



Gender inequality, economic growth, and the intergenerational transmission of adverse health consequences at birth

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ABSTRACT

We estimate a gender differential in the intergenerational transmission of adverse birth outcomes. We link Taiwan birth certificates from 1978 to 2006 to create a sample of children born in the period 1999–2006 that includes information about their parents and their maternal grandmothers. We use maternal-sibling fixed effects to control for unobserved family-linked factors that may be correlated with birth outcomes across generations, and define adverse birth outcomes as small for gestational age. We find that when a mother is in the 5th percentile of birth weight for her gestational age, then her female children are 49–53% more likely to experience the same adverse birth outcome compared to other female children, while her male children are 27–32% more likely to experience this relative to other male children. We then investigate whether long-run improvements in local socio-economic conditions experienced by the child's family, as measured by intergenerational changes in town-level maternal education, affect the gender differential. We find no evidence that intergenerational improvements in socioeconomic conditions reduce the gender differential.

1. Introduction

In recent decades, countries around the world have made significant investments to narrow gender gaps, particularly in female education and employment. Studies have provided robust empirical evidence of the positive impact of gender equality on economic growth (Klasen and Lamanna, 2009; Balioune-Lutz and McGillivray, 2009; Forbes, 2000). However, evidence of a feedback effect from greater prosperity to more gender equality is weaker and less consistent (Kabeer and Natali, 2013; Eastin and Prakash, 2013). Some researchers trace this asymmetric relationship between gender equality and economic growth to the persistent effects of existing social structures and norms, or to the discrimination against women workers (Moghadam, 2003; Beneria et al., 2015).

In this study, we examine whether unequal intergenerational transfer of adverse health outcomes at birth might contribute to this asymmetric link. Researchers have established that children who experienced unfavorable intrauterine events not only have adverse birth outcomes but also have poorer health (Hales and Barker, 2001) and worse human capital outcomes (Almond and Currie, 2011) during their later lifetime, which is widely interpreted as evidence of a fetal programming effect. Recent studies have further found a strong

intergenerational association in adverse birth outcomes, especially from the maternal side (Collins et al., 2002, 2003; Kuzawa and Sweet, 2009; Qian et al., 2017), suggesting that the consequences of unfavorable intrauterine events may not be limited to one generation and can be inherited by offspring (Lee, 2014).

Using the same data and identification strategy as in Qian et al. (2017), we investigate whether the strength of intergenerational transmission differs by gender. Biological studies have shown that male and female fetuses may respond differently to maternal signals received *in utero*, and thus exhibit sexually dimorphic birth outcomes (Di Renzo et al., 2007; Eriksson et al., 2010), but have not focused on whether there is a gendered pattern in intergenerational health consequences. To our knowledge, ours is the first paper to estimate a gender differential in the intergenerational transmission of adverse birth outcomes in a general population.

If such a differential persists, its impact could perpetuate inequality in the later lives of the next generation. However, findings from a number of previous studies suggest that the intergenerational transmission of adverse health consequences at birth can be weakened if maternal socio-economic status improves (e.g., Currie and Moretti, 2007; Bhalotra and Rawlings, 2013). We therefore study whether improved socioeconomic conditions benefit male and female newborns

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equally for a general population. Finding that such improvements do not eliminate the gender differential could help explain gender gaps in subsequent lifetime outcomes that persist despite economic growth, and thus provide an explanation for the weaker link from economic growth to gender equality.

We identify a child as having an adverse birth outcome if its birth weight is small for its gestational age (Kramer, 1987), a measure typically employed by physicians (Saccone et al., 2016) to diagnose intrauterine growth restriction, i.e. poor growth while *in utero*, a condition that may lead to low Apgar scores, low resistance to infection, and other complications at birth. We use gender-specific measures because they may be more sensitive in identifying growth-restricted fetuses and inferior health at birth (Trudell et al., 2013). Specifically, we use a birth weight in the 10th percentile (SGA 10th pct.), given the child's sex and gestational age, or alternatively the 5th percentile (SGA 5th pct.) (Unterscheider et al., 2013), to indicate an adverse birth outcome.

It is empirically challenging to identify intergenerational associations in adverse birth outcomes because omitted variables, for example genetic factors, may be correlated with these outcomes across generations. We address this issue by constructing a sample of children (the third generation, G3) with their parents' (the second generation, G2) and maternal grandmothers' (the first generation, G1) information observed, using data from birth certificates registered in Taiwan from 1978 through 2006. Following Qian et al. (2017) and Currie and Moretti (2007), we employ maternal-sibling comparisons to control for family-specific heterogeneity, such as genetic factors or other persistent family effects. The strength of the intergenerational transmission is then identified by variations in adverse birth outcomes of the G3 children whose mothers are siblings, that is, who share the same maternal grandmother. We also include in the estimations observable characteristics of the G3 child, of the G2 mother and father, and of the G1 maternal grandmother, to control for other potentially confounding factors. Our key variable is an interaction term between the SGA status of the G2 mother and an indicator of the G3 child's gender to identify the gender differential in the intergenerational transmission of adverse health consequences at birth from the maternal line.

We then investigate whether long-run intergenerational change in socioeconomic conditions affects gender-based inequality in the transmission of poor birth outcomes. The average per capita GDP grew substantially in Taiwan, from US\$2389 in 1980 to US\$14,941 in 2000, evidence of substantial economic growth, but we lack information about local incomes for the entire study period. However, we do have information about the education attained by mothers in the G2 generation as well as in the G1 generation, and we use these data to measure differences in socio-economic conditions, because education is highly correlated with economic growth (Hanushek and Woessmann, 2010). Researchers have established that the level of socioeconomic status, measured in various ways, improves birth outcomes (Currie and Moretti, 2007; Bhalotra and Rawlings, 2013). We focus instead on intergenerational changes in maternal educational attainment because such changes better represent long-run, broad-based economic growth, and allow us to examine whether such growth reduces the gender differential in intergenerational transmission of adverse birth outcomes.

We find evidence that the intergenerational transmission of adverse birth outcomes is gendered: a female child born to an SGA mother measured at the 5th percentile is 49–53% more likely to experience the same adverse birth outcome compared to other female children, while a male child's chances increase by 27–32%. However, our findings provide no evidence that either the current level of maternal education or significant increases in maternal education experienced by the child's family across two generations reduce this gender-based differential. Persistent intergenerational transmission of adverse health consequences at birth may therefore help to explain the weakness in the link leading from economic growth to greater gender equality.

2. Methods

2.1. Data and sample

Our sample is constructed from birth certificates that Taiwan's Ministry of the Interior collects and digitizes for the entire population. The data on each certificate includes a newborn's characteristics (birth date, gender, birth order, name of the hospital or clinic/maternity home where birth took place, and town and county of birth), birth outcomes (birth weight and length of gestation), and parental information (each parent's age, years of schooling, and town and county of birth). Each certificate also provides the birth date and personal identification number of the newborn's mother, which we use to link the newborn's birth certificate to the mother's own birth certificate.

To construct the sample, we identify births during the years 1999–2006 as potential third generation children, and female births during years 1978–1985 as potential mothers of the G3 children. We eliminate from both sets of certificates all births that are not singleton, that did not have a gestation length between 22 and 44 weeks, and that did not report a birth weight between 400 and 6500 g. We then merge the remaining qualified birth certificates of the mothers to those of the children using mothers' birth dates and social identification numbers. In doing so, we carry along information about each newborn's maternal grandmother, because the grandmother's information is listed on the mother's own birth certificate. (We do not include information from the paternal line because results in Qian et al. (2017) indicate that such transmission effects are small and insignificant under paternal sibling comparisons using Taiwan data.)

Our final sample consists of 284,314 observations of G3 singleton newborns whose mothers (the G2 generation) can be identified in our data. Note that our matching procedure requires the mothers to have given birth to their children in the years 1999–2006, that is, before the mothers are 28 years old, for their children to be observed in the final sample. Since the average age of mothers having their first child during the period 1999–2006 was 26.7–28.1 years (*Demographics Fact Book*, Ministry of the Interior, Republic of China), our sample is, in general, relatively representative for Taiwan mothers experiencing birth during that period.

Given our sample matching procedure, it is possible that the inclusion of a mother-child pair in our sample is negatively correlated with a mother's adverse birth outcome. For example, mothers who were themselves born with small birth size may have been less likely to marry, or if married, to have had a lower probability of giving birth or a higher probability of miscarriage, any of which would cause them to be excluded from our sample. However, Qian et al. (2017) did a comprehensive search for this type of sample selection bias, and their results suggest, consistent with Royer (2009), that this type of selection does not bias our estimates.

2.2. Measures

We use gender-specific SGA thresholds reported by Hsieh et al. (2006) to identify the occurrence of adverse health consequences at birth for each gestational age from 22 to 44 weeks (Table S1 in Supplementary Material). These thresholds were calculated using the birth certificates of 1.3 million singleton births in Taiwan from 1998 to 2002, virtually the entire population of singleton births. We use these same thresholds for both the G3 children and their G2 mothers because Hsieh et al. (2006) also show that the thresholds they calculate are very similar to thresholds calculated using births during the years 1979–1989.

We use the educational attainment of mothers to measure changes in the socio-economic conditions experienced by the G3 child's family, and therefore of the G3 child *in utero*. We use birth certificates of the entire singleton population born during the G3 generation (1999–2006) to calculate the average years of schooling, for each town and year, of their mothers. Similarly, we use birth certificates of the entire singleton

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