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Online comment and rejoinder

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## **“Linear effects of maternal age and period trends cannot be distinguished”**

### **Response from Kieron Barclay and Mikko Myrskylä**

In our recent article “Advanced Maternal Age and Offspring Outcomes: Advanced Maternal Age and Counterbalancing Period Trends”, we examined whether delaying childbearing to older ages might be associated with more positive educational and health outcomes for the offspring (Barclay and Myrskylä 2016). Previous research has shown that older women have lower fecundity (Schwartz and Mayaux 1982), are at a greater risk of miscarriage (Andersen et al. 2000), and their children are more likely to be born pre-term and have low birth weight (Jacobsson et al. 2004), amongst other poor outcomes (Yoon et al. 1996). These poor outcomes are primarily thought to be attributable to DNA damage to germ cells, which increases with increasing maternal age (Abdalla et al. 1993). Furthermore, pre-term birth and low birth weight have been shown to be associated with worse long-term outcomes, such as lower educational attainment, lower earnings, and lower cognitive ability in adulthood (Conley and Bennett 2000; Black, Devereux, and Salvanes 2007). However, although there is a large body of literature that has demonstrated the risks associated with reproductive ageing, the past decades have also been characterized by a number of positive secular trends. Educational expansion across Europe and North America has meant that more people go to university, and more people spend longer in the educational system, than ever before (Breen et al. 2009; Breen 2010). There have also been secular increases in height across much of the Western world (Gustaffson et al. 2007; Komlos and Lauderdale 2007), and height is correlated with better nutrition early in life (Hatton et al. 2013), and lower mortality in adulthood (Davey-Smith et al. 2000). From the perspective of an individual woman, delaying childbearing to an older age always means giving birth into a later birth year. For example, a woman born in 1950 who gives birth at age 20 gives birth in 1970. If she waits until she is aged 35, she gives birth in 1985. Even though the risks of pre-term birth and low birth weight increase exponentially with increasing maternal age, these positive secular trends in the intervening years might counterbalance or even outweigh the negative effects of reproductive ageing. Our study sought to evaluate that proposition.

We addressed this question using data from Swedish population registers, covering all men and women born in Sweden between 1960 and 1990, and we examined a mixture of educational and health outcomes. The educational outcomes that we examined were high school GPA at age 16, making the transition to university by age 30, and total years of education by age 30. The health outcomes that we examined were height and physical fitness measured between ages 17 and 20. These health measures were taken from the Swedish military conscription register, and were unfortunately therefore only available for men. In our analyses we employed sibling comparison models to adjust for time-invariant factors that are shared by siblings that might confound the relationship between maternal age at the time of birth and the various outcomes that we studied. Our study showed that compared to siblings born when their mother was younger, children born when the mother was older had a higher GPA in high school, they were more likely to go to university, they had spent longer in the educational system by age 30, and, at least amongst men, they were taller. There were no benefits to being born to an older mother in terms of physical fitness, which was consistent with the fact that there have not been any clear improvements in population-level physical fitness over the past

