



Public education spending and private substitution in urban China[☆]

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ARTICLE INFO

Article history:

Received 30 June 2013

Received in revised form 4 October 2014

Accepted 25 February 2015

Available online 5 March 2015

Keywords:

Public education spending

Household education spending

Tuition

Private tutoring

Urban China

ABSTRACT

This paper documents robust evidence that increases in public spending on basic education are associated with significant reductions in household private tutoring spending in urban China. This reduction comes primarily from the top and bottom income households, suggesting multi-dimensional demands for private tutoring. It concentrates on households with an only boy and is larger for middle-school than primary-school children. Increases in public education spending are associated with significant reduction in school tuition, which is homogeneous across households of different income levels. Changes in household spending on textbooks in response to more public education spending are modest but statistically insignificant.

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1. Introduction

Most governments devote considerable resources to provide universal basic education. Whether more public school spending leads to better educational outcomes is essential for education policy-making. Empirical studies aiming to estimate this causal relationship abound, but a consensus is lacking.¹ One confounding factor that has been little studied in the literature is the behavioral response of households to changes in public education inputs by varying their own inputs such as parents' time assisting children's school work and spending on learning materials and private tutoring (Todd and Wolpin, 2003). Todd and Wolpin point out that estimates based on the production function approach will capture a "policy-effect" that incorporates both a direct impact of school inputs on outcomes and an indirect impact through household responses to such inputs. Neglecting the latter is particularly

problematic for developing countries where household spending is an important contributing factor in the entire education system.²

This paper estimates the relationship between local government education spending and household education spending in urban China, which has arguably the largest basic education system in the world. We extract detailed information about household spending on public school tuition, textbooks, and private tutoring from the 2002–2006 Urban Household Survey data for households with children in compulsory education (primary and middle schools). The unique features of the decentralization system in China imply that municipal public education spending is not in response to household preferences. To deal with potential confounding factors that may be related to both public education spending and household spending, we estimate a model controlling for city and province-year fixed effects and a wide range of household and municipal characteristics; we also construct falsification tests to alleviate the concern that our estimates are driven by unmeasured contemporaneous changes in local economy or policies.

We have several robust findings. First, increases in public education spending are associated with significant decreases in household spending on public school tuition, a mandatory spending item; this decrease in tuition spending is homogeneous across income groups, suggesting

[☆] We thank Douglas Almond, Alan Auerbach, Julie Cullen, Jacob Fowles, Eric Hanushek, Jie Ma, Jonah Rockoff, Emmanuel Saez, Jing Zhao, two anonymous referees, and the participants of the China Economics Summer Institute, Public Finance Issues in China conference, Renmin University of China, and UC-Berkeley Public Finance Lunch Seminar for their helpful comments; Jing Liu and Ying Zeng for their valuable research assistance; Hongbin Li and Binzhen Wu for their generous assistance with the Urban Household Survey data. Part of the research was completed when Lei Zhang was a Senior Fellow and Assistant Director of the National Institute for Fiscal Studies of Tsinghua University.

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¹ Hanushek (2002) and Glewwe et al. (2011) survey these studies in both developed and developing countries.

² Bray (2003) and Dang and Rogers (2008) are two recent surveys that summarize evidence on the prevalence of private tutoring in both developing and developed countries; also see Kim and Lee (2010) and references therein. Chi et al. (2011) document household education spending in urban China for 2007. These studies mostly investigate what household characteristics may affect household spending and do not consider the interaction with government inputs.

a lump-sum income transfer to households with school-aged children. Changes in household spending on textbooks, another mandatory item, are modest but not precisely estimated. Second, increases in public education spending are associated with significant decreases in household spending on private tutoring, a discretionary spending item, and the reduction comes primarily from the lowest and highest income households. This is consistent with predictions from a simple model where household demand for private tutoring may be multi-dimensional, some substitutes to public spending and others complements. While higher public school spending and better school teaching substitute basic education tutoring of all households, changes in demand for complementary tutoring vary depending on household income levels.

Third, urban households with an only girl spend more on private tutoring than those with an only boy, especially at the primary-school level; in addition, the reduction in household tutoring spending in response to higher public education spending concentrates on only-boy households, and it is much larger at the middle-school level. These findings suggest that the only-child policy may inadvertently contribute to gender equality in education in urban China. They are also consistent with the differential admission policies for middle school and high school.

This paper contributes to the growing literature that studies how changes in public education resources affect private inputs, in both time and money. Kim (2001), using PSID data, finds that increases in school expenditure lead to a reduction in childcare time of mothers with high-school education or less but no change for college-educated mothers, suggesting differential substitutability between school inputs and inputs of different types of parents. Houtenville and Conway (2008) find that parents appear to reduce their efforts in response to increased school resources; in addition, they find that parental effort has a strong positive impact on children's achievement. Pop-Eleches and Urquiola (2013) find that Romanian children who are barely eligible for admission to higher-quality secondary schools are less likely to get help on homework from their parents, suggesting that parents view their own effort and school quality as substitutes.

Using data collected from the rural areas of India and Zambia, Das et al. (2013) estimate that households reduce spending on textbooks or writing materials when they expect an increase in public spending on these items. They also find that an unanticipated increase in public spending that is not accompanied by a corresponding reduction in private spending leads to an increase in student test scores. Shi (2012) shows that when school fees are reduced in rural China, households increase their spending on school supplies. Both papers study rural households that have considerably lower income than households in our sample, and hence the margin of response is rather different. Bray (2003) and Bray and Kwok (2003) document that private tutoring is predominantly an urban phenomenon.³

The paper is organized as follows. Section 2 provides background information about public financing of basic education in China and the roles played by household spending. Section 3 outlines the theoretic framework and the empirical model. Section 4 describes the data and summary statistics of key variables. Section 5 presents the estimation results. Section 6 concludes with a brief discussion of policy implications and future work.

