Online Appendix for Status Externalities in Education and Low Birth Rates in Korea*

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A Data Appendix

A.1 Preliminaries

We use the Korean Labor and Income Panel Study (KLIPS) data to document fertility and educational spending across households. The KLIPS is a longitudinal survey of representative samples of Korean households and individuals. The survey has been conducted annually since 1998 on a sample of 5,000 households and members of the households. The data contains a rich variety of information including household demographics, education, labor market mobility, income, fertility, etc. We adjust income for inflation using CPI. The unit of income is 10,000 Korean Won (KRW), which is similar to 9 USD. We use the data up to the 20th survey which was conducted in 2017.

As in Jones and Tertilt (2008), we use a cohort-based approach. The baseline results focus on the women born in between 1970 and 1975 and their household members.[1] Specifically, we include households in which the woman's age is between 40 to 43 and there are at least three observations within this age band. Also, we include only

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[1]The KLIPS used to represent the urban households in South Korea until 2008. In 2009, new households are added so that it can represent the whole population. Therefore, our empirical results are based on the data from 2009 which represent the whole population. We check robustness using the earlier cohort of 1961-1966 from the data before 2009.

Table A1: The Distribution of the Number of Children

Number of children	0	1	2	3	4	5
Proportion (%)	2.91	19.58	63.10	12.83	1.46	0.13

Notes: We calculate the proportion of households (married or cohabiting couples) using completed fertility of women born between 1970 and 1975.

married or cohabiting couples in the analysis because single women are more likely to have lower fertility and lower family income than couples. The number of two-adult households satisfying all the required conditions is 756. We also provide the results including both singles and couples below for sensitivity.

Completed fertility is the number of children ever born to a woman, and includes both intensive and extensive margins of fertility. The extensive margin of fertility is whether to have any child or not. The intensive margin is about the number of children conditional on having at least one child. Table A1 shows the proportion of households, satisfying all the above requirements, with different numbers of children. The childlessness rate is 2.9%. Among parents who decide to have at least one child, the proportion of parents with two children is the highest at 63.1%. Note that we include the small fraction of women with four and five children (1.59% in the data) in the three children category in the quantitative analysis. We further look into the relationship between income and fertility along both intensive and extensive margins.

To measure permanent household income, we utilize the longitudinal feature of the data by taking long term averages (Chetty et al. 2014). Specifically, we use the average income of households in which the woman's age is between 40 to 43. Our income measure is family income that combines labor income from both members of couples as well as capital income, but excludes income from social insurance and transfers. The Gini coefficient from our measure of long-term average income is 0.263.

A.2 Education Expenditures by Income and Child's Age

The KLIPS has two different types of questions regarding education in both the individual-level survey data and household-level survey data. First, the individual-level survey asks about per-child spending on private education, such as cram schools, for each child since Wave 3. Although this question excludes household expenditures on public education (e.g., tuitions), this is advantageous because we can observe the characteristics of the child which the money is spent on. We use this individual-level survey question to investigate the cross-sectional relationship between expenditures on private education and income. Second, the household-level survey also asks about total household-level expenditures on both private and public education since Wave 1. This gives a very comprehensive measure of out-of-pocket educational spending. However, it is hard to control for each child's characteristics when there are multiple children in a household. Thus, we use this information to measure per-child spending on education relative to household income.

Figure A1 shows the relationship between the log of average education expenditures on private education per child and the log of average income for each income quintile and for each education stage.[2] The slope implies the income elasticity of private education increases as children go to the next level of school: 0.57 for preschool, 0.63 for elementary school, 0.77 for middle school, and 1.03 for high school. Because education costs also change as children go to the next level of school, we calculate the weighted average expenditures across different education stages using the number of years spent in each education stage as the weight. Specifically, we first calculate the education-stage-specific average spending for the given income quintile and education stage, and then averaging across different education stages weighted by the number of years spent in each education stage. The weighted average income elasticity of private education is 0.698 and is used for calibration.

Tables A2 and A3 show the level of private education spending per child conditional on positive spending (intensive margin) and the fraction of households with no private education spending (extensive margin), respectively, by income quintile and education stages. The last columns show their averages across different education stages weighted by the number of years spent in each education stage. Table A2

[2]The income quintile is defined each year based on current income. Alternatively, we have considered ranking families within each education stage. The results do not change considerably.

Figure A1: Expenditures on Private Education by Income and Education Stage

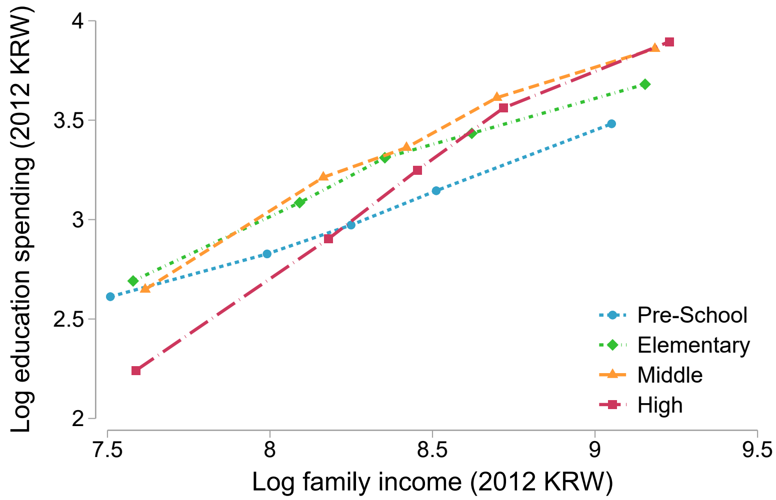


Table A2: Level of Monthly Private Education Spending (10,000 Won)

Income quintile	Pre-school	Elementary school	Middle school	High school	Weighted average
1st	21.5	19.3	27.5	31.2	23.3
2nd	23.3	24.1	31.3	33.2	26.4
3rd	26.2	29.4	34.9	42.5	31.1
4th	29.4	32.2	42.2	49.6	35.5
5th	39.6	40.5	51.0	59.9	44.9

Notes: The table shows the level of monthly education spending among those spending non-zero amounts.

shows that all income groups increase spending from elementary to high school, conditional on participating in private education. Note that Table A3 is based on the percentage of households that did not spend on private education in the year of the survey. Thus, reporting no spending on private education does not mean that they do not spend anything across all stages of education.

Figure A2 shows the average monthly education expenditures per child from birth to age 24 and their shares relative to income. We use households with one child to plot this figure because we want to focus on the variation by child's age. The vertical lines indicate the typical ages at which children enter the next level of school in Korea. Note that the education expenditures increase rapidly, reaching 10% of

Table A3: Fraction of Households with No Private Education Spending (%)

Income quintile	Pre-school	Elementary school	Middle school	High school	Weighted average
1st	36.5	23.5	48.7	69.8	39.6
2nd	27.4	9.2	20.6	45.0	23.3
3rd	25.3	6.7	17.4	39.3	20.4
4th	21.1	3.7	12.0	29.0	15.4
5th	18.0	2.2	7.0	18.0	11.2

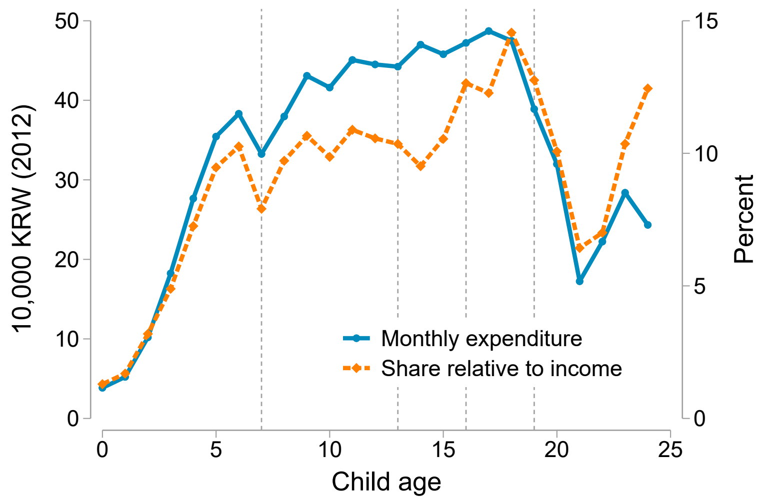
Notes: The table reports the fraction of households that did not spend on private education in the year of the survey. We assign zeros to missing responses for the amount of private education expenditure if parents answer to other questions that they do not use private education at all or that they use parental tutoring.

income, before children enter elementary school. Then, it continually increases at a lower speed until children graduate from high school. The peak is at age 17 when children is in the second year in high school and the amount is around 500,000 KRW (similar to 450 USD) per month. The share of education expenditure in income has a similar shape but jumps when children enter high school. The share drops from the third year in college. Expenditures on private education for college students would be low but tuition is much higher. This implies that many Korean parents provide financial supports for their children's college tuition though their supports decrease rapidly from the third year in college.[3]

In Section 4, we use the fraction of total life-time education spending per child in income to calibrate our model. The life-time spending per child for 25 years from birth to age 24 is 9.2% of income. To obtain this, we first sum the education expenditures and incomes separately across ages for 25 years and then divide the sum of expenditures with the sum of incomes (after-tax income).

[3]The rapid drop can be related to the conscription system in Korea. Many male students go to the army after finishing their second year in college.

Figure A2: Household Education Expenditures by Child Age



Notes: This figure shows the total education expenditures on both private and public education per child for 25 years from age 0 to 24 and their shares in household income.

A.3 Instrumental Variable Estimation of Spillovers in Private Education Choice

The two-stage least-squares estimation, Equations (1)–(2), is based on the average regional spending in private education calculated from the Private Education Expenditures Survey (PEES) microdata, and our baseline household-level samples from KLIPS. A very small number of samples remain in our baseline KLIPS data for some provinces once we disaggregate them at the province level. Therefore, we calculate the province-level average variables externally from PEES, which provides richer information at the disaggregated level. Although PEES contains high-quality information on private education spending, income is available only as a categorical variable (eight income categories). Thus, we merge the two data sets for this analysis. All nominal variables are adjusted for inflation using CPI.

We construct the curfew indicators based on the ordinances of each province we collect manually. When the curfew was implemented in the middle of a year, the curfew indicator is set to one for that year. The main results do not change considerably when we allow the indicators to incorporate the intensity using the exact implementation time during the year. Although there are additional variations in the curfews before 2009, we utilize them only from 2009 because the PEES regional information is only available since 2009 (e.g., see also Choi and Choi (2016)). As the final curfew variations occur in 2013, we choose the final year 2015 to capture their potential lingering effects.

Our estimation focuses on parents with middle school students. Elementary school students usually finish school before 3 pm and *hagwon* before dinner. Therefore, the curfews are much less likely to bind for elementary school students. Although a significant portion of high school students do attend *hagwons* late at night (Choi and Cho 2016), curfews for high school students feature much less variations, as shown in Figure A3. For example, most provinces maintain a relatively weak curfew at 12 p.m. for the entire periods. Therefore, these are not suitable for us to use as instruments in the first stage, yielding the weak instrument issue.

Figure A3: Curfews across Province over Time

Panel A. Middle School

Province	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Seoul	10	10	10	10	10	10	10	10	10	10
Busan	10	10	10	10	10	10	10	10	10	10
Daegu	12	12	10	10	10	10	10	10	10	10
Daejeon	11	11	11	11	11	11	11	11	11	11
Incheon	12	12	12	10	10	10	10	10	10	10
Gwangju	10	10	10	10	10	10	10	10	10	10
Ulsan	12	12	12	12	12	12	12	12	12	12
Gyeonggi	11	11	10	10	10	10	10	10	10	10
Gangwon	12	12	12	11	11	11	11	11	11	11
Chungbuk	11	11	11	11	11	11	11	11	11	11
Chungnam	12	12	12	11	11	11	11	11	11	11
Jeonbuk	11	11	11	10	10	10	10	10	10	10
Jeonnam	12	12	10	10	10	10	10	10	10	10
Gyeongbuk	11	11	11	11	11	11	11	11	11	11
Gyeongnam	12	12	12	12	11	11	11	11	11	11
Jeju	12	12	12	11	11	11	11	11	11	11

Panel B. High School

Province	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Seoul	10	10	10	10	10	10	10	10	10	10
Busan	11	11	11	11	11	11	11	11	11	11
Daegu	12	12	10	10	10	10	10	10	10	10
Daejeon	12	12	12	12	12	12	12	12	12	12
Incheon	12	12	12	11	11	11	11	11	11	11
Gwangju	12	12	10	10	10	10	10	10	10	10
Ulsan	12	12	12	12	12	12	12	12	12	12
Gyeonggi	12	12	10	10	10	10	10	10	10	10
Gangwon	12	12	12	12	12	12	12	12	12	12
Chungbuk	12	12	12	12	12	12	12	12	12	12
Chungnam	12	12	12	12	12	12	12	12	12	12
Jeonbuk	11	11	11	11	11	11	11	11	11	11
Jeonnam	12	12	12	12	12	12	12	12	12	12
Gyeongbuk	12	12	12	12	12	12	12	12	12	12
Gyeongnam	12	12	12	12	12	12	12	12	12	12
Jeju	12	12	12	12	12	12	12	12	12	12

Notes: The curfew indicators were constructed by the authors based on the ordinances of each province.

For the exclusion restriction of instrumental variables, it is important that our baseline samples are not directly affected by the curfew changes. In other words, we should consider families with children unlikely to attend *hagwons* after 10 p.m. Since we do not have their time diary information in our KLIPS samples, we indirectly check if our samples, chosen as those whose income is below the median (*low income*) or those families where both parents have at most a high school degree (*low education*), are generally those who spend significantly less in private education.[4]

Specifically, we compute how much less families with low socioeconomic status (SES) spend on private education per child, relative to everyone else, before the period of the main analysis. We focus on the main sample of families with middle school-aged children. Taking simple averages on monthly private education spending per child over 2000–2008, we find that families with low income spend 141,041 KRW, which is substantially lower than 335,041 KRW by families with high income. Similarly, when we use the definition of low SES families by parental education, the difference is similarly considerable: 176,933 KRW (low education) versus 334,897 KRW (high education).

Since the above mean differences may partially reflect provincial income differences, Table A4 reports the coefficient of each low SES dummy variable from a separate equation where we regress private education spending per child on the low SES dummy (either low income or low education) and province fixed effects. The results show that the above mean differences by parental SES remain quantitatively similar.

Additionally, we find a significant positive relationship between the father's income and the student's last *hagwon* attendance time using the Korean Time Use Survey (KTUS) conducted in 2009. Because the KTUS microdata provide only eleven income categories, we calculate the average income of fathers in the KLIPS data corresponding to the KTUS income categories and impute these average values to the KTUS households. Then, we calculate the average income for each *hagwon* attending time from 4 p.m. to midnight, based on the *last attendance time*. Panel A of Figure A4 shows that the father's income is significantly higher for students attending *hagwons* late. Panel B shows the fraction of students for each last attendance time.[5] Only around 15% of students attend *hagwons* at 10 p.m. or later. Panels C and

[4]In doing so, we also circumvent the reflection problem (Manski 1993) because the regressor is based on rich families.

[5]The total sum is around 68% as 32% of students do not attend *hagwons*.

Table A4: Private Education Spending by Parental Socioeconomic Status (SES)

(Unit: 1,000 KRW)	(1)	(2)
Low SES indicator	-185	-152
s.e.	(22.5)	(21.7)
Definition of Low SES	Income	Education
Province FE	Yes	Yes
Obs.	4,225	
Avg. Monthly Spending per Child	240	

Notes: Reported values are the coefficient estimates from a regression equation where the dependent variable is monthly private education spending per child at the household-level in 1,000 KRW. We regress this on the indicator variable for either "low income" or "low education" while controlling for province fixed effects over 2000–2008. Standard errors are clustered at the province level. As of 2022, 1,200 KRW corresponds approximately to 1 USD.

D show the fraction of students divided by father's income (low income: bottom 6 income categories among eleven) and parents' education (low education: both parents at most a high school degree). Notably, the relative shares of high-income and high-education families increase as students attend *hagwons* late.

We also use the PEES microdata to inspect if curfew adoptions across provinces were plausibly exogenous. Specifically, we check the trend of private education spending using the following regression:

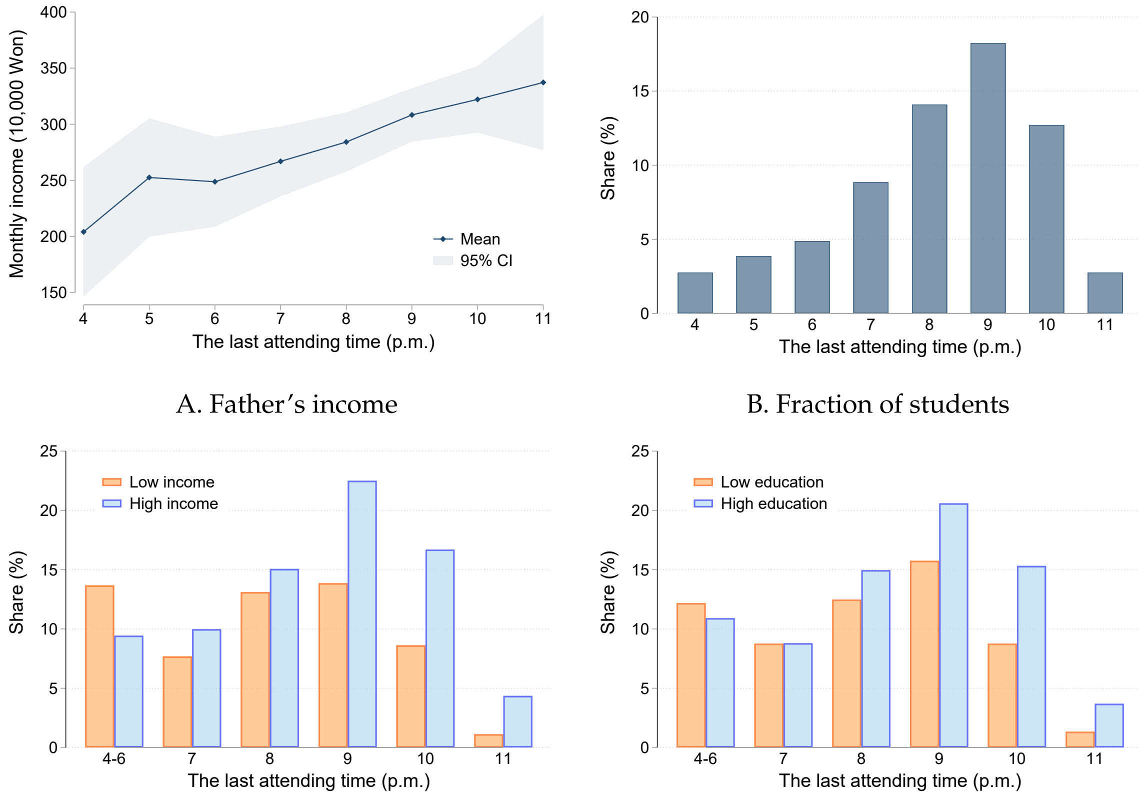
$$\ln E_{ist} = \sum_{t \neq 2009} \alpha_t \mathcal{Y}_t + \sum_{t \neq 2009} \eta_t (T_s \times \mathcal{Y}_t) + \xi_s + \epsilon_{ist} \tag{A1}$$

where $\ln E_{ist}$ is the log of (real) average private education expenditures per child for household i in province s and year t. $\mathcal{Y}_t$ is the year dummies. $\mathcal{Y}_{2009}$ is excluded as the base year. T_s is the indicator for provinces with curfew changes from 2011 to 2013 (*treatment group*). The other group of provinces (*control group*) had not experienced curfew changes since 2009. ξ_s is the province fixed effect.[6]

Figure A5 illustrates the average log private education expenditures for the two groups of provinces as specified in Equation (A1): Panel A for all households, Panel B for the bottom 50% income households, Panel C for the top 50% income house-

[6]The regression excludes one province, Daejeon, where the curfew changed in 2009, the start year of the analysis window. Including Daejeon does not make a significant change.

Figure A4: Students' Last *Hagwon* Attendance Time



A. Father's income

B. Fraction of students

C. Fraction by father's income

D. Fraction by parents' education

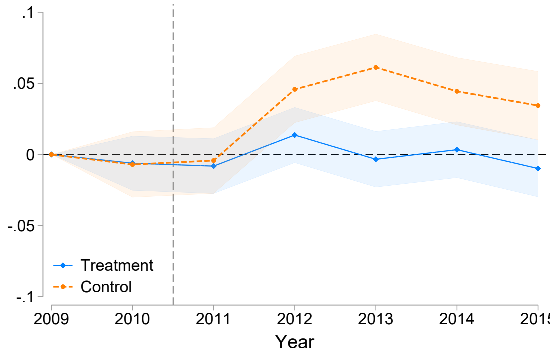
holds, and Panel D for the top 15% income households.[7] Panel A shows that pre-trends were not distinguishable between the two groups, which means that the parallel-trend assumption is satisfied. Panel B shows no significant differences in the spending of low-income households between the two groups. Panels C and D show significant differences in spending between the two groups after 2011 for high-income consumers, with a larger difference among the top 15% income households.

In addition, we re-estimate the IV regression using different income groups to construct the regional average variable E_{st}. For the comparison group, we consider top 5% and top 50% in addition to top 15%.[8] The first-stage F-statistics and the second-stage β are given in Table A5. A small value of the F-statistic would indicate the

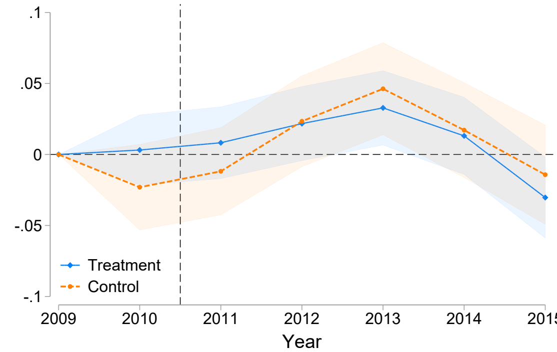
[7]We define households in the bottom four categories as low-income households. These households are roughly half of all households. The top two income categories account for around 15% of all households. Note that when we focus only on the top income category, the direct effect becomes smaller and less significant.

[8]The top 5%, 15%, and 50% correspond to the top one, top two, and top four categories, respectively, in the PEES data.

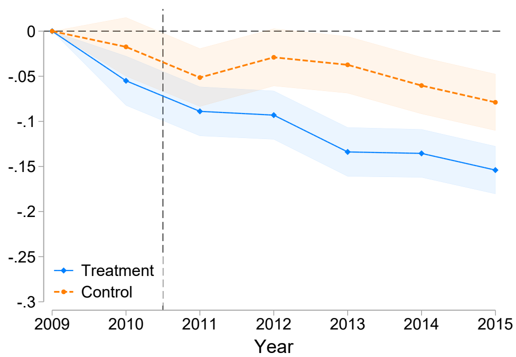
Figure A5: Curfew Changes and Trends in Private Education Spending



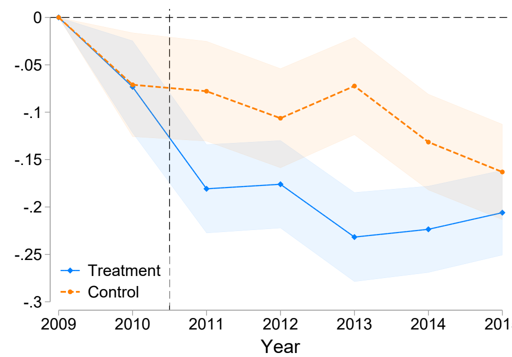
A. All households



B. Bottom 50% income households



C. Top 50% income households



D. Top 15% income households

Notes: The lines depict the average log private education expenditures for the treatment group (with a curfew change since 2011) and control group (with no curfew change) as specified in Equation (A1). The shaded areas indicate the 95% confidence intervals.

issue of weak instruments, leading to biased estimates of the spillover effects. Note that F-statistics become noticeably smaller for the cases with the top 5% or top 50% groups. If the definition is narrow (top-5%), then the number of observations for the first stage becomes very small. This in turn makes the regional average of the rich less accurate statistically, as manifested by the lower F-stats compared to the ones from top 15%. On the other hand, since the curfews affected relatively rich families the most, the first stage F-statistic becomes lower if a broader income group is used (top-50%). Therefore, we opt for the top 15% income households to construct the regional average spending (E_{st}) for the baseline IV regression in the main text. Nonetheless, we find that the estimates of β do not change wildly across the different definitions.

Table A5: Results with Different Groups for Regional Spending E_{st}

E_{st} based on:			Low Income		Low Education	
Top 5%	*2nd stage*	β	0.057	0.054	0.034	0.046
		s.e.	(0.014)	(0.037)	(0.013)	(0.039)
	1st stage	F-stat.	9.4	2.1	11.1	2.4
Top 15%	*2nd stage*	β	0.065	0.049	0.039	0.042
		s.e.	(0.014)	(0.038)	(0.015)	(0.043)
	1st stage	F-stat.	16.6	4.4	20.0	5.2
Top 50%	*2nd stage*	β	0.109	0.081	0.071	0.070
		s.e.	(0.027)	(0.049)	(0.026)	(0.063)
	1st stage	F-stat.	6.9	3.2	6.8	3.1
Year FE:			No	Yes	No	Yes

Notes: This table shows F-statistics of the first stage in the IV regression and the β-estimates of the second stage, with and without year fixed effects, using different groups to construct the regional spending variable E_{st}.

There are also recent empirical studies related to our findings. These papers adopt different empirical strategies and find a positive peer effect on parents' investment. For example, Kim, Jang, and Kim (2022) and Guo and Qu (2022) use the random class assignment of students within schools in Korea and China, respectively. Agostinelli (2018) uses changes in racial composition across cohorts within a school in the U.S.

A.4 Intergenerational Persistence

To estimate the intergenerational persistence of income between parents and children, we use our samples from the KLIPS data. Specifically, we first select households with information on labor earnings (including self-employed) for both parents and children in working ages. We focus on the average income of fathers aged 39 to 44 and that of children aged 30 to 35. We include households only when they have at least two observations for each person in the target ages. The number of matches increases as the gap in the target age bands for fathers and children getting apart. However, to get a better measure of the intergenerational earnings persistence, it is

Table A6: Intergenerational Elasticity of Earnings

	Father's age		
	39-42	40-43	41-44
Child's age			
30-33	0.28	0.25	0.23
31-34	0.36	0.24	0.23
32-35	0.41	0.53	0.35

Notes: This table shows the estimated intergenerational earnings persistence when ages of fathers and children vary.

better to reduce the gap in target age bands. We select the current age bands for fathers and children to balance these two factors. Also, we can mitigate the life-cycle bias by focusing on the narrow target ages for parents and children (Haider and Solon 2006). Among parents, we use father's earnings because mother's working status is affected more by other factors than human capital, such as childbearing. This is standard in the empirical literature on intergenerational mobility (Solon 1999). Then, we regress the log income of children on the log income of father. The estimates depend on the target ages of fathers and children. Table A6 shows that the estimated elasticity ranges from 0.2 to 0.5. We take the simple mean of the estimates, 0.32, for calibration. This value is quite close to the U.S. estimates (Chetty et al. 2014).