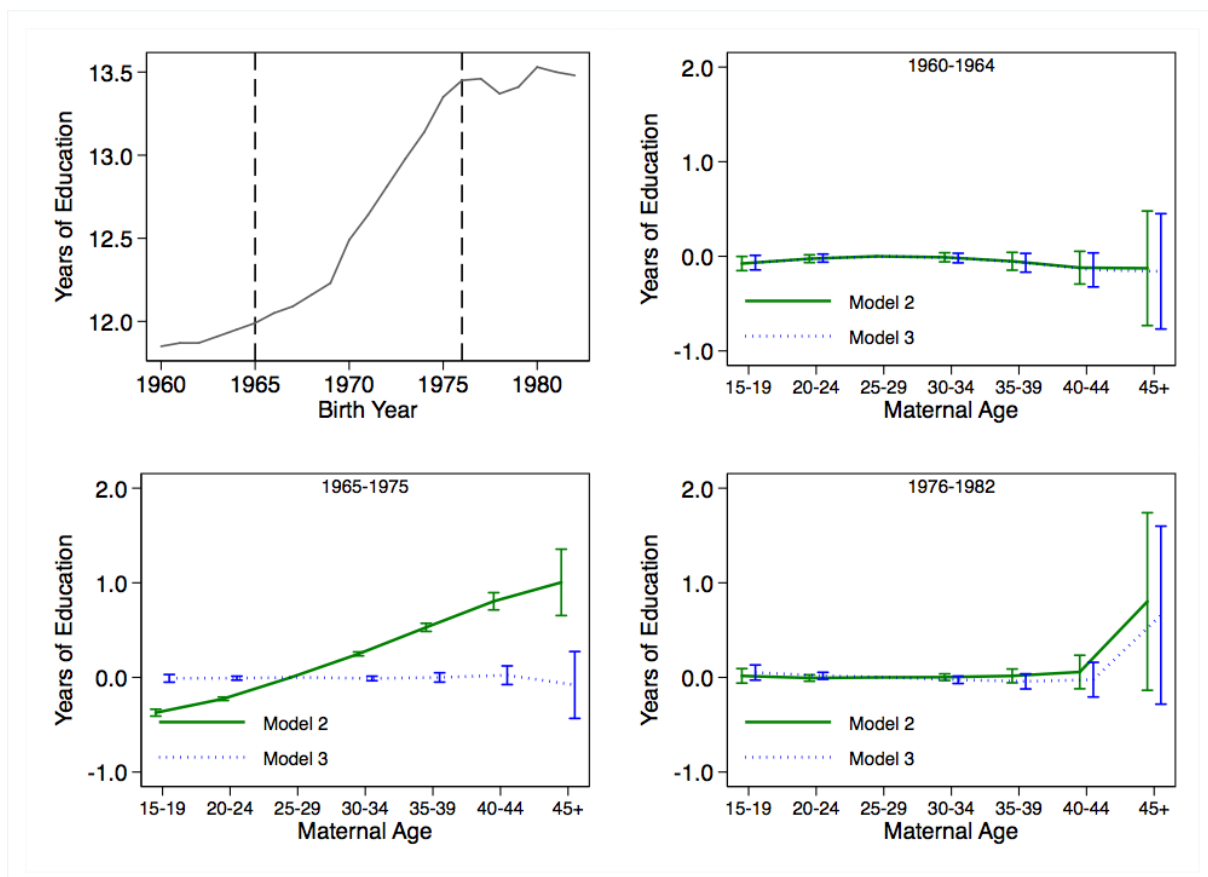
decades in Sweden (Westerstahl et al. 2003; Ekblom, Oddson, and Ekblom 2004). Therefore, we concluded that delaying childbearing to older ages was, from the perspective of an individual woman, actually likely to improve the educational and health outcomes amongst her children.

In their commentary piece “Linear effects of maternal age and period trends cannot be distinguished”, Niels Keiding and Per Kragh Andersen (from here, NK-PKA) raise an important point about the identification problem in Age-Period-Cohort (APC) models. Although sibling fixed effects models are not typically discussed in the context of APC analysis, the authors note that the same problems that have plagued other attempts to separate APC effects apply to sibling models when terms for age and period are entered into the model equation.

We commend NK-PKA for raising this point, which certainly has merit. However, this point does not challenge the conclusions drawn from our study. The point that we made in our article was that, for any given woman, delaying childbearing to older ages can lead to better outcomes for her children. The technical point that NK-PKA make concerns Model 3 in our paper, where we include covariates for maternal age and birth year simultaneously, but the key conclusions we draw in our study are clearly based upon the results from Model 2. In Model 2, we do not enter covariates for maternal age and birth year simultaneously. The point of Model 2 was to address our central research question, which was, what is the total effect of maternal age at the time of birth, factoring in both reproductive ageing and period trends. The results from Model 2 showed that when comparing children within the same sibling group, those who are born when the mother is older have better grades in high school, spend longer in the educational system, are more likely to go to university, and are taller. In their comment, NK-PKA suggest that we would have found different results had we used different operationalizations for maternal age and birth year. However, our key conclusions were based upon the results from Model 2, which did not include a control for birth year, rendering this point moot.

In the conclusion of NK-PKA’s comment, they do not dispute our conclusion that being born later is better, but instead cast doubt on the relative role of maternal age and period in explaining the advantage that falls to those who are born later. This, therefore, turns to a discussion about the mechanisms that could produce the advantage of being born to an older mother. There are essentially three forces operating in conjunction. The first is reproductive aging, the second is increases in socioeconomic resources with increasing age, and the third is period trends. As described above, the first factor could be expected to lead to worse long-term outcomes for those born to older mothers, as advanced maternal age is associated with an increased risk of poor peri-natal outcomes such as pre-term birth and low birth weight (Jacobsson et al. 2004). The second factor could be expected to lead to better long-term outcomes for those born to older mothers. Previous studies have shown that older parents have greater incomes and more socioeconomic resources (Powell, Steelman, and Carini 2006), and a large body of research has shown that greater socioeconomic resources are beneficial for the long-term outcomes of children (Ermisch, Jäntti, and Smeeding). The third factor, period trends, is highly contingent upon the trends in the period from which the data are drawn for the analysis. If conditions are improving over time, then being born later is better. If conditions grow worse over time, then being born later is worse. If nothing changes, then birth cohort doesn’t matter.

In detailed supplementary analyses for our paper (published online in the Supporting Information that accompanied our article), we showed that adjusting for parental income and socioeconomic status does not substantially reduce the advantage of children born when the mother was older in Model 2 (the model with no controls for birth year). Therefore we concluded that the second mechanism, increases in socioeconomic resources, is not particularly important for the advantage that children born to older mothers have in relation to the five educational and health outcomes that we studied. Given that reproductive aging should have a negative effect on long-term outcomes, this means that the remaining plausible candidate for explaining an advantage for children born to older mothers is period improvements in opportunities and social and public health conditions. It is not clear what the logical alternative explanation should be.



**Figure 1. Maternal Age and Educational Attainment by Age 30 for Swedish Men and Women Born 1960-1982.**

To illustrate this point, we have conducted additional analyses where we examine the relationship between maternal age at the time of birth and educational attainment at age 30 in three different periods: one where education was expanding and two where it was not. We use the same sibling sample and cohort groups that we used in our article: men and women in multi-child sibling groups born in Sweden between 1960 and 1982. We also use the same control variables (and same operationalization) that we used in our original article. Figure 1 shows the results from Models 2 and 3 (analogous to Models 2 and 3 in our original article) for the three different periods. As can be seen in the top-left panel of Figure 1, education in Sweden was expanding most strongly for cohorts born between 1965 and 1975. When we conduct our analyses separately by cohort group, we

can see that the benefit of being born to an older mother is only apparent for Swedes who were born into cohorts that benefitted from educational expansion. In the bottom-left quadrant it can be seen that the results for Model 2 show that being born to an older mother is advantageous for cohorts born when educational attainment was increasing rapidly. However, the top-right and bottom-right quadrants show that when education was not expanding, the results from Model 3 and Model 2 are extremely similar.

In conclusion, although NK-PKA raise an important issue in their comment, they do not substantively challenge the central point of our article, which is that being born later and to an older mother was better for the cohorts that we studied. Furthermore, their implication that it is not possible to be completely certain that these benefits are attributable to period improvements such as educational expansion may be technically true, but given our knowledge of substantive mechanisms there is no clear logical alternative to that explanation. Finally, through additional analyses we have empirically demonstrated that when education is not expanding, being born later does not produce better outcomes for children born to older mothers. We use the analysis of educational outcomes as an example, but the same principal applies to the other outcomes that we studied. Since positive secular trends in terms of educational attainment and health have been observed across a wide range of developed countries, and continue apace to this day, we expect that our results will also generalize to other settings and to more recently born birth cohorts.

## References

- Abdalla, Hossam I. et al. 1993. "Pregnancy—Age, pregnancy and miscarriage: Uterine versus ovarian factors," *Human Reproduction* 8(9): 1512–1517.
- Andersen, Anne-Marie Nybo, Jan Wohlfahrt, Peter Christens, Jørn Olsen, and Mads Melbye. 2000. "Maternal age and fetal loss: Population based register linkage study," *BMJ* 320(7251): 1708–1712.
- Barclay, Kieron and Mikko Myrskylä. 2016. "Advanced maternal age and offspring outcomes: reproductive ageing and counterbalancing period trends," *Population and Development Review* 42(1): 69-94.
- Black, Sandra E., Paul J. Devereux, and Kjell G. Salvanes. 2007. "From the cradle to the labor market? The effect of birth weight on adult outcomes," *Quarterly Journal of Economics* 122(1): 409–439.
- Breen, Richard. 2010. "Educational expansion and social mobility in the 20th century" *Social Forces* 89(2): 365–388.
- Breen, Richard, Ruud Luijkx, Walter Müller, and Reinhard Pollak. 2009. "Nonpersistent inequality in educational attainment: Evidence from eight European countries," *American Journal of Sociology* 114(5): 1475–1521.

Conley, Dalton and Neil G. Bennett. 2000. "Is biology destiny? Birth weight and life chances," *American Sociological Review* 65(3): 458–467.

Davey Smith, George et al. 2000a. "Height and risk of death among men and women: Aetiological implications of associations with cardiorespiratory disease and cancer mortality," *Journal of Epidemiology and Community Health* 54(2): 97–103.

Ekblom, Örjan, Kristjan Oddsson, and Björn Ekblom. 2004. "Health-related fitness in Swedish adolescents between 1987 and 2001," *Acta Pædiatrica* 93(5): 681–686.

Ermisch, John, Markus Jäntti, and Timothy Smeeding. 2012. *From Parents to Children: The Intergenerational Transmission of Advantage*. New York: Russell Sage Foundation.

Gustafsson, Anders, Lars Werdelin, Birgitta S. Tullberg, and Patrik Lindenfors. 2007. "Stature and sexual stature dimorphism in Sweden, from the 10th to the end of the 20th century," *American Journal of Human Biology* 19(6): 861–870.

Hatton, Timothy J. 2013. "How have Europeans grown so tall?," *Oxford Economic Papers* 66(2): 349–372.

Jacobsson, Bo, Lars Ladfors, and Ian Milsom. 2004. "Advanced maternal age and adverse perinatal outcome," *Obstetrics & Gynecology* 104(4): 727–733.

Komlos, John, and Benjamin E. Lauderdale. 2007. "The mysterious trend in American heights in the 20th century," *Annals of Human Biology* 34(2): 206–215.

Powell, Brian, Lala Carr Steelman, and Robert M. Carini. 2006. "Advancing age, advantaged youth: Parental age and the transmission of resources to children," *Social Forces* 84(3): 1359–1390.

Schwartz, D. and Mayaux, M. J. 1982. "Female fecundity as a function of age: results of artificial insemination in 2193 nulliparous women with azoospermic husbands," *New England Journal of Medicine* 306(7): 404–406.

Westerstahl, M. M. Barnekow-Bergkvist, G. Hedberg, and E. Jansson. 2003. "Secular trends in body dimensions and physical fitness among adolescents in Sweden from 1974 to 1995," *Scandinavian Journal of Medicine & Science in Sports* 13(2): 128–137.

Yoon, Paula W. et al. 1996. "Advanced maternal age and the risk of Down syndrome characterized by the meiotic stage of chromosomal error: a population-based study," *American Journal of Human Genetics* 58(3): 628.