2. Background of China's basic education system

2.1. Public finance of basic education in China

Basic education in China spans primary school (Grades 1–6), middle school (Grades 7–9), and high school (Grades 10–12) education. The Compulsory Education Law of 1986 stipulates that primary and middle school education is mandatory for all children. It also established a decentralized system of financing and administration of basic education, in which municipal governments assume the primary responsibility.⁴

One serious challenge to basic education financing in this decentralized system is the lack of accountability of local officials to local residents' preferences for public goods that is intrinsic to China's unique decentralization system (Bardhan, 2002; Xu, 2011). In this system, termed "Regionally Decentralized Authoritarian" by Xu (2011), local officials are responsible for and have decision-making power in all aspects of local administrative and economic affairs, but they are appointed, evaluated, and promoted by the upper level governments and not through local elections, and the evaluation is based first and foremost on local economic growth and tax revenue. Li and Zhou (2005) provide evidence that provincial officials' promotions are determined by the performance of their province relative to the national average. Jin et al. (2005) and Gordon and Li (2011) show that given the fiscal incentives they face, local officials prioritize their efforts to activities promoting economic development. Xu (2011) cites abundant evidence that the current Chinese institution provides local officials strong incentives to allocate public resources and work efforts to activities that directly improve short-term economic performance, rather than to cater to local residents' preferences for public goods such as basic education.

Not only are local residents unable to express their preferences for public goods through electing local officials, but they are also unable to influence local public goods provision through "voting by their feet" (Tiebout, 1956). While it is no longer a major hurdle for labor market mobility, China's rigid residence registration system (*Hukou*) continues to restrict households' ability to move to a municipality with higher-quality public schools. Households occasionally are able to enroll their children in a public primary or middle school outside their *Hukou* city by paying a hefty fee. This lack of mobility exacerbates the disincentive of local officials in public goods provision. Consistent with Keen and Marchand (1997) prediction that under decentralization, local officials care more about mobile factors than immobile factors, Jia et al. (2014) document that China's decentralization is associated with larger local spending on infrastructure relative to education, the former being essential in attracting investment.

To influence local officials' spending decision on basic education, the Education Law of 1995 mandates a "two-growth" rule for local education spending (Tsang, 1996). First, the growth rate of the budgetary education spending should be higher than the growth rate of regular government revenue at the locality; second, per student budgetary education spending (both personnel and non-personnel) should increase annually. Since the 1995 law does not specify a target spending level or growth rate, both the growth rate and the level of per-student spending exhibit great variations across localities and within a locality over time. The most important source of variation is local economic conditions. Basic education is financed out of the local tax revenue, which, in the tax-sharing system created by the fundamental tax reform of 1994, consists of the local share of the tax levy (including tax refunds) and transfers from the provincial governments. In urban areas, the

³ Mu and Du (2012) study how pension coverage expansion in urban China affects household spending on children's education. They find that expansion of coverage leads household to spend more on children's education, in particular on private tutoring and interest classes.

⁴ In rural areas the responsibility was delegated to the township government till 2001. The county (municipality) government re-assumed the responsibility at the mandate of the State Council following the 2000 reform that abolished the education surcharges on rural households.

former is the main source of the local tax revenue. Since the tax types and tax rates are determined by the central government, the fiscal capacity of municipalities is primarily constrained by the size of the local economy. Given fiscal capacity, education spending level may vary with the preferences of local officials. Anecdotal evidence suggests that local officials may choose to spend more on basic education because of personal concerns for children's wellbeing or visions for long-term economic development and the important role played by education.⁵ In more recent years, evaluations of local officials have taken more explicit account of their performance in public goods provision such as education, health care, and social security coverage. To what extent this alters local official incentives and behavior depends on the weight and stringency of goals in the evaluation system and remains to be seen.⁶ Wang (2002) provides an interesting case study about the local budgeting process, which involves little input from local residents and is largely determined by a few officials in charge.

Fig. 1 depicts China's public education spending per student in primary, middle, and high schools from 1996 to 2008. Public spending on basic education has increased steadily since the mid 1990s, especially after 2002. The growth is faster for the compulsory education levels than for high schools and is visible in all three categories of spending: personnel, current operation funds, and infrastructure. Nationwide the pupil–teacher ratio decreases from 23.7 to 18.4 for primary schools and from 17.2 to 16.1 for middle schools during the 1996–2008 period.

2.2. Household educational spending

Despite continued growth, the level of public education spending in China has been low. Households are required to pay tuition and miscellaneous fees set by municipal governments to supplement school current operation expenses. Schools quite often charge extra and substantial fees for a variety of purposes to compensate for their meager budgets (Qin, 2008; Zhang, 2008). The government had taken a firefighting approach and only cracked down on the most egregious cases till 2005 when it started to enforce nationwide the “one-fee” policy, under which public schools of compulsory education can only charge a one-time tuition-and-fee each semester (shortened to “tuition” henceforth). The tuition level is determined by the provincial education bureau and varies by school level and geographical factors. The policy is widely publicized in the news media, government websites, and schools' bulletin boards to ensure its strict implementation.⁷ The much larger increase in public spending on current operation starting in 2005 (Fig. 1C) in part reflects government effort to make up for the shortfall in school funds due to the tuition reduction. Households however continue to pay separately for textbooks and other learning materials.

⁵ For example, a low-income municipality in Shaanxi Province waived fees for all children to attend 15 years of pre-school and basic education (<http://www.huaxia.com/zjsx/xwsc/2011/09/2600594.html>); a municipality in Yunnan Province devoted large amount of revenues to schools instead of renovating the forty-year old office building (<http://politics.people.com.cn/GB/101380/15987329.html>). In both cases, local officials' long-term vision was cited as the underlying reason. The primary newspaper of CCP, People's Daily, extols the personal moralities of local officials for their devotion to the cause of “people's welfare” (http://paper.people.com.cn/rmrb/html/2012-02/17/nw.D110000renmr20120217_1-01.htm?div=-1). There are also cases that local officials were forced to give education higher priority by the upper-level government, or they lost the quota for new chauffeured vehicles (http://news.xinhuanet.com/local/2012-02/03/c_122653726.htm).

⁶ For example, the 2012 official evaluation standards in Wuhan, the capital city of Hubei Province, allocates 1% to education performance, which is measured by the percentage of middle school graduates that are promoted to high school. URL: http://www.360doc.com/content/13/0922/09/7157405_316151906.shtml.

⁷ “Propositions regarding nationwide implementation of the one-fee policy”, jointly issued in March 2004 by the Ministry of Education, National Development and Reform Commission, and Ministry of Finance. Tuition for compulsory education was abolished in September 2007 in rural areas and September 2008 in urban areas.

Urban households spend a substantial amount of income on private tutoring and after-school classes (shortened to “private tutoring” henceforth) to supplement school teaching. This service is provided by college students, private education institutions, or public school teachers themselves. There are two main reasons for households' demand for private tutoring. One is dissatisfaction with regular school teaching and education quality, which, in some cases, is attributed to teacher disincentives. For example, some teachers tend to withhold essential materials in their formal instruction and only to teach these during private sessions for a fee to earn extra income; most parents choose to enroll their children in these classes.⁸ The other reason is for children to gain a competitive edge in school promotion in urban China's fiercely competitive environment, especially admission to prestigious middle schools. In this case, parents tend to enroll children in sessions that teach advanced materials in various subjects (most commonly math and English) or in arts and sports classes.

3. Model

3.1. Conceptual framework

We outline a simple two-period household utility maximization model as a framework to organize our empirical study. The model is based on the classic analysis of Becker and Tomes (1986), and we borrow part of the framework from Nordblom (2003).⁹ Each household i is composed of an altruistic parent and a child.¹⁰ In period 1, parent is middle-aged and child is in school, and parent cares about family consumption (c_1); in period 2 parent is retired and child is young adult, and parent cares about own consumption (c_2) and child consumption (c_k):

$$u_p = u_1(c_1) + u_2(c_2) + \delta u_k(c_k),$$

where $\delta > 0$ reflects the degree of parent altruism. For simplicity we assume that the discount factor is 1.

Parent's budget constraints are given by:

$$\begin{aligned} c_1 &= w_p h_p - s - q, \\ c_2 &= s(1+r) - b + P, \end{aligned}$$

where h_p is parent human capital level, which varies across households, and w_p is after-tax wage rate of the parent generation.¹¹ s is parent saving, and r is after-tax rate of return to capital; b is parent bequest to child. P is public pension in a pay-as-you-go (PAYG) pension system; we assume that P is sufficiently small so that parents cannot leave bequest out of P .

Child consumption is determined jointly by his own labor income and parent bequest:

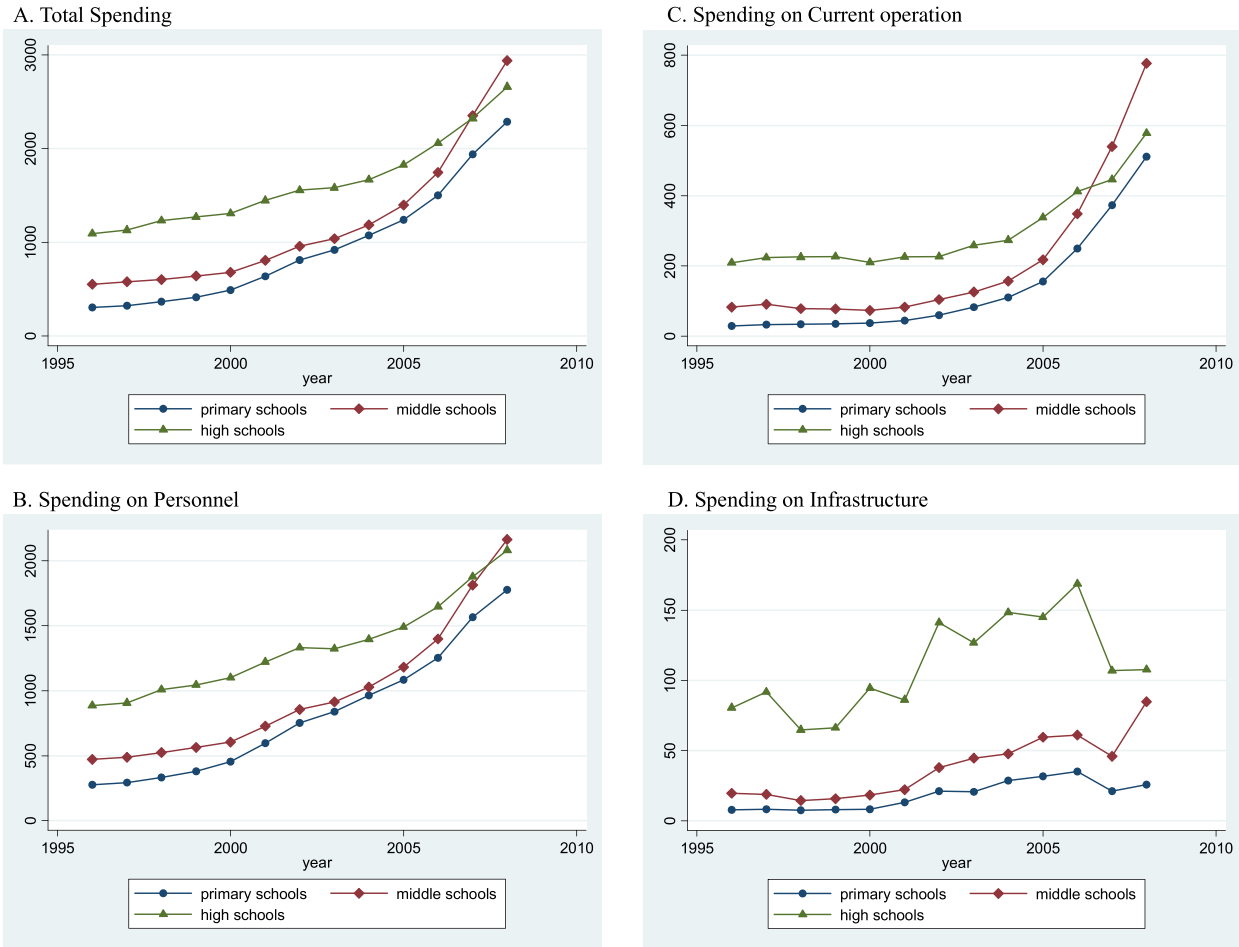
$$c_k = w_k h_k + b,$$

⁸ Biswal (1999) provides a theoretical analysis of this phenomenon that stems from teachers' monopolistic position in the education system. Bray (2003) and Bray and Kwok (2003) provide abundant evidence that this is the case in many developing countries. Jayachandran (2014) finds evidence from Nepalese schools that less is taught during the regular school day when schools offer for-profit tutoring, and student performance suffers.

⁹ Nordblom (2003) theoretically studies distribution implications of increases in public education spending; she assumes that public education spending and household spending are complements, and there are two types of households, the rich and the poor.

¹⁰ Mu and Du (2012) provide evidence consistent with the hypothesis that urban parents in China are altruistic. Introducing exchange motive into the model however will not change the predictions.

¹¹ In the model, parent human capital and hence household income is the only difference across households. Alternatively, one may assume that wealthier households have stronger preferences for children's education than low-income households as in Lawrance (1991), Atkeson and Ogaki (1996), and Zhang (2008).



Notes: All spending variables are in constant 2002 Yuan. Data source: China Educational Finance Statistical Yearbook.

Fig. 1. Per student spending at primary, middle, and high schools, national average. Notes: All spending variables are in constant 2002 Yuan. Data source: China Educational Finance Statistical Yearbook.

where h_k is child human capital level, w_k is after-tax wage rate of the child generation. Child human capital h_k is produced by combining public education spending (g) and household spending (q) in a concave production function^{12,13}:

$$h_k = f(g, q),$$

with $f_g > 0$, $f_{jj} < 0$; ($j = g, q$); for simplicity we assume that f satisfies the Inada conditions: $\lim_{j \rightarrow 0} f_j = +\infty$ and $\lim_{j \rightarrow +\infty} f_j = 0$, which guarantees that q is positive. Public education spending and household spending may be complements or substitutes; i.e., f_{qg} may be positive or negative. The actual relationship is an empirical issue.

We assume that w_p , w_k , r , P , and g are exogenous and same for all households, and public education, public pension, and any other public

programs unrelated to household consumption are financed by taxes on labor and capital income. The model is thus partial equilibrium, where a small change in public education spending does not affect tax rates and hence household labor supply or savings. We assume that a measurement of c and q is chosen so that the relative price is 1.

We consider the response of household education spending to an increase in public education spending ($\partial q / \partial g$) for households of different income levels and facing different degrees of credit constraint; i.e., parents cannot borrow against children's future income or public pension and hence $s \geq 0$, $b \geq 0$. We provide an intuitive analysis below and leave full derivation of comparative statics in Appendix A. We focus on changes in g which are sufficiently small such that credit constraints remain binding for low- and middle-income households.

(1) *Low-income households* have no savings or bequest and rely on the public pension for period 2 consumption ($s = 0$, $b = 0$); they invest only in children's human capital.

The first order condition with respect to q is $\frac{\partial u_p}{\partial q} = -u'_1 + \delta u'_k w_k f_q = 0$, and an increase in g generates two effects. First, it leads to an increase in child's human capital h_k and hence child income $w_k h_k$ and consumption c_k ; thus the marginal utility u'_k decreases. Optimization requires the first-period marginal utility u'_1 to decrease, and hence consumption c_1 increases and household education spending q decreases. This is the direct effect. Second, an increase in g may lead

¹² For clarity of discussion, we omit other plausible inputs in the human capital production function such as parent time, child ability, and child effort.

¹³ We also assume that household decision is on the intensive margin, i.e., to what extent to supplement public teaching, and not on the extensive margin regarding enrollment. Almost all compulsory school-aged children in urban areas are enrolled. In 2003, 2.4% and 3.8% of primary and middle school students enrolled in private schools, which increased to 4.2% and 7.1% in 2007. These include a large number of migrant workers' children who attend under-funded and schools in cities (China Education Statistics Yearbook, 2004, 2008). Our data suggest that less than 5% of children with an urban *Hukou* enrolled in private primary and middle schools.

to an increase or decrease in the marginal productivity of household education spending, depending on the sign of f_{qg} , i.e., whether household and public inputs are complements or substitutes. If they are complements ($f_{qg} > 0$), then an increase in g leads to an increase in f_q , which requires the first-period marginal utility u_1' to increase, leading to a decrease in c_1 and an increase in household education spending q . In contrast, if $f_{qg} < 0$, then c_1 increases and q decreases. This is the indirect effect. Overall, the total effect of an increase in public education spending is a decrease in household spending if the two inputs are substitutes, but the direction of the effect is indeterminate if they are complements.

(2) *Middle-income households* save for period 2 consumption but leave no bequest ($s > 0, b = 0$); similar to low-income households, they invest only in children's human capital.

The first order conditions are:

$$q : \frac{\partial u_p}{\partial q} = -u_1' + \delta u_k' w_k f_q = 0$$

$$s : \frac{\partial u_p}{\partial s} = -u_1' + (1+r)u_2' = 0$$

and thus $\delta u_k' w_k f_q = (1+r)u_2' = u_1'$. The analysis and prediction of the change in q following an increase in g is similar to the case of low-income households. In addition, for both the direct and the indirect effects re-optimization also requires c_2 and hence the first-period saving s to adjust, and the direction of the change in s is opposite to that of q .

(3) *High-income households* save for period 2 consumption and leave children bequest ($s > 0, b > 0$); their investment in children includes both human capital and physical capital.

The first order conditions are:

$$q : \frac{\partial u_p}{\partial q} = -u_1' + \delta u_k' w_k f_q = 0;$$

$$s : \frac{\partial u_p}{\partial s} = -u_1' + (1+r)u_2' = 0;$$

$$b : \frac{\partial u_p}{\partial b} = -u_2' + \delta u_k' = 0.$$

It follows immediately that $f_q = \frac{1+r}{w_k}$. Apply the implicit function theorem, and we have $\frac{\partial q}{\partial g} = -\frac{f_{qg}}{f_{qq}}$. The sign of $\partial q/\partial g$ thus only depends on whether public education spending and household spending are substitutes or complements, and the margin of adjustment may be in both saving and bequest. When the two inputs are complements, q increases while both s and b decrease; when the two inputs are substitutes, q decreases but the direction of changes in s and b is indeterminate.

We summarize results from the above analysis of an increase in public education spending g in the following chart; a question mark indicates that the direction of the change is indeterminate:

	g and q are complements			g and q are substitutes		
	q	s	b	q	s	b
Low income	?	0	0	↓	0	0
Middle income	?	?	0	↓	↑	0
High income	↑	↓	↓	↓	?	?

Several remarks are in order. First, the model sketched above is static in nature, and we consider how household spending varies with public spending during the child's entire schooling career. This is in contrast to the dynamic model in Das et al. (2013), which predicts how households adjust education spending in one year versus the other in response to

changes in public school spending in a particular school year. This difference in modeling reflects the difference in data structure: Das et al. employ a household panel that allows them to capture the dynamics of household spending during a short period of time, while our repeated cross-sectional data limit us to a description of average differences in household spending over a relatively longer time period. Second, while q decreases following an increase in g for all income groups when the two inputs are substitutes, the magnitude of $\partial q/\partial g$ is however not comparable across households as the optimal level of household spending varies across households. Third, the model assumes only one type of household education spending. In reality, households may spend on different types of educational inputs, some complements to public spending and others substitutes. An increase in g will lead to differential responses of different types of spending, making the effect on total household education spending theoretically more ambiguous. Fourth, in the Chinese context, g is essentially the sum of government budgetary education spending, required tuition that is set by the municipal government, and expenditure on textbooks listed on the curriculum that all students are required to purchase. Tuition and required textbooks are virtually the same for all students in the same grade in the same city. When government spending increases, it is partially allocated to increase schools' current operation funds, and the municipal government will set a new, lower tuition.

3.2. Empirical specification

We estimate the influence of public education spending on household education spending in the following model:

$$H_{ikpt} = \alpha_k + \alpha_{pt} + \beta \cdot G_{kt} + \gamma \cdot X_{ikpt} + \varepsilon_{ikpt}. \tag{1}$$

The primary dependent variable H_{ikpt} is per-student spending on private tutoring by household i living in city k of province p in year t , and we also consider household spending on public school tuition and textbooks. G_{kt} is per-student public education spending by local government k in year t . Since our data contain five-year repeated cross-sections of households with children in primary or middle schools rather than a household panel, we interpret the coefficient estimate of β as the average difference in annual household education spending when faced with different public education spending; in other words, we use current-year public school spending as a proxy for annual public education inputs over a child's entire schooling career and examine household behavior in different local public education systems. Because we interpret G as public school quality perceived by households, and households may use more information than current spending to gauge school quality, in robustness checks we also measure G with public education spending averaged over the past several years. We expect higher public education spending to reduce household spending on tuition and have no effect on textbook spending, but its impact on household tutoring spending is uncertain.

As discussed in the previous section, local public education spending does not reflect local resident preferences; thus reverse causality is unlikely a threat to the identification of β . The more serious concern is omitted variables that may be related to both public education spending and household preferences for children's human capital investment. We deal with this primarily by controlling for potential confounding factors in Eq. (1). α_k is city fixed effects, which capture constant city characteristics such as geography and culture that may bear on both the current local public spending level and household taste for education. α_{pt} is province-year fixed effects, which capture province-specific common time trends that may affect both local public and private education spending. Additionally, we control for time-varying city economic and demographic characteristics in X_{ikpt} , most importantly local per capita GDP. Local per capita GDP plays a crucial role in determining local fiscal capacity and hence public education spending; at the same time, local economic conditions may affect household and student expectations

about labor demand and perceived returns to education, which may in turn affect their demand for schooling (Jensen, 2010). We also control for growth rate of school-aged population; *ceteris paribus*, it limits local *per student* public spending; meanwhile it may also affect household education spending due for example to competition in the education promotion process.

We further address the concern that other unmeasured simultaneous changes in local economy or government policies may be related to both public and household educational spending by constructing several falsification tests, and these are discussed in detail in Section 5.3. Nevertheless, data limitation does not allow a full investigation of all possible confounding factors, and the estimation results of this paper should be interpreted with caution.

Other variables in X_{ikpt} include household characteristics that potentially affect household demand for education, including household average disposable income and its square, father's and mother's education, share of students in the household and their average age. We investigate potential heterogeneous responses of households of different income in the following specification,

$$H_{ikpt} = \alpha_k + \alpha_{pt} + \beta_1 \cdot G_{kt} + \beta_2 \cdot G_{kt} \cdot Y_{ikpt} + \gamma \cdot X_{ikpt} + \varepsilon_{ikpt}, \quad (2)$$

where Y is per person disposable income of household i . Alternatively, we interact G with quintile indicators of household average disposable income to allow household responses to public education spending to be nonlinear in income.

We investigate whether household education spending responds differentially to public education spending by child gender and schooling level. These dimensions of heterogeneity are of particular interest given the unique family structure in urban China due to the one-child policy and differences in admission policy at different schooling levels. Section 5.4 presents detailed discussions.

4. Data

Data come from several sources. Household education spending information is extracted from the annual Urban Household Survey (UHS) conducted by the National Bureau of Statistics of China. The UHS uses a stratified random sampling method to select households to be representative of the urban population.¹⁴ Sampled households report the demographic and income information of each member and itemized expenditure of entire households. We use data for the years 2002–2006, when detailed information about household spending on education is available. Out of the full UHS data that cover all provinces, we have access to a subset of nine provinces (Beijing, Liaoning, Zhejiang, Anhui, Hubei, Guangdong, Sichuan, Shaanxi, and Gansu), which are from the three broadly defined regions of China (coastal, central, and western) and representative of the national population. This subset contains about 15,000 households in just below 160 municipalities each year.

Local budgetary public education spending data are from the Municipal Public Finance Statistics Yearbooks published by the Ministry of Finance. Information on per capita GDP and number of students in basic education is from various publicly available City Statistics Yearbooks.

We focus on households with children in primary or middle schools, the compulsory education stage.¹⁵ We drop 0.5% of households with the highest education spending relative to household disposable income

and three municipalities (100 households) with extremely high or low per-student public education spending. These leave us with 21,024 observations, about 4200 households per year.

Table 1 reports summary statistics of per-student education spending by municipal governments and by households for all five years under study and for each year separately. All monetary values are in constant 2002 Yuan.

Per-student public education spending is created as the ratio between municipal budgetary education spending and the number of primary, middle, and high school students. Due to data limitation, we are unable to create precise per-student spending at the compulsory schooling level for municipalities; however, the variable thus created is comparable to the provincial level per-student spending on primary and middle schools over time, lending us confidence that it captures the actual underlying spending. Over the 5-year period, municipalities on average spend 1340 Yuan per student; however, at a median of 790 Yuan and a standard deviation of 1650 Yuan, the dispersion of spending is tremendous. The spending is highly correlated with local per capita fiscal revenue and per capita GDP, with correlations being 0.63 and 0.41 respectively.

On average, annual household education spending is 1510 Yuan per child, about 6.6% of household disposable income, of which 530 Yuan is on public school tuition, 175 Yuan on textbooks, and 800 Yuan on private tutoring.¹⁶ Spending on private tutoring is not concentrated on a small number of households; 79.7% of households report positive spending, ranging from 71% of those in the bottom quintile of income distribution to 87% at the top.

The remaining columns of Table 1 provide the time trend of education spending over the 5-year period. We also depict the means of the spending in Fig. 2. First, per-student public education spending maintains a high growth rate over the entire period, averaging almost 13% annually. This is accompanied by a much slower growth of total household education spending and a decline in spending on public school tuition, suggesting that a portion of the increased public spending has been used to replace the tuition charges. Second, household spending on private tutoring has increased over the 5-year period, from 590 Yuan in 2002 to almost 1000 Yuan in 2006. This increase stems in part from the growth in household income, but it may also capture household responses to changes in public education policies. The regression analysis below seeks to separate these different forces. Finally, household spending on textbooks barely changes over time.

There is substantial disparity in household education spending across households of different income as reported in Table 2, where households are grouped into quintiles based on per person disposable income in each year and city of residence. First, wealthier households spend more on children's education, but it constitutes a smaller share of household disposable income: 4.8% and 9.9% for the top and bottom quintiles in 2002, 4.2% and 8.2% in 2006. Second, each year different types of household spend roughly the same amount on public school tuition; thus its decrease results in a larger reduction in tuition burden for lower-income households. Third, higher income households devote significantly more resources to private tutoring than low-income households, and it also increases more substantially over time. These statistics paint a picture of a universal gap between public school teaching and household education demand, which is often supplemented with instructions provided by the private sector. The question of interest is thus to what extent increased government spending narrows this gap and for which income groups.

¹⁴ The UHS does not survey households of migrant workers mostly because they lack a fixed residence; it also under-samples the extremely wealthy households due to lack of access to their residence.

¹⁵ We do not consider households with students in high school level because the survey questions do not allow us to separately measure household spending on public school tuition and on private schooling.

¹⁶ A fourth type of educational spending that a household may incur is the private school tuition and school choice fee. However, only 5% of the households in our sample incur these fees, and they spend an average of 6000 Yuan. These fees are usually paid lump-sum at the beginning of primary or middle school; therefore, it is not comparable to the other annual fees incurred by households. Summary statistics and results of regression analysis for this variable are available from the authors upon request.

Table 1
Mean and standard deviation of education spending variables.

Year	All years	2002	2003	2004	2005	2006
Per student public education spending (1000 Yuan)	1.34 (1.65)	0.97 (1.22)	1.08 (1.32)	1.29 (1.53)	1.56 (1.89)	1.77 (1.99)
Per student total HH spending (Yuan)	1509.56 (1380.88)	1313.89 (1125.22)	1398.09 (1240.94)	1573.07 (1424.49)	1580.38 (1478.20)	1666.40 (1543.82)
Total HH spending as % of HH disposable income	6.61 (5.65)	6.81 (5.66)	6.90 (5.99)	6.92 (5.77)	6.41 (5.62)	6.04 (5.14)
Per student HH spending on public school tuition (Yuan)	533.68 (514.79)	570.90 (514.08)	551.83 (500.95)	545.00 (522.17)	532.55 (535.94)	470.25 (493.74)
Per student HH spending on textbooks (Yuan)	175.42 (233.15)	150.23 (199.55)	171.75 (251.96)	179.25 (242.77)	175.39 (223.70)	198.73 (239.51)
Per student HH spending on private tutoring (Yuan)	800.46 (1169.67)	592.77 (896.42)	674.51 (1015.21)	848.82 (1200.43)	872.44 (1255.02)	997.42 (1358.79)

Notes: Per student public education spending equals to total municipal spending on basic education (Grades 1–12) divided by the number of students in basic education. Numbers in parentheses are standard deviations. The sample includes households with only students at the compulsory education level (Grades 1–9).

Household average disposable income has a mean of 8960 Yuan and standard deviation of 6910 Yuan. The implied coefficient of variation (0.77) is smaller than that for total education spending (0.91) and even smaller than that for spending on private tutoring (1.46). 95% of households are composed of two parents and a child, typical of the nuclear family in urban China; 39% of fathers and 28% of mothers have at least a three-year college education.

5. Estimation results

We first report estimated impacts of public education spending on mandatory household spending on tuition and textbooks. We then focus on household discretionary spending on private tutoring. We consider heterogeneous responses by household income, child gender and schooling level. A series of robustness checks is conducted to deal with simultaneity bias. Since each spending category have zero values, we employ a Tobit model for all estimation. All standard errors are robust and clustered at the city level.

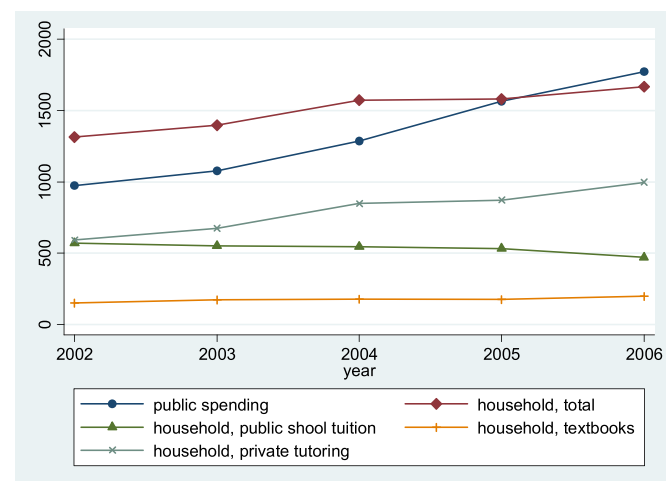


Fig. 2. Public and household per student educational spending. Notes: Public spending is per student public education spending, equals to total municipal spending on basic education (Grades 1–12) divided by the number of students in basic education. Household spending variables are calculated for the sample of households with only students at compulsory education level (Grades 1–9). All spending variables are in constant 2002 Yuan.

5.1. Results for mandatory household spending: public school tuition and textbooks

Columns 1–4 of Table 3 report the estimated response of household spending on public school tuition to public education spending.¹⁷ All specifications control for city and year–province fixed effects, household average disposable income and its square, fraction of students in a household and their average age, and father's and mother's education levels.

In Column 1, the estimate on public education spending is negative and significant at the 1% level: for a 1000-Yuan increase in per-student public spending, household spending on tuition decreases by 36 Yuan. School tuition, per-student household spending is not systematically related to household disposable income, fraction of students in household, and parents' education; it does increase with the age of students as public school tuition in general rises with grade. Column 2 includes additional controls of local per capita GDP and growth rate of students in basic education. Coefficient estimates on these variables are insignificant economically and statistically, and estimate on public education spending is smaller in absolute value but not statistically different from that in Column 1. For the nine provinces in our sample, per student total public education spending and spending on current operation increase by about 250 Yuan and 85 Yuan annually for compulsory schooling during the 5-year period (China Educational Finance Statistical Yearbook); the latter more than offsets the reduction in tuition, suggesting that more public funds are devoted to school equipment and teaching materials, which may potentially improve learning.

Column 3 allows the response to public education spending to vary linearly with household disposable income, and estimate on the interactive term between household disposable income and public education spending is insignificant. In Column 4, we replace this interactive term with interactions between public education spending and indicators for household disposable income quintiles. Estimates on the five interactive terms are not significantly different from each other – the p-value for an F test of joint equality is 0.14. Thus tuition reduction following the increase in public education spending is largely a lump-sum income transfer to households with children.

The last two columns of Table 3 report estimates for household spending on textbooks using the same specifications as those in Columns 2 and 4. In Column 5, the estimate on public education spending is positive but statistically insignificant; in Column 6, estimates on the

¹⁷ About 10% and 20% of households in the sample have zero values for spending on public school tuition and textbooks respectively, spanning all income groups. We suspect that some of these are reporting errors and conduct linear estimation dropping the zero values. The estimation results are almost identical to those in Table 4.

Table 2
Mean of per student household education spending and household education spending as % of household disposable income.

	Income quintile	Per student HH education spending (Yuan)					HH edu spending as % of disposable income				
		Year					Year				
		2002	2003	2004	2005	2006	2002	2003	2004	2005	2006
All	1	1011.42	1025.96	1130.65	1092.35	1167.63	9.92	10.04	9.66	8.79	8.16
	2	1128.48	1217.77	1337.24	1369.46	1436.92	7.29	7.39	7.53	7.01	6.55
	3	1277.29	1397.45	1609.54	1565.88	1590.94	6.35	6.56	6.87	6.04	5.74
	4	1411.93	1548.50	1723.61	1838.04	1984.48	5.52	5.58	5.64	5.70	5.41
	5	1765.78	1828.81	2092.52	2071.18	2184.45	4.83	4.70	4.81	4.34	4.24
Public school tuition	1	540.91	513.79	504.38	496.67	470.05	5.57	5.35	4.70	4.26	3.53
	2	572.03	556.46	528.61	533.66	467.83	3.79	3.57	3.12	2.90	2.27
	3	578.56	549.62	563.76	544.57	461.61	3.04	2.72	2.61	2.26	1.78
	4	556.61	568.46	547.14	553.29	485.13	2.29	2.20	1.90	1.82	1.44
	5	609.42	573.16	583.44	535.81	466.39	1.80	1.61	1.48	1.24	0.99
Textbooks	1	125.63	145.20	145.95	142.79	173.04	1.30	1.42	1.31	1.23	1.28
	2	129.23	160.15	168.98	149.92	175.25	0.88	0.95	0.97	0.80	0.85
	3	144.99	166.36	177.03	176.69	198.37	0.75	0.79	0.80	0.73	0.77
	4	164.80	175.46	183.83	196.12	212.39	0.66	0.64	0.63	0.65	0.64
	5	188.41	214.13	222.89	214.11	236.67	0.53	0.56	0.54	0.48	0.48
Private tutoring	1	344.87	366.97	480.32	452.89	524.54	3.04	3.28	3.65	3.30	3.35
	2	427.22	501.16	639.65	685.88	793.84	2.62	2.88	3.43	3.30	3.43
	3	553.74	681.46	868.75	844.63	930.96	2.57	3.06	3.46	3.05	3.19
	4	690.52	804.58	992.64	1088.63	1286.96	2.56	2.74	3.12	3.23	3.33
	5	967.95	1041.52	1286.19	1321.26	1481.39	2.49	2.53	2.79	2.62	2.77

Notes: Income quintiles are defined by year and city of residence. Quintile 1 refers to the lowest income group, and quintile 5 is the highest income group. The sample includes households with only students at the compulsory education level (Grades 1–9).

interactive terms between public education spending and household income quintile indicators are positive but not significantly different from zero, and we cannot reject the hypothesis of joint equality (p -value: 0.9). The results are consistent with the fact that increases in public education spending are not intended to replace household textbook purchases.

Household spending on textbooks increases with household disposable income and parents' education, suggesting that some of the spending is discretionary and on optional learning materials.¹⁸ The income elasticity is 0.4 evaluated at the sample means. Households with more children spend slightly less perhaps because these books may be shared. Estimate on average age is positive and significant: as children progress in school, households spend more on books.

In sum, the results for household tuition and textbook spending are consistent with our expectations of the function of public education spending and lend confidence in data quality.

5.2. Results for discretionary household spending: private tutoring

The first two columns of Table 4 report estimates for household spending on private tutoring using the same specifications as those in Columns 2 and 4 of Table 3. In Column 1, for a 1000 Yuan increase in public education spending, an average household reduces tutoring spending by 36 Yuan, significant at the 10% level. This however masks the heterogeneity in response across households of different income levels. For households in the bottom quintile of income distribution, the reduction is almost 80 Yuan and about 23% of their tutoring spending in 2002, and the estimate is significant at the 1% level. The reduction is 46 Yuan and 54 Yuan for households in the second-lowest and top quintiles of income distribution, 11% and 6% of their tutoring spending in 2002, and the p -values are 0.13 and 0.09 respectively. For other households, the response is not significantly different from zero.¹⁹

¹⁸ Viewed in this light and while not precisely estimