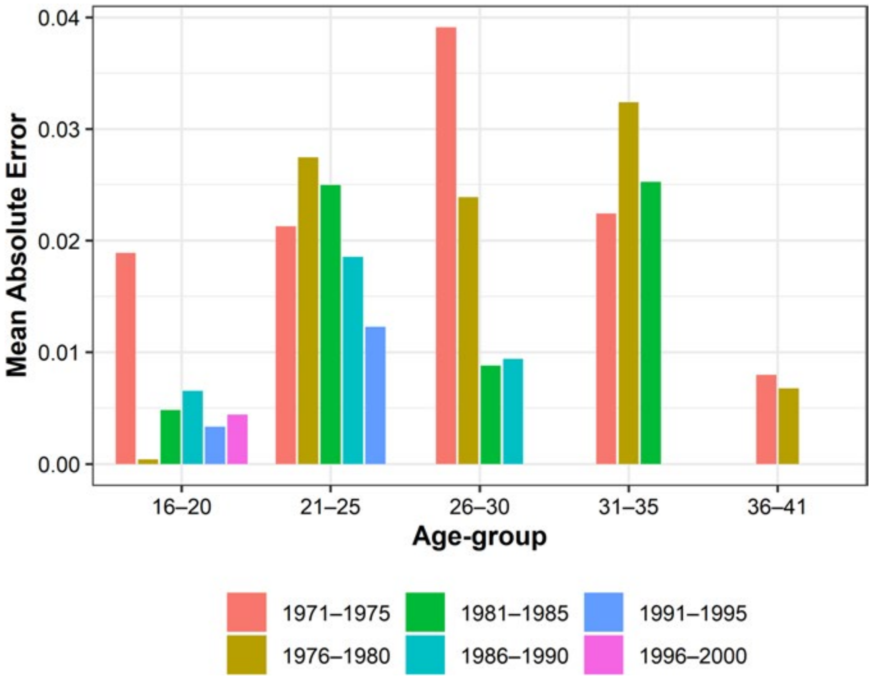


**Fig. 4** Mean absolute error between the observed and simulated proportions of women with at least one child according to groups defined by age and birth cohort. Figures correspond to those obtained in the baseline scenario. *Source:* Authors' calculations and Statistics Netherlands (2020a).

the absolute error between the simulated and observed proportions still childless inside of groups of five years of age and birth. Error tends to be lower among younger and older age-groups and tends to diminish among younger cohorts. Error reaches higher values between ages 21 and 35, but falls below 0.01 at ages 36 and older, when women approach the end of their reproductive life span.

### Household- and Union-Formation Patterns Across Cohorts

Table 1 presents summary statistics on the mean number of sojourns and total time spent in each state in the model, among five-year birth cohorts. Mean sojourn number refers to the mean number of times that each person in the model visits a specific state, while total time refers to the cumulated time in each state across all sojourns. Statistics concern the part of life encompassed between age 15 and first birth or age 42 and do not include earlier and later parts of life. For example, mean time spent in state 4 (married) refers to any time spent married before living with a child or reaching age 42.

Mean numbers of sojourns in states 1 (parental home), 2 (alone), and 3 (cohabiting) increase among each cohort born between 1971 and 1990, but decrease among the cohorts born in 1996–2000. Meanwhile, each younger cohort born between 1971–1975 and 1981–1985 visits state 4 (married) a decreasing number of times, while those born between 1991–1995 and 1996–2000 visit this state an increasing

**Table 1** Mean number of sojourns and total time spent in each state according to cohort group

| | 1971–1975 | 1976–1980 | 1981–1985 | 1986–1990 | 1991–1995 | 1996–2000 |
|---|---|---|---|---|---|---|
| 1. Parental Home | | | | | | |
| Mean sojourn number | 1.17 | 1.21 | 1.29 | 1.35 | 1.35 | 1.28 |
| Total time (years) | 7.52 | 7.39 | 7.42 | 7.75 | 7.99 | 9.01 |
| 2. Alone | | | | | | |
| Mean sojourn number | 1.05 | 1.08 | 1.17 | 1.26 | 1.37 | 1.31 |
| Total time (years) | 3.75 | 4.01 | 4.32 | 4.50 | 4.74 | 4.51 |
| 3. Cohabiting | | | | | | |
| Mean sojourn number | 1.18 | 1.19 | 1.20 | 1.25 | 1.32 | 1.29 |
| Total time (years) | 3.43 | 3.29 | 3.09 | 3.10 | 3.40 | 3.49 |
| 4. Married | | | | | | |
| Mean sojourn number | 0.60 | 0.51 | 0.45 | 0.45 | 0.47 | 0.48 |
| Total time (years) | 1.76 | 1.46 | 1.29 | 1.27 | 1.35 | 1.36 |

*Note:* Statistics encompass the period before giving birth or reaching age 42.

number of times. Concerning the total time spent in each state, time spent in states 1, 3, and 4 first decreases among the older cohorts and then increases among the younger cohorts. The total time spent in state 2 increases between all cohorts, except between the last two. The total time spent in state 1 increases by one year between the 1991–1995 and 1996–2000 cohorts, the largest increase across all states and cohorts.

Both the mean number of sojourns and the total time spent in each state may increase because more people ever visit a given state or the same people visit it several times. To explore this point, Table 2 presents summary statistics on the first and second sojourns in each state in the model for the same six cohorts. Proportions refer to the percentage of simulated individuals ever visiting (first sojourn) or returning (second sojourn) to each state. In addition, the table presents the mean age at which individuals enter and exit each given state at each sojourn, as well as the mean amount of time spent in each state at each sojourn. For example, the rightmost column shows that women born between 1996 and 2000 left the parental home for the first time on average at age 23; about 25% of them then returned at an average age of 24.1 years and stayed in this state for an average of 3.7 years.

Results show that ages at leaving the parental home after a first sojourn stay rather constant throughout the projection period, but that both the proportion ever returning and the time spent in this state at the second sojourn tend to increase among each younger cohort. Despite this, ages at living alone stay rather constant throughout the projection period, at both sojourns. One explanation could be that singlehood used to follow the disruption of a cohabiting relationship, but that increasingly it precedes cohabitation. This form of household arrangement is also increasingly popular: the proportion ever living alone increased by about 10 percentage points between the 1971–1975 and 1991–1995 cohorts, and the proportion ever returning to this state increased by nearly 15 percentage points between the same cohorts.

The proportion ever cohabiting hovers between 81% and 84% across cohorts with no clear increase or decrease, while the proportion ever returning to this state increases with each cohort, in total by about eight percentage points. Ages at entering this state tend to increase slightly across cohorts, probably as a result of the increase

**Table 2** Summary statistics of transition dynamics between household- and union-formation statuses according to cohort group for first and second sojourns

| | 1971–1975 | 1976–1980 | 1981–1985 | 1986–1990 | 1991–1995 | 1996–2000 |
|---|---|---|---|---|---|---|
| 1. Parental Home | | | | | | |
| First sojourn | | | | | | |
| Proportion ever visiting | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Mean age upon entering | 15.0 | 15.0 | 15.0 | 15.0 | 15.0 | 15.0 |
| Mean age upon exiting | 22.0 | 21.8 | 21.6 | 21.7 | 21.8 | 23.0 |
| Mean time spent in state | 7.0 | 6.8 | 6.6 | 6.7 | 6.8 | 8.0 |
| Second sojourn | | | | | | |
| Proportion ever visiting | 0.16 | 0.19 | 0.25 | 0.30 | 0.30 | 0.25 |
| Mean age upon entering | 23.1 | 23.4 | 23.3 | 23.3 | 23.3 | 24.1 |
| Mean age upon exiting | 26.0 | 26.3 | 26.3 | 26.4 | 26.7 | 27.8 |
| Mean time spent in state | 2.9 | 2.9 | 3.0 | 3.1 | 3.3 | 3.7 |
| 2. Alone | | | | | | |
| First sojourn | | | | | | |
| Proportion ever visiting | 0.72 | 0.74 | 0.77 | 0.79 | 0.81 | 0.79 |
| Mean age upon entering | 22.5 | 22.2 | 21.9 | 21.9 | 22.1 | 23.3 |
| Mean age upon exiting | 26.0 | 25.9 | 25.6 | 25.5 | 25.6 | 26.8 |
| Mean time spent in state | 3.5 | 3.6 | 3.6 | 3.6 | 3.5 | 3.5 |
| Second sojourn | | | | | | |
| Proportion ever visiting | 0.25 | 0.26 | 0.30 | 0.34 | 0.39 | 0.37 |
| Mean age upon entering | 27.3 | 27.1 | 26.9 | 27.0 | 27.2 | 27.9 |
| Mean age upon exiting | 31.1 | 31.0 | 30.8 | 30.6 | 30.6 | 31.3 |
| Mean time spent in state | 3.8 | 3.9 | 3.8 | 3.6 | 3.4 | 3.4 |
| 3. Cohabiting | | | | | | |
| First sojourn | | | | | | |
| Proportion ever visiting | 0.84 | 0.82 | 0.82 | 0.83 | 0.83 | 0.81 |
| Mean age upon entering | 23.7 | 23.6 | 23.8 | 24.2 | 24.5 | 25.3 |
| Mean age upon exiting | 26.6 | 26.4 | 26.4 | 26.7 | 27.1 | 28.1 |
| Mean time spent in state | 2.9 | 2.8 | 2.6 | 2.5 | 2.6 | 2.8 |
| Second sojourn | | | | | | |
| Proportion ever visiting | 0.28 | 0.29 | 0.31 | 0.32 | 0.36 | 0.36 |
| Mean age upon entering | 28.0 | 27.9 | 28.0 | 28.4 | 28.7 | 29.2 |
| Mean age upon exiting | 30.8 | 30.6 | 30.6 | 30.9 | 31.3 | 31.8 |
| Mean time spent in state | 2.9 | 2.7 | 2.6 | 2.5 | 2.6 | 2.6 |
| 4. Married | | | | | | |
| First sojourn | | | | | | |
| Proportion ever visiting | 0.58 | 0.50 | 0.45 | 0.44 | 0.46 | 0.47 |
| Mean age upon entering | 26.9 | 26.9 | 27.3 | 28.1 | 28.7 | 29.1 |
| Mean age upon exiting | 29.8 | 29.8 | 30.2 | 31.0 | 31.5 | 31.9 |
| Mean time spent in state | 3.0 | 2.9 | 2.8 | 2.9 | 2.9 | 2.9 |
| Second sojourn | | | | | | |
| Proportion ever visiting | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Mean age upon entering | 31.9 | 32.2 | 32.7 | 33.3 | 33.8 | 34.1 |
| Mean age upon exiting | 35.0 | 35.2 | 35.7 | 36.2 | 36.8 | 37.1 |
| Mean time spent in state | 3.1 | 3.0 | 2.9 | 2.9 | 3.0 | 3.0 |

*Notes:* Statistics encompass the period before giving birth or reaching age 42. Mean time spent in state is in years.

in returns to the parental home and in the popularity of living alone. Mean times spent in this state diminish among the cohorts born before 1991, translating into constant ages at exit from this state, but increase afterward. Finally, the decrease in the popularity of marriage is mostly noticeable among the cohorts born before 1991, while we witness a slight increase thereafter. Ages at entering this state increase throughout, and very few women marry for a second time before the birth of a first child or age 42. Mean times spent married are relatively constant. Note that statistics concern marriages before a first birth or reaching age 42 and can be influenced by the timing and propensity of married couples to have a first child.

In general, Table 2 shows that the mean time spent in each state at each sojourn tends to stay constant or decrease across cohorts (with the exception of the time spent at the parental home at the second sojourn, which increases) but that the number of transitions back to each state tends to increase. Given that the time spent in each state tends to stay constant, the increasingly older ages at entering a first and second cohabitation or marriage are likely because of an increase in the complexity in the transition to adulthood, with increases in transitions back to each previous state. In fact, in line with the increase in the proportions entering each state for a second time, proportions entering these same states a third or higher order time also increase with each younger cohort (results not shown).

## Childlessness Across Cohorts

The trends toward older ages at leaving the parental home, fewer marriages, more returns to each state, and concomitant older ages at entering cohabitation and marriage strongly suggest that the proportion of childless women will increase for the cohorts born from 1971 onward. Figure 5 shows the proportion of childless women at age 42 among each cohort born between 1941 and 2000. Proportions for the cohorts born in 1970 or before are observed, while those for the cohorts born after are based on our different projection scenarios and the projection from Statistics Netherlands. The expectation of higher levels of childlessness is confirmed, but only among the younger cohorts. Indeed, childlessness is first projected to decrease among the cohorts born in the 1970s and early 1980s, consolidating the reversal initiated by the cohorts born in the 1960s. This prospect seems highly likely to materialize as each scenario presents highly comparable estimates among these cohorts.

All scenarios then project an increase in childlessness among the cohorts born between the 1980s and the year 2000. The onset of the increase varies somewhat between scenarios: it is earlier in the Statistics Netherlands scenario and later in the unlimited one. The rate of increase in childlessness is initially similar across scenarios but starts diverging among the women born in the 1990s. The projection from Statistics Netherlands predicts that childlessness will stabilize rapidly at levels similar to those observed among the cohorts born in the mid-1960s, but each of our three scenarios predicts a continuation of the increase among the cohorts born in the 1990s, albeit at different paces. According to our baseline scenario, which lies between the freeze rate and the unlimited scenarios, childlessness among the cohort born in the year 2000 will reach 23%, a level that was reached in the Netherlands for the last time by women born around the year 1900.

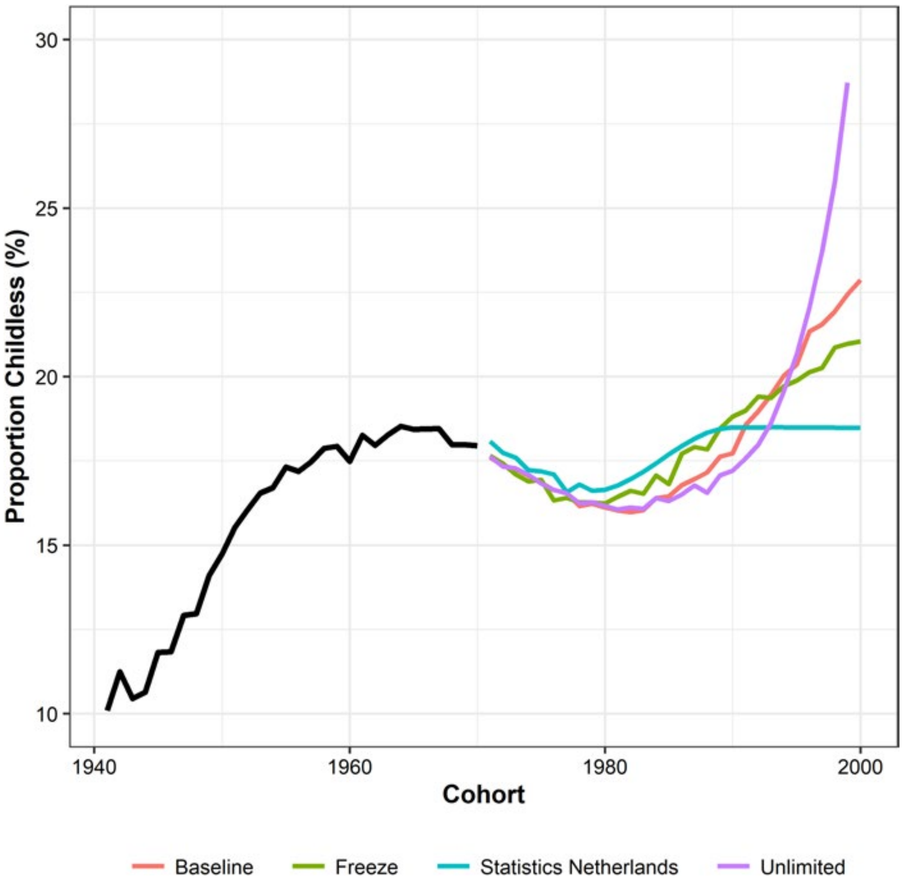


**Fig. 5** Observed and projected levels of childlessness at age 42 among Dutch cohorts of women born between 1941 and 2000. The black line represents the observed levels and the colored lines represent the projected levels reflecting different scenarios and the projection by Statistics Netherlands. *Source:* Authors' projection and Statistics Netherlands (Stoeldraijer et al. 2017).

## Alternate Projections of Household- and Union-Formation Patterns and Impact on Intercohort Changes in Childlessness Levels

The previous two sections suggest that the increase in ages at independent living, the increase in life course complexity, and the decrease in the popularity of marriage could be responsible for the projected increase in levels of childlessness. In this section, we describe how change in each transition in our model explains the projected trend. Effects in Figure 6 represent the difference between the levels projected in the baseline scenario and the levels projected in each alternate scenario, for each cohort. Each alternate scenario supposes that transition probabilities between two given states stay constant at the levels of the 1971 cohort throughout the whole projection period. Effects are to be interpreted as the effect of change in each transition on levels of childlessness. For example, the dotted line in panel d shows that the way that the transition between being married and first birth changes over time

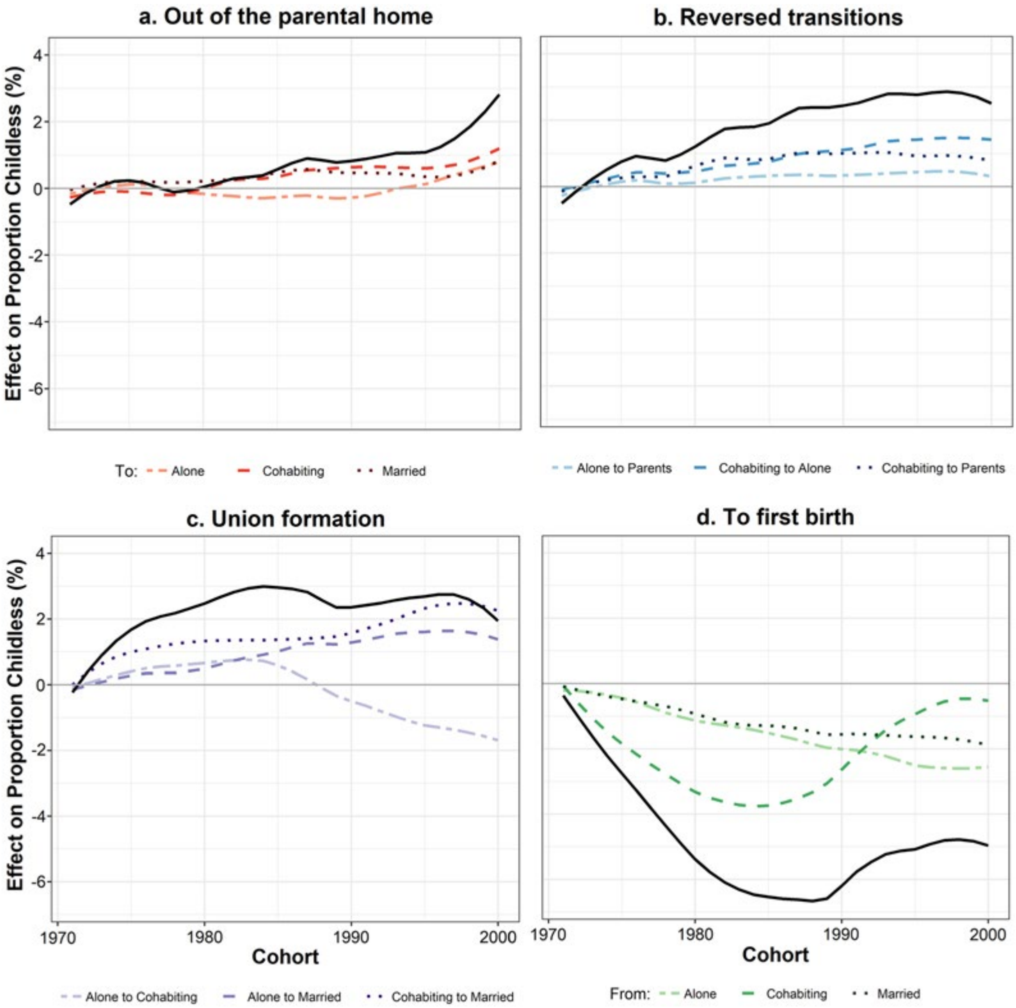


**Fig. 6** Effect of change over time in each transition in the model on intercohort change in levels of childlessness. Each colored line corresponds to the effect of one specific transition in the model; different patterns among the lines represent different transitions in the model. The solid black lines reflect the sum of all effects depicted in each panel.

is responsible for a steady decrease in levels of childlessness, culminating at two percentage points among cohort 2000. To facilitate the interpretation of the results, transitions are grouped into the categories “Out of the parental home,” “Reversed transitions,” “Union formation,” and “To first birth.” The black lines represent the sum of the effects associated with the three transitions in each group.

Panel a of Figure 6 shows that changes in the way that younger cohorts leave the parental home first had a neutral effect on levels of childlessness, to then contribute to progressively larger increases among the cohorts born from the mid-1980s onward. This evolution occurs mostly because of changes in the transition from living at the parental home to cohabiting. Changes in transitions from cohabiting back to the parental home or to living alone (Reversed transitions, panel b) also contribute to higher levels of childlessness, while changes in transitions from living alone to living at the parental home have a mostly neutral impact. The lower propensity of younger cohorts to marry strongly contributes to increases in levels of childlessness, especially in the case of cohabiting couples (panel c). Change in the transition from living alone to cohabiting first contributes to an increase in levels of childlessness before contributing to a decrease.

Contributions to lower childlessness levels otherwise concentrate among the changes affecting the transitions to first birth. Change in the propensity of cohabiting women to give birth for the first time contributes to strong decreases in levels of childlessness among the cohorts born in the 1970s and 1980s, but to much weaker ones among those born in the 1990s. Changes in the propensity of single and married women to give birth for the first time contribute to increasingly lower levels of childlessness among each younger cohort.

## Discussion

In this study, we used microsimulation to project household- and union-formation histories of Dutch women born between 1971 and 2000 and the impact of changes therein on levels of childlessness. We relied on second demographic transition theory and related empirical evidence to elaborate two sets of hypotheses about the direction of change in household- and union-formation patterns (H1, H2) and two sets about how change in these patterns might lead to lower or higher levels of childlessness (H3, H4).

The first set of hypotheses predicted increasingly late and protracted patterns of transition to adulthood. According to our projection, the transition to adulthood indeed became later (H1a). It also became more protracted, except among the 1996–2000 cohort, which experienced somewhat less protracted pathways because of a sharp increase in age at leaving the parental home. In parallel with these changes, time spent alone increased among each younger cohort except 1996–2000 (H1c). Meanwhile, the transition to adulthood became more complex because of more returns to the parental home and higher union instability (H2b), but again only among the cohorts born before 1996. Moreover, marriage became less popular among the cohorts born before 1986, but its popularity stabilized or increased among those born from that year onward (H2a). In sum, the pattern of transition to adulthood became later, but became more protracted and more complex only among the older cohorts.

According to Hypotheses 3a and 3b, the shift toward later, more protracted, and more complex patterns among the cohorts born in the 1970s and 1980s should have led to higher levels of childlessness; however, levels of childlessness decreased among these cohorts. This is not to say that later, more protracted, and more complex pathways contribute to lower levels of childlessness. On the contrary: according to our alternate projections, change in the transitions between living at the parental home and living in one's own household, and change in the transitions between union statuses, actually contributed to increases in levels of childlessness (panels a–c of Figure 6), confirming Hypotheses 3a and 3b. However, this effect was smaller than that associated with other factors that acted in the opposite direction, leading to a net decrease in levels of childlessness.

By far the most important factor promoting lower levels of childlessness was the increase in the propensity of cohabiting women to give birth for the first time. The influence of this factor peaked among the cohorts born between 1980 and 1985 and then returned to its initial level among women born in the 1990s. In parallel with this change, levels of childlessness first decreased to reach a minimum among the 1983 cohort, and then increased to reach unprecedently high levels among the 2000 cohort. As Hypothesis 4 suggested, levels of childlessness thus seem to increasingly depend on transitions to first birth among cohabiting women. This may not come as a surprise. According to second demographic transition theory, as societies become increasingly secular and individualist, it is expected that the share of cohabiting couples will increase and that out-of-wedlock births will become increasingly accepted (Lesthaeghe 2014). Accordingly, the share of births to cohabiting couples have increased in almost all Western countries during the last decades (Andersson et al. 2017; Kennedy and Bumpass 2008; Perelli-Harris et al. 2012).

This does not explain, however, why transitions to first births among cohabiting couples initially contributed to strong decreases in levels of childlessness and then to no change in comparison to the 1971 cohort. As the transition to adulthood becomes increasingly late and complex, we can hypothesize that women who wish to have children are increasingly likely to make a swift transition to family formation once they have found the right partner. This could explain why transitions to first birth increasingly contributed to lower levels of childlessness among married women (panel d of Figure 6). The contribution of cohabiting women, on the other hand, could be more sensitive to change in the availability of a suitable partner (Iacovou and Tavares 2011; Liefbroer 2009). Connected to this point is the changing meaning of cohabitation (Manting 1996; Wright 2019). Births will increase among cohabiting couples if they see cohabitation as a long-term commitment (eventually including marriage), but not if couples see it as a test (Hiekel and Castro-Martín 2014). Alternatively, the changing influence of first births among cohabiting couples could be related to punctual events, such as economic recessions (Currie and Schwandt 2014; Sobotka et al. 2011). The economic recession of 2008–2013 induced an important postponement of fertility in Europe (Goldstein et al. 2013; Matysiak et al. 2021). Some of the women who postponed family formation during that period subsequently may not have been able to have children, and this effect may have been enough to reverse the descending trend in levels of childlessness among the women born in the 1980s. It is less clear, however, why this should affect cohabiting women and not single and married women, who continued to become more likely to make transitions to first birth throughout the whole projection period.

The fact that levels of childlessness decreased as the transition to adulthood became later, more protracted, and more complex raises interesting questions. It is generally assumed that the second demographic transition brings about higher levels of childlessness. For example, Sobotka (2008:188) claims that the rise in childlessness observed in Europe is "closely linked to the transition." As societies become more secular and self-realization becomes more valued, childlessness forms an increasingly accepted option (Lesthaeghe 2014). However, as our results show, the fact that childlessness is more accepted does not necessarily mean that its levels will increase. Rather, secularization and individualization lead to more freedom of choice, including the choice to have children no matter whether one is married or not.

Our simulation points to two unexpected developments among the cohorts born in the late 1980s and 1990s: the halt in the increase in pathway complexity and the contraction of the gap between ages at leaving the parental home and first union formation, leading to less protracted pathways. Pathways became less complex as marriage became more popular and fewer returns to the parental home occurred. Proportions married have stabilized or even started to increase in Sweden since the early 2000s (Ohlsson-Wijk et al. 2020). Also in Sweden, van Winkle (2020) identified some "re-standardization" in the transition to adulthood among young cohorts of women. These were linked with the fact that educational attainment is becoming more homogeneous among younger cohorts. Our results and the ongoing trend in Sweden add to the literature that casts doubt about second demographic transition as a destiny (Zaidi and Morgan 2017; Zimmermann and Konietzka 2018).

Meanwhile, pathways became less protracted as age at leaving the parental home strongly increased among the cohorts born in the 1990s. Age at leaving the parental home has been increasing in the United States for a few decades now (South and Lei 2015). Such trends have been linked with the growing economic constraints faced by young people when establishing themselves in their own household (Warner and Houle 2018). In the Netherlands, the increase in age at leaving the parental home among the cohorts born after 1995 could be because of changes to the student loan system made by the Dutch government in 2014, which forced many young people to continue to live at their parental home during their studies (Statistics Netherlands 2019). Meanwhile, though we expected returns to the parental home to increase as unions become less stable among younger cohorts, they actually decreased among the cohorts born in the 1990s. Returns to the parental home also often occur among single people upon completing their studies (Stone et al. 2014). Thus, if students remain at their parental home while studying, returns to it will necessarily decrease. In sum, despite the growing importance of fertility decisions made among couples for levels of childlessness, earlier life course events seem to continue to play an important role (Hart 2019; Jalovaara and Fasang 2017; Keizer et al. 2008). This observation overlaps with those of Esteve et al. (2020:1), who argue that exits from the parental home and union-formation histories should be studied as "social determinants of low fertility."

As transitions to first birth ceased to increase among cohabiting women born in the 1990s, one of the main factors contributing to lower levels of childlessness is transitions to first birth among single women. These have been increasing for a few decades already in the Netherlands and have been linked to the increases in the population of Antillean origin, among which rates of unpartnered childbearing are relatively high (Centraal Bureau voor de Statistiek (CBS) 2018). Much of the research on trends in numbers of births according to union status comes from the United States, where births to single mothers have been shown to occur much more often among the less educated (Gibson-Davis and Rackin 2014). However, it is less clear whether such a strong gradient exists in Europe.

There are some policy implications linked to our results. The higher levels of childlessness projected among women born in the 1990s mean that more women will grow old without the care and support traditionally offered by children. This can have implications for health care and social benefits spending (Keefe et al. 2012).

Two of the factors that contribute to the projected increase are later transitions out of the parental home and a decrease in cohabiting and married unions. An important hurdle that younger people face in establishing themselves in their own household is the cost associated with buying a house (Mulder and Billari 2010). Policies that promote financial independence among young adults and facilitate buying a first home could thus help limit the increase in levels of childlessness (Arundel and Lennartz 2017).

### Limitations

This study has some limitations. The data set used only allowed us to assess the effect of change in household- and union-formation histories on childlessness and did not allow the examination of the impact of other factors, such as change in professional pathways. In the Netherlands, as well as in other countries, the share of young people with temporary contracts and less well-paid jobs has increased in recent years (de Lange et al. 2014). Lower job stability has been shown to have a negative effect on the decision to start a family (Vignoli et al. 2013). Though our model probably captured part of these trends through changes in household transitions, explicitly modeling this component could provide new and interesting insights.

Another limitation is the use of aggregate data for estimating the parameters used in the microsimulation. Individual-level register data offer more possibilities for estimating such parameters, but their access is strictly regulated. Aggregate register data have the advantage of being more freely available, but do not allow one to consider duration in time-dependent models. While not including duration does not affect macro-level outcomes, including it would allow more realistic modeling of individual outcomes, which in turn would allow us to unravel new insights into how individual pathways are linked to childlessness (Ritschard and Studer 2018).

It is also worth discussing the fact that we did not include men in our analyses despite their important role in fertility decisions. This choice is partly explained by practical reasons. First, fertility is more difficult to measure among men than among women, especially in the case in which fertility is inferred from household transitions, such as here. Second, the data only allowed us to follow people during a maximum period of 22 years, which represents only a small proportion of a man's reproductive life span. This decision is further explained by the fact that including men would have added little value to the analyses while making them considerably more complicated. According to Keizer et al. (2008), men and women differ in their pathways to childlessness with respect to their professional careers, but less so with respect to their household careers. Furthermore, the effect of household transitions among men is in part implicitly accounted for in our model because household transitions and the decision to have a child usually involve couples. In contrast, models of joint fertility decisions are quite complex, and considering them fell beyond the scope of this article (Stein et al. 2014).

Finally, this study had the typical limitations of population projections. To this end, we used a method that has been shown to perform as well as or better than others, without being overly complicated (Bohk-Ewald et al. 2018). As such, our baseline scenario supposed a five-year continuation of the trend observed over the last five years of observation, followed by constant probabilities. Another plausible scenario could assume a reversal of the trends recently observed, which could lead to a stabilization or new decreases in levels of childlessness among the cohorts born in the late 1990s. Such a situation would mainly depend on the behavior of these women in their 30s, who will have to compensate for the fact that they are leaving the parental home at comparatively much older ages than their older counterparts did. ■

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