A.5 Fertility by Cohorts

Our baseline results are based on the women born between 1970 and 1975. Since the fertility rate has been decreasing quickly in Korea, we check how the relationship between fertility and income has been changed. Table A7 shows the number of children and childlessness rate for the recent cohorts (women born in 1970-75) and the earlier cohorts (women born in 1961-66). Overall, the number of children is higher, and the childlessness rate is lower for the earlier cohorts. Next, we find that the positive slope between the number of children and income is slightly steeper for recent cohorts, as compared to the earlier cohorts. For example, the estimated income elasticity of fertility is 0.082 from our recent baseline cohort samples, whereas it is 0.041

Table A7: Fertility and Income (Couples Only)

Income quintile	Number of children		Childlessness rate (%)	
	1970-75	1961-66	1970-75	1961-66
1th	1.80	1.99	5.26	3.17
2nd	1.91	1.97	3.97	0.79
3rd	1.87	2.06	1.99	0.79
4th	1.93	2.13	1.32	0.00
5th	2.03	2.08	1.99	0.79

Notes: This table shows the average fertility rate, the childlessness rate in each income quintile for each cohort group excluding single households.

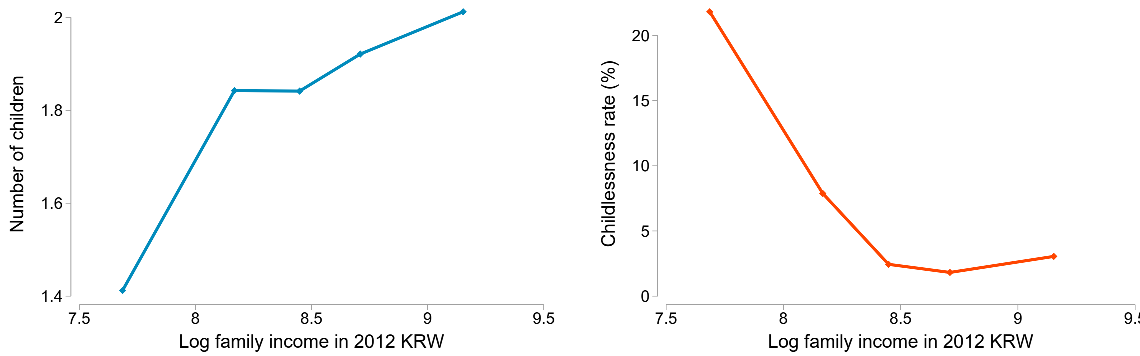
in these earlier cohorts. Finally, the last two columns of Table A7 show that the relationship between fertility and childlessness rates is still negative also for the earlier cohorts although the overall childlessness rate was even lower at 1.1% compared to 2.9% for the recent cohorts.

A.6 Income and Fertility for Singles and Couples

As explained in Section 2, our main analysis focuses on the couples, excluding singles such as widowed, divorced, separated, and never married females. Among our target cohorts who answer the question about marriage status in KLIPS, there is no never-married women whose ages are in between 40 and 43. However, there are missing answers, and we define these women as singles if they do not have information about spouse such as age. If they have information about spouses, we define they are couples. Among the target households, the portion of single women is around 8%. The portion of never-married women in Korea is in an increasing trend especially for young women in their 30s. These young women are not included in our analysis because they are still in their childbearing years and the completed fertility cannot be calculated for them.

Note that there are several issues when it comes to the relationship between fertility and income if we include singles. First, the completed fertility, the number of children a woman ever had, and income are somewhat systematically influenced by being single. Single families tend to have lower income than couples and are more

Figure A6: Fertility by Income Quintile (including Singles)



A. Completed fertility

B. Childlessness rate

Notes: We group all households including singles into quintiles based on their long-term income and calculate the average completed fertility and the childlessness rate in each quintile for cohorts born in between 1970 and 1975.

likely to have lower fertility. Therefore, the positive relationship between the completed fertility and income and the negative relationship between the childlessness rate and income become stronger when we include single households (See Figure A6). The changes mostly come from the childlessness rate and from the lowest-income quintile as this group includes most of the single women.

A.7 Time Use of Parents

We calculate the average weekly working hours and the average parental time per child using the KLIPS data. We focus on adults aged between 26 and 50 (inclusive). We use *regular* working hours for wage workers and *average* working hours for non-wage workers. The total average working hours include both intensive and extensive margins. As our model does not take into account gender differences, we take the equal-weight average of both members of households. As a result, we get the total average working hours of 30.1 hours per week.

To calculate the average parental time per child, we use the supplementary survey of KLIPS on the use of time conducted in 2014. The survey respondents recorded what they did for 24 hours by a 30-minute interval. Thus, we take the total hours used for childcare and multiply 7 to calculate weekly parental time. We focus on parents

Table A8: Average Weekly Childcare Hours by Parental Education

	(1) Young children		(2) Any children	
Education:	High	Low	High	Low
Mothers	24.6	25.6	16.4	15.4
No. obs.	(319)	(474)	(589)	(1,058)
Fathers	6.4	5.9	4.8	3.7
No. obs.	(394)	(399)	(749)	(898)

Notes: This table reports the average weekly childcare hours by parental education (1) if the minimum age of children is less than or equal to five, or (2) if the maximum age of children is less than 18. "High" refers to college-educated, and "Low" refers to below college-educated. The numbers in parentheses are the number of observations.

whose children's ages are below 18 years old. On average, mothers spend more time with children (15.8 hours per week) than fathers (4.2 hours per week). This pattern is similar to the U.S., where mothers and fathers spend 14.0 and 6.8 hours per week, respectively, with their children (Guryan, Hurst, and Kearney 2008), though the gender gap is slightly larger in Korea. Because our model does not address gender differences, we take an average of the time spent by mothers and fathers and divide it by the average number of children (1.76) to obtain average time per child (5.7 weekly hours).

Table A8 reports the average childcare time by education. We consider two cases: (1) if the minimum age of children is less than or equal to five (i.e., with young children); and (2) if the maximum age of children is less than 18 (i.e., with any children). It is not clear that more educated parents spend more time with children in Korea. This is in contrast to the robust positive educational gradients in parental time in U.S. data (Guryan, Hurst, and Kearney 2008).

A.8 Low Fertility Awareness Survey

The Korea Population, Health and Welfare Association conducted the Low Fertility Awareness Survey in 2017 (Korea Population, Health and Welfare Association 2017). Table A9 shows responses to the question "What do you think are the main causes of low birth rates?" The answers reveal that the most important reason for the low

Table A9: Survey Responses of Reasons for the Low Birth Rate

Reason for low birth rate:	Fraction (1)	Fraction (2)
Financial burden of raising children (education expenses, etc.)	42.6%	64.3%
Lack of work-parenting balance culture (overtime work, etc.)	14.3%	33.3%
Delay of marriage or no marriage	13.0%	26.8%
Difficulty of getting a job	6.8%	13.0%
Changes in values for children (no children, one child)	6.4%	17.5%
Difficulty of getting a house	5.6%	12.2%
Unequal division of housework and care (childcare) toward women	4.3%	9.4%
Insufficient government support for childcare	3.2%	11.4%
Lack of day-care facilities to leave children safely	3.1%	10.8%
Economic hardship or income inequality	0.4%	0.4%

Notes: This table shows responses to the question ”What do you think are the main causes of low birth rates?” Column (1) shows the portion of answers based on the first priority only. Column (2) is based on the first and second priorities. The answers are ordered based on column (1).

birth rate is the financial burden of raising children, including education expenses. This result suggests that our mechanism is the most relevant to the recent cohorts' fertility decisions in Korea. On the other hand, unequal division of housework and care (childcare) toward women, which used to be considered a key driver of low fertility in Korea, is the seventh reason based on the first priority and the ninth based on the first and second priorities.

B Theoretical and Computational Appendix

B.1 Equilibrium Definition and Computation

The key object of the stationary general equilibrium is the endogenous distribution of human capital. In stationary equilibrium, $\tilde{h}$ is constant, thus not an aggregate state variable.

A stationary equilibrium is a set of decision rules $n(h, b, \kappa^p)$, $l(h, b, \kappa, n)$, $c(h, b, \kappa, n)$, $x(h, b, \kappa, n)$, aggregate quantity L, and the distribution $F(h, b, \kappa^p)$ such that

- Given prices, households' decision problem leads to $n(h, b, \kappa^p)$, $l(h, b, \kappa, n)$, $c(h, b, \kappa, n)$, and $x(h, b, \kappa, n)$.
- Prices are competitively determined: $w = A$.
- Markets clear:

$$L = \sum_j^{N_\kappa} \tilde{\pi}_j^\kappa \sum_i^{N_b} \pi_i^b \int_h \sum_k^{N_\kappa} \pi_{jk}^\kappa \left(h \left(1 - \lambda n(h, b_i, \kappa_j^p) - l(h, b_i, \kappa_k, n(h, b_i, \kappa_j^p)) \right) \right) F(dh, b_i, \kappa_j^p). \tag{A2}$$

- The stationary distribution of human capital is a fixed point:

$$\int_0^{h_c} F(dh, b_m, \kappa_k) = \frac{\sum_j^{N_\kappa} \tilde{\pi}_j^\kappa \sum_i^{N_b} \pi_i^b \int_{\{h | \mathfrak{h}(h, b_i, \kappa_k) \leq h_c\}} \pi_m^b \pi_{jk}^\kappa n(h, b_i, \kappa_j^p) F(dh, b_i, \kappa_j^p)}{2(1+g)} \tag{A3}$$

  where $\mathfrak{h}(h, b_i, \kappa_k)$ is the human capital implied by the decision rules—$n(h, b_i, \kappa^p)$ and $x(h, b_i, \kappa_k, n(h, b_i, \kappa^p))$—and κ_k, and the population growth rate is given by

$$1 + g = \frac{\sum_j^{N_\kappa} \tilde{\pi}_j^\kappa \sum_i^{N_b} \pi_i^b \int_h n(h, b_i, \kappa_j^p) F(dh, b_i, \kappa_j^p)}{2}. \tag{A4}$$

Theoretically, $\tilde{h}$ is also a key object but is immediately found as a by-product once we obtain the distribution. The key restriction of the equilibrium distribution is that it should be stable over time when implied by the policy functions given $\tilde{h}$, which is implied by the distribution. The below algorithm uses an iterative method to find the policy tool that clears the government budget.

1. Make an initial guess for government lump-sum taxes (or transfers) T.
2. Make an initial guess for the distribution $F(h, b, \kappa_j^p)$ (which also gives $\tilde{h}$).
3. Given $\tilde{h}$ and T, compute $V(h, b, \kappa_k, n)$ and the (conditional) policy functions for consumption $c(h, b, \kappa_k, n)$, investment $x(h, b, \kappa_k, n)$ and leisure $l(h, b, \kappa_k, n)$.
4. Compute the expected value function $\sum \pi_{jk}^{\kappa} V(h, b, \kappa_k, n)$ and based on it, obtain the policy function for fertility $n(h, b, \kappa_j^p)$.
5. Obtain the time invariant distribution $F(h, b, \kappa^p)$, based on the policy functions for fertility $n(h, b, \kappa^p)$ and $x(h, b, \kappa, n)$. obtained above.
6. Iterate from 2 to 5 until $F(h, b, \kappa^p)$ converges.
7. Compute T by checking government budget based on the policy functions and the distribution obtained above.
8. Iterate from 1 to 7 until T converges.

The stationary equilibrium definition should be generalized slightly for equilibrium along the transitional path. There are two key changes. First, the state vector additionally includes an aggregate state: $\tilde{h}$. Second, the last condition for the fixed-point stationary distribution is replaced by the consistency condition stating that in each period, the agents' perceived law of motion, $\tilde{h}' = \Gamma(\tilde{h})$, is consistent with the actual evolution of $\tilde{h}$ implied by the current distribution $F(h, b_i, \kappa^p)$ and the equilibrium decision rules.

Along the transition path, the key equilibrium object is the distribution of human capital in each period over time (or mean human capital over time given the stationary distributions at the end periods). As in steady state, the key properties of these distributions are that they should be consistent with both individual agents' expectations and the actual evolution implied by the policy functions that take into account the expectation. Below is an algorithm to find the equilibrium transition that clears the government budget in each period as well, but note that there can be alternative ways of obtaining the same equilibrium.

The economy is initially in steady state. In period $t = 1$, the economy is hit by the policy change. Let $\tilde{t}$ denote the time period sufficiently long enough so that the economy converges to the new steady state with new policy.

1. Compute the original steady state and the new steady state following the algorithms above. Store the information of the original steady state as $t = 0$ and that of the new steady state as $t = \tilde{t}$.

2. Make initial guesses for a sequence of government taxes (or transfers if negative) for each period $\{T_t\}_{t=1}^{\tilde{t}-1}$.

3. Make initial guesses for the evolution of the benchmark human capital $\left\{\tilde{h}_t\right\}_{t=2}^{\tilde{t}-1}$.

4. For each period $t = 1, ..., \tilde{t} - 1$, given $\tilde{h}_{t+1}$, T_t and policy variables specified, compute the (conditional) policy functions for consumption $c_t(h, b, \kappa_j, n)$, investment $x_t(h, b, \kappa_j, n)$ and leisure $l(h, b, \kappa_j, n)_t$.

5. Compute the expected value function $\sum \pi^{\kappa}_{jk} V_t(h, b, \kappa_k, n; \tilde{h}_t)$ and based on it, obtain the policy function for fertility $n_t(h, b, \kappa^p_j)$ for all $t = 1, ..., \tilde{t} - 1$.

6. Obtain the distribution $F_{t+1}(h, b, \kappa^p)$ for $t = 1, ..., \tilde{t} - 2$, based on the policy functions for fertility $n_t(h, b, \kappa^p)$ and $x_t(h, b, \kappa_j, n)$ obtained above. Compute $\tilde{h}_t$ based on $F_t(h, b, \kappa^p)$ for $t = 2, ..., \tilde{t} - 1$.

7. For $t = 1, ..., \tilde{t} - 1$, compute T_t by checking government budget based on the policy functions and the distribution obtained above.

8. Iterate from 1 to 7 until $\{T_t\}_{t=1}^{\tilde{t}-1}$ and $\left\{\tilde{h}_t\right\}_{t=2}^{\tilde{t}-1}$ converge.

B.2 Details about Calibration

Our calibration target moments include the spillover effect estimated from the instrumental variable regression in Section 2.2, in the spirit of indirect inference. We compute the spillover effect in the model as follows.

Specifically, for each evaluation of a set of parameter values, we first need to figure out the required change in $\tilde{h}'$ induced by an exogenous change in the education spending of the rich parents (top 15%). To do so, using the human capital technology (4), we compute the average of children's human capital from the top 15% parents under two scenarios:

$$\bar{h}'_{top,0} = A_h \bar{\kappa}_{top} \big(\theta + \bar{x}^{\alpha}_{top}\big) \tag{A5}$$

$$\bar{h}'_{top,1} = A_h \bar{\kappa}_{top} \Big(\theta + \big((1+\Delta_{top})\bar{x}_{top}\big)^{\alpha}\Big) \tag{A6}$$

where $\bar{\kappa}_{top}$ and $\bar{x}_{top}$ refer to their respective average values among the top 15% families based on the steady state distribution of human capital. Let $\Delta_{\bar{h}'_{top}}$ denote the ratio $(\bar{h}'_{top,1}/\bar{h}'_{top,0})$.

We then solve the model again by using the benchmark human capital exogenously set at $\tilde{h}_1 \equiv \Delta_{\bar{h}'_{top}} \times \tilde{h}_0$ where $\tilde{h}_0$ is the equilibrium benchmark (i.e., top 15% average human capital among children) based on the steady state distribution. Using the simulated data, the share of education spending in total expenditures,

$$\tilde{\vartheta} \equiv \frac{x_i}{c_i + x_i n_i}, \tag{A7}$$

is computed using $\tilde{h}_1$ (which gives $\tilde{\vartheta}_1$) and also using $\tilde{h}_0$ (which gives $\tilde{\vartheta}_0$). The model-implied spillover effect then is given by:

$$100 \times (\mathbb{E}(\tilde{\vartheta}_1|\Upsilon_{bottom}) - \mathbb{E}(\tilde{\vartheta}_0|\Upsilon_{bottom}))/\Delta_{top}, \tag{A8}$$

where we use the conditional means of $\tilde{\vartheta}$ among the families whose income is below the median income (i.e., Υ_{bottom}) in the steady state. We use $\Delta_{top} = -0.1$ in our calibration, and check robustness around this value.

B.3 Policy Effects without Externality Feedback

One might ask what role the externality plays in the policy experiments presented in Section 6. In particular, does the externality amplify or mitigate government policy? To assess this, one could set $\chi = 0$ and recompute the policy experiments. However, note that a positive χ has not only equilibrium feedback effects but also a level effect, as is investigated in Section 5. To isolate the role of equilibrium feedback channel, we thus hold the functional form constant while fixing the value of $\tilde{h}$

Table A10: Long-run Policy Effects without Externality Feedback

	Baseline	$\psi = .02$		$\tau_x = .20$	
Externality Feedback?	Yes	Yes	No	Yes	No
Fertility rate n	1.92	2.08	2.06	2.01	1.97
		(8.5%)	(7.4%)	(4.8%)	(3.0%)
Childlessness rate	3.4%	2.9%	3.1%	3.3%	3.5%
Avg x per kid/income	11.0%	9.9%	10.1%	7.4%	7.7%
Avg labor supply	.290	.286	.287	.275	.277
Avg human capital	3.29	3.20	3.21	3.11	3.13

at 5.78, its steady state value of the no-policy economy (i.e., treating it like a parameter). In other words, we allow no feedback effects and thereby essentially shut off the externality while keeping the functional form the same.

Table A10 reports the policy effects when we shut down the externality feedback channel. We can see that in the model without externality feedback, fertility tends to increase less and negative effects of the two policies on education expenditure become mitigated. Overall, the above results indicate that externality feedback helps the policy tools to better achieve their policy goals (i.e., raising fertility while reducing education expenditures).

B.4 Effects of Means-tested Pro-natal Transfers

Table A11 reports the long-run effects of pro-natal transfers for two cases. The first case corresponds to the universal one independent of income. The second case is means-tested in that pro-natal transfers are provided only if family income is below the income threshold level. We set the threshold level to 0.81, below which 50% of families belong to in the universal pro-natal transfer economy. To make the comparison easier, the value of $\psi = 0.0266$ is chosen such that the required ratio of taxes to output is the same in the two cases.

For a given government budget, means-tested transfers are more effective in raising the fertility rate and reducing the childlessness rate. As they operate mostly on the poorer half of the population, they also change the fertility-income relationship by more leading to a relatively large negative income elasticity of fertility. On the flip

Table A11: Long-run Effects of Pro-natal Transfers: Universal vs. Means-tested

		Pro-natal transfers	
	Baseline	Universal	Means-tested
Fertility rate n	1.92	2.08	2.14
(% change)		(8.5%)	(11.5%)
Childlessness rate	3.4%	2.9%	2.6%
Avg x per child/income	11.0%	9.9%	9.4%
Income elasticity of n	.080	-.021	-.096
Income elasticity of x	.775	.868	.868
Avg labor supply	.290	.286	.276
Avg human capital	3.29	3.20	3.14
Output per capita	.958	.918	.873
Gini income	.266	.271	.282
IGE	.327	.324	.318
T/Y		4.5%	4.5%

Notes: Numbers in parentheses show the percent change relative to the baseline model. T denotes lump-sum taxes. The second column shows the results with $\psi = 0.02$. In the last column, pro-natal transfers are assumed to be given to those below the income threshold level, which is set to 0.81 (below which 50% of families belong to in the universal pro-natal transfer economy). The value of $\psi = 0.0266$ is chosen such that the required ratio of taxes to output is the same as the second column.

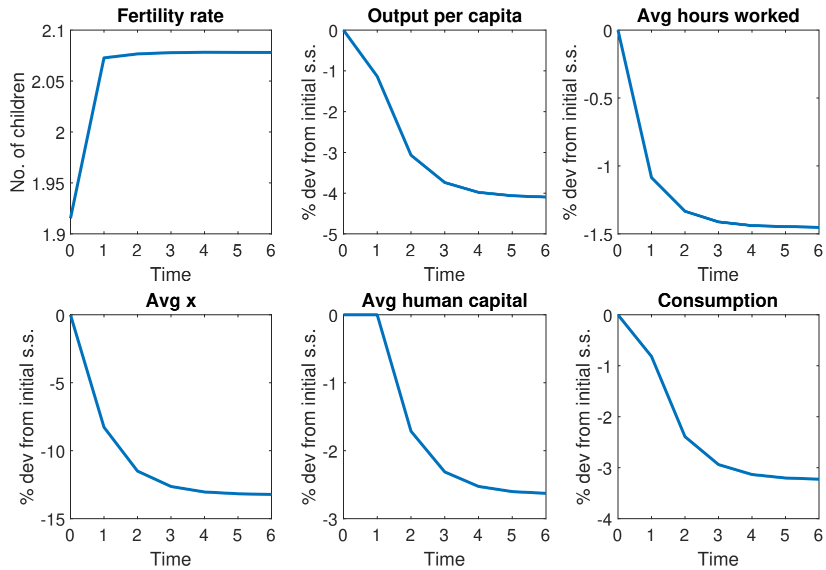
side, output per capita falls by more precisely because more children are now born to parents with lower human capital and those children themselves will have lower human capital (as parents invest less but also because of a lower expected κ).

B.5 Policy Effects along the Transition

The results discussed in Section 6 capture long-run changes. But how long would it take to reach the new steady state and what would be the effects on fertility during the transition? To answer these questions, we now consider full transition dynamics. Specifically, until period 0, the economy is in the initial steady state. Then, at the beginning of period 1 ($t = 1$), a certain policy reform is introduced unexpectedly and permanently. The economy then transitions to a new steady state.

Figure A7 plots the transitional dynamics when a pro-natal transfer of $\psi = 0.02$ is introduced, unexpectedly and permanently, at the beginning of period 1. The fertil-

Figure A7: Policy Effects along the Transition: Pro-natal Transfers



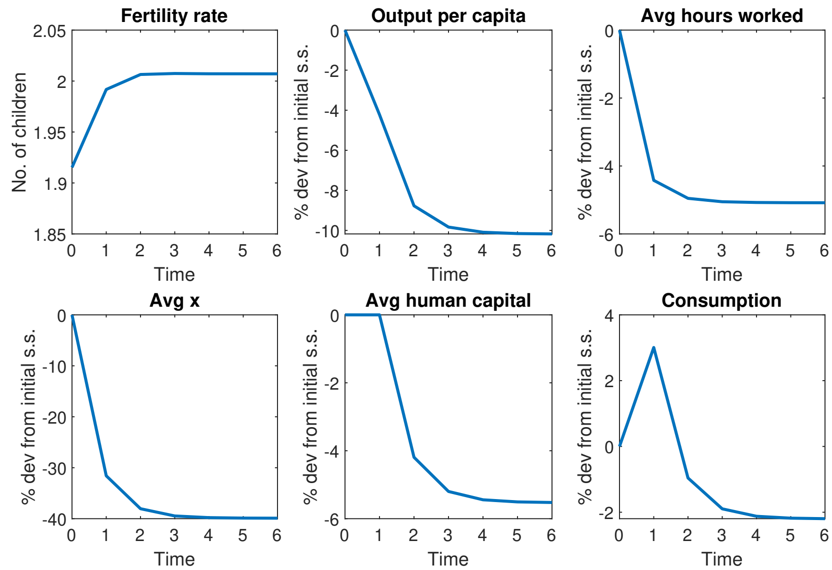
Notes: A pro-natal transfer of $\psi = 0.02$ is introduced unexpectedly and permanently in period 1. A model period corresponds to 25 years.

ity rate and labor supply respond immediately when the policy is introduced, while the other aggregate variables, such as output, consumption, and human capital, decline gradually towards the new steady state. Given that the change in labor supply is quite small, the decline in output per capita is driven by the decline in aggregate human capital due to reduced spending on education.

Figure A8 shows how the key macroeconomic variables evolve during the transition to the new steady state, following educational tax changes. In period 1, right after the introduction of the tax, education spending per child (x) drops quite significantly. Since the need for funds to spend on education decreases, parents work less. The human capital of adults entering the period 1 (or the first generation) is not affected by policy changes because human capital is a state variable. However, the human capital of the following generations is affected as the first generation's endogenous investment decisions start to have intergenerational consequences. Because people have lower human capital and work less, output per capita falls over time. This demonstrates that taxing education spending to address the externality-driven distortions may not be desirable for future generations due to the adverse long-run implications for human capital accumulation.

The bottom right panel of Figure A8 shows that the first generation actually expe-

Figure A8: Policy Effects along the Transition: Private Education Taxes



Notes: The reform ($\tau_x = 0.2$) is introduced unexpectedly and permanently in period 1. A model period corresponds to 25 years.

riences an increase in consumption. Given that the quantity and quality of children both decrease, parents (the first generation) benefit from the education tax by enjoying more leisure and consumption, whereas future generations experience lower human capital and consumption relative to the initial steady state.

B.6 Ramsey Planning Problem

We consider a Ramsey-style optimal policy problem. Let us consider a social planner who faces the steady state equilibrium with $\tau_x(t) = \psi(t) = T(t) = 0$ in period $t = ..., -2, -1, 0$. In period $t = 1$, given the distribution $F_{t=1}(h, b, \kappa^p)$, the planner is given the optimal policy instruments considered in Section 6: $\tau_x(t)$ and $\psi(t)$. The optimal policy problem is to maximize the weighted social welfare by introducing $\tau_x(t)$ and $\psi(t)$, while satisfying the period budget constraint through $T(t)$ for $t = 1, 2, ..., \infty$. Specifically, the planner solves

$$\max_{\tau_x(t),\psi(t)} \sum_j^{N_\kappa} \tilde{\pi}_j^\kappa \sum_i^{N_b} \pi_i^b \int_h \varphi(\cdot) \left\{ \mathbb{E}_{\kappa|\kappa^p} V_{t=1}(h, b, \kappa, n_t; \tilde{h}_t) \right\} F_{t=1}(dh, b_i, \kappa_j^p)$$

subject to government budget constraints in period $t = 1, 2, ..., \infty$:

$$\sum_{j}^{N_\kappa} \tilde{\pi}_j^\kappa \sum_{i}^{N_b} \pi_i^b \int_h \left[\psi(t) n_t - \tau_x(t) x_t n_t - T(t)\right] F_t(dh, b_i, \kappa_j^p) = 0, \tag{A9}$$

where $\tilde{\pi}_j^\kappa$ captures the probability mass of κ_j^p and n_t, c_t, x_t and l_t are the policy functions that solve each family's optimization problem of (6)–(8) in each period t. We consider two possible welfare weights $\varphi(\cdot)$: (i) Negishi weights and (ii) equal weights. Next, note that we present two cases depending on policy tools allowed for the planner. The *permanent* policy reform restricts $\tau_x(t)$ and $\psi(t)$ to be $\tau_x^* \in [0, 1]$ and $\psi^* \in \mathbb{R}_{\geq 0}$, respectively, for all $t = 1, 2, ..., \infty$. On the other hand, the *temporary* policy reform allows $\tau_x(t = 1)$ and $\psi(t = 1)$ to be $\tau_x^* \in [0, 1]$ and $\psi^* \in \mathbb{R}_{\geq 0}$, respectively, and $\tau_x(t) = 0$ and $\psi(t) = 0$ for all $t = 2, ..., \infty$.

B.7 Welfare Weights

To construct Negishi weights, we estimate consumption of each household using state variables, such as h, κ^p, b, and κ. As Negishi weights are proportional to the inverse of the marginal utility of consumption ($b/\hat{c}$ in our model), Negishi weights are constructed as follows. First, using the simulated cross-sectional data in steady state, estimate coefficients, $\left\{\hat{\beta}_0, \hat{\beta}_1, ..., \hat{\beta}_4\right\}$ from

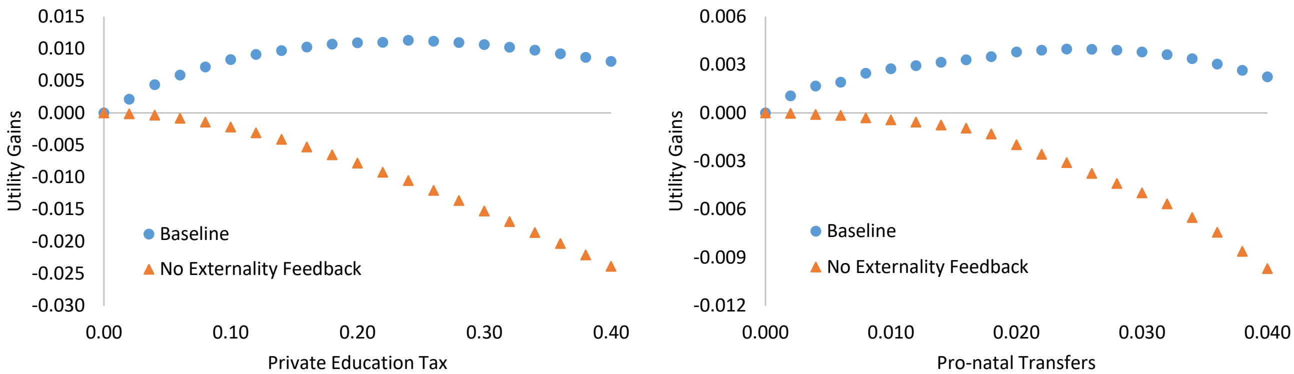
$$\log c = \beta_0 + \beta_1 \log h + \beta_2 \log \kappa^p + \beta_3 \log b + \beta_4 \log \kappa + \epsilon. \tag{A10}$$

Then, along the transition path, for an individual with a state vector (h, κ^p, b, κ), we use the estimated $\left\{\hat{\beta}_0, \hat{\beta}_1, ..., \hat{\beta}_4\right\}$ to predict $\hat{c}$, which gives $\varphi = \hat{c}/b$. Finally, we re-scale φ in each period such that they sum up to one.

B.8 Marginal Effect of Each Policy

To better understand the importance of the two policy instruments, it is instructive to see the marginal effects of each policy instrument on the welfare of the first generation, which is portrayed in Figure A9. The change in the weighted average utilities of the first generation has a hump-shape for each policy individually in our base-

Figure A9: Effects of Each Policy on First Generation.



line model with externality feedback. By contrast, it also shows that any positive education tax or positive pro-natal transfers would reduce the welfare of the first generation in an economy without such externality feedback.

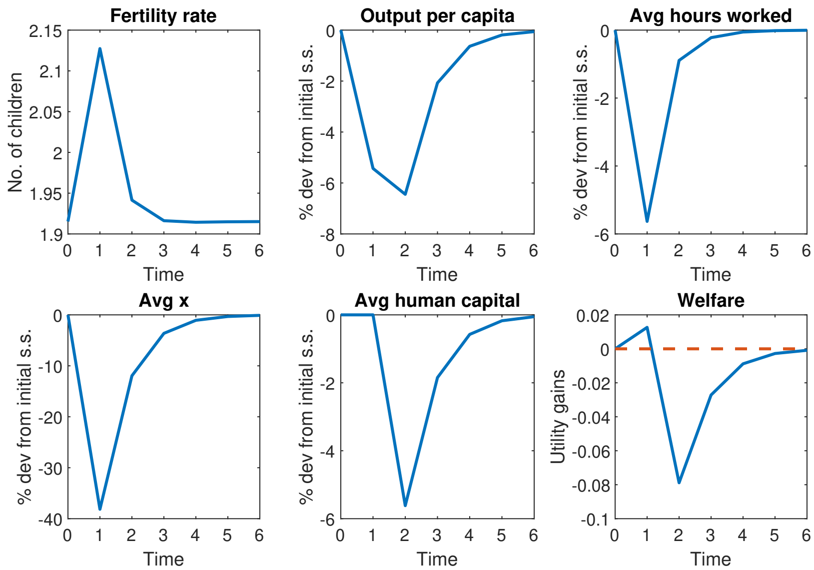
B.9 Additional Optimal Policy Results

Note that policy reforms can also take place only temporarily on the first generation to focus on addressing distortions for the first generation that has the fixed pool of agents since their parents already made fertility decisions. The optimal policy mix is a combination of $\psi = 0.0178$ and $\tau_x = 0.216$, which are virtually identical to the counterpart with permanent changes in the main text. Transitions with the optimal policy are shown in Figure A10. The temporary policy reform has almost identical effects on the first generation. After the policy change is revoked, fertility, hours worked, and education spending go back to the initial level quite quickly while human capital and output move more slowly over time.

In the optimal policy exercise in the main text, we have mainly used unequal welfare weights that are designed to focus on the distortions generated by the status externality. In this subsection, we present optimal policy results when we use equal welfare weights, which are widely used in the quantitative macroeconomics literature. This exercise illustrates that these equal weights put substantial motives for redistribution, as compared to our baseline welfare weights.

When we use the equal welfare weights, the optimal policy mix sets higher education tax rates while the pro-natal transfer is zero $\psi = 0.0$ whether policy changes

Figure A10: Optimal Policy: Unexpected and Temporary Policy Reform

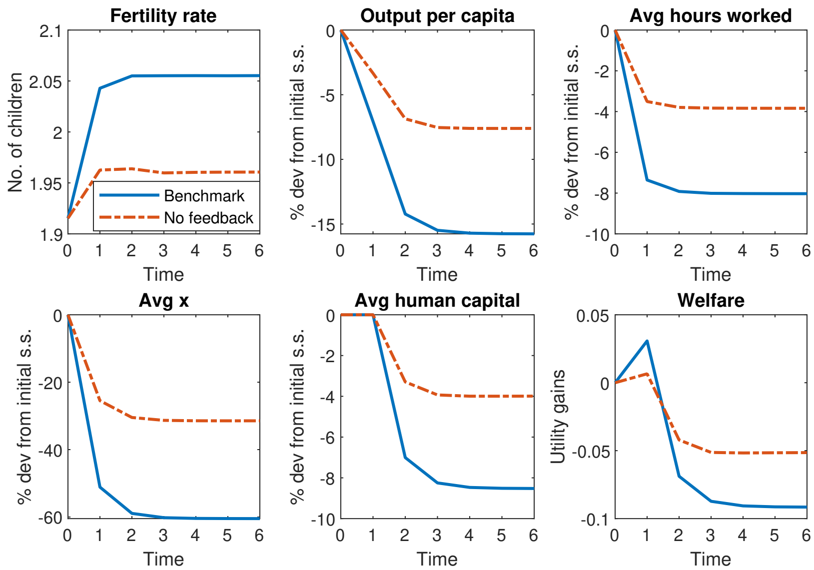


Notes: The optimal policy reform is introduced unexpectedly and temporarily in period 1. Welfare is measured by Negishi-weighted average utility. A model period corresponds to 25 years.

are permanent or not. Specifically, when policy changes are permanent, optimal $\tau_x = 0.397$ with externality feedback, which is considerably larger than the optimal tax $\tau_x = 0.167$ without it. When the externality feedback is shutdown, the optimal policy leads to the welfare gain for the first generation that is smaller than its counterpart in the baseline model with externality. Figure A11 shows the transition dynamics with respect to these two optimal policies for their corresponding economies (with/without externality feedback). When policy changes are only temporary, optimal policies are similar: $\tau_x = 0.398$ with externality feedback and $\tau_x = 0.161$ without it, both along with $\psi = 0.0$. Figure A12 shows the transition dynamics with these optimal policies.

Finally, the left panel of Figure A13 plots the effects of education tax (marginal effects) on the first generation's welfare when equal welfare weights are used. Its right panel shows the counterparts of pro-natal transfers.

Figure A11: Optimal Policy (Unexpected and Permanent) with Equal Welfare Weights

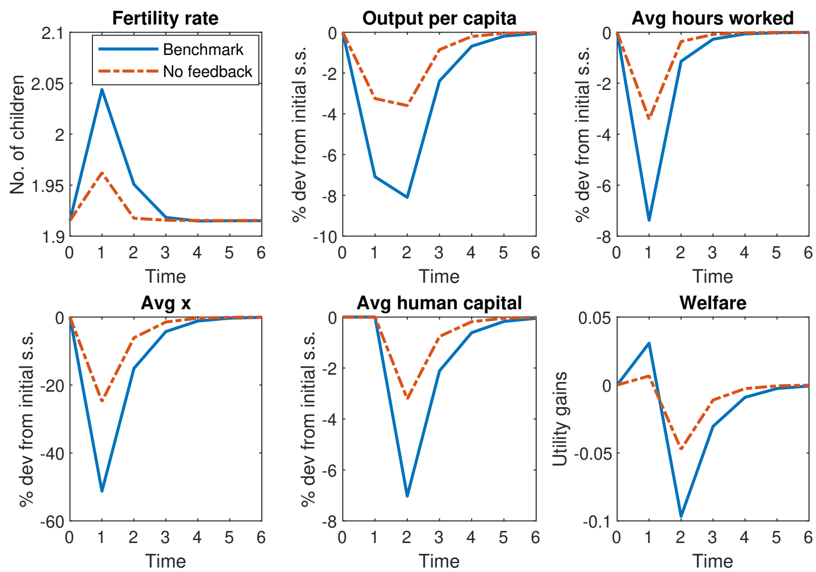


Notes: The optimal policy reform is introduced unexpectedly and permanently in period 1. Welfare is measured by equally-weighted average utility. "Benchmark" shows the results when externality feedback is operative through changing benchmark human capital. "No feedback" shuts down externality feedback. A model period corresponds to 25 years.

Table A12: Heterogeneous Effects of Optimal Policy on the First Generation with Equal Welfare Weights

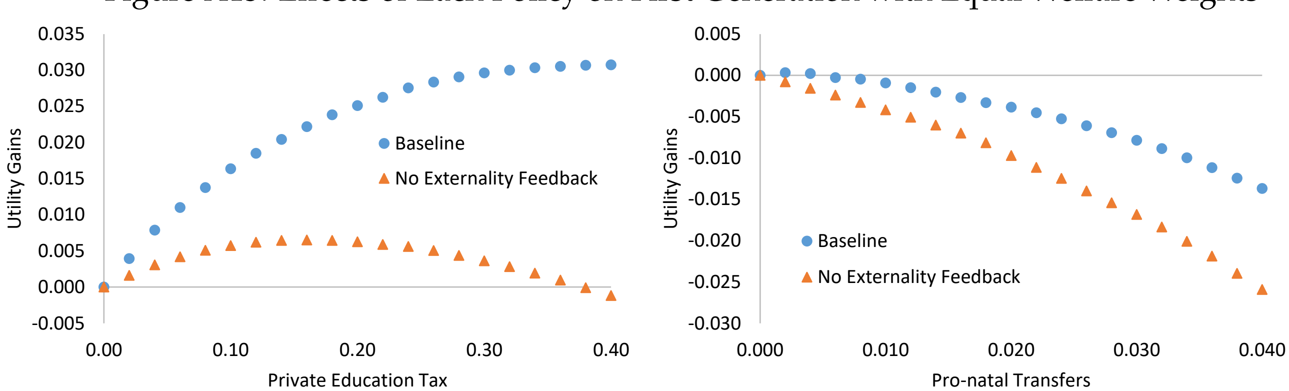
		Income quintile					
Average		1st	2nd	3rd	4th	5th	All
Fertility, n	Baseline	1.78	1.89	1.94	1.99	1.97	1.92
	Optimal	2.02	2.10	2.06	2.05	1.97	2.04
	% change	+13.6	+11.2	+6.3	+3.1	+0.1	+6.6
Childlessness rate (%)	Baseline	5.2	2.9	3.1	3.0	2.7	3.4
	Optimal	3.6	3.0	3.0	3.0	3.2	3.2
	p.p. change	-1.6	0.1	-0.1	0.0	0.5	-0.2
Investment per child, x	Baseline	.061	.080	.096	.116	.175	.106
	Optimal	.028	.037	.045	.056	.088	.051
	% change	-54.8	-54.4	-52.6	-51.1	-49.9	-52.0

Figure A12: Optimal Policy (Unexpected and Temporary) with Equal Welfare Weights



Notes: The optimal policy reform is introduced unexpectedly and temporarily in period 1. Welfare is measured by the change in equally-weighted average utility. "Benchmark" shows the results when externality feedback is operative through changing benchmark human capital. "No feedback" shuts down externality feedback. A model period corresponds to 25 years.

Figure A13: Effects of Each Policy on First Generation with Equal Welfare Weights

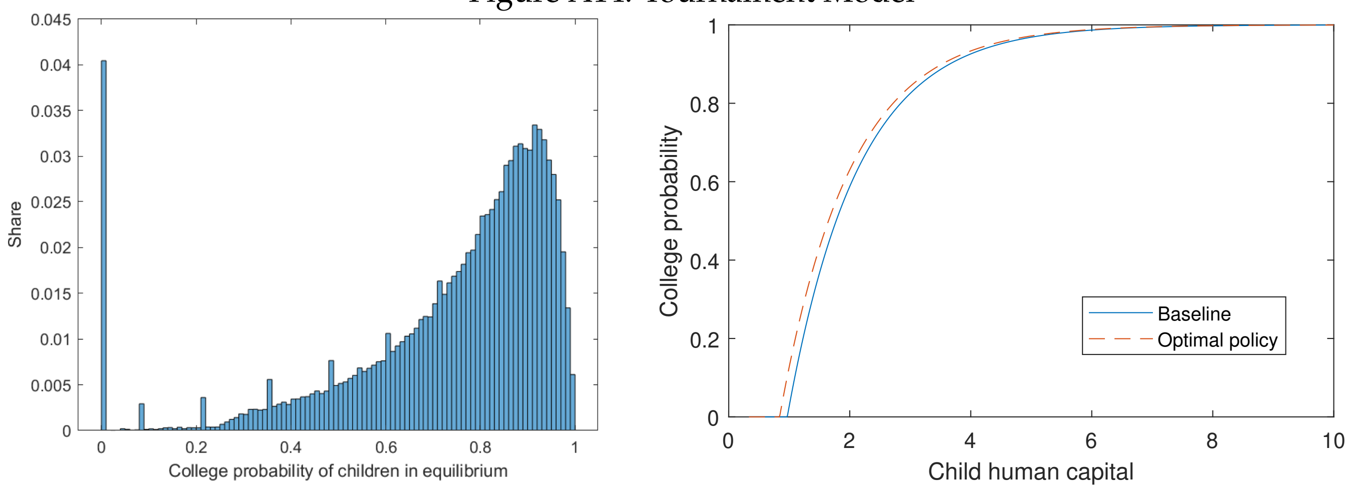


B.10 Details on the Tournament Model

Table A13: Internally Calibrated Parameters for Tournament Model

Parameter	Interpretation	Moment	Model	Data
$\phi_1 = 1.22$	Utility from number of children	Pr(# child = 1)	.201	.196
$\phi_2 = 1.98$		Pr(# child = 2)	.627	.631
$\phi_3 = 2.43$		Pr(# child $\geq$ 3)	.147	.144
$\sigma_\kappa = .508$	Ability dispersion	Gini income	.223	.263
$\nu = 1.57$	Leisure constant	Avg total hours worked	.308	.301
$\sigma_b = .429$	Preference dispersion	Income elasticity of fertility	.084	.082
$\iota_0 = .420$	Location of zero prob.	Childless in 1st income quintile	.055	.053
$\iota_1 = .283$	Inv. externality	Education inv. spillover estimate	.038	.039
$\iota_2 = .858$	Curvature of Π	Share of the college-educated	.763	.690
$\theta = .266$	HK production technology	Avg investment-income ratio	.096	.092
$\alpha = .662$		Income elasticity of investment	.673	.698
$\rho_\kappa = .251$	Ability persistence	Intergenerat. income elasticity	.293	.320
$A_h = 6.06$	HK scale	Output per capita (normalization)	.939	1.00

Figure A14: Tournament Model



A. Equilibrium Distribution of College Probabilities

B. College Probability by Child Human Capital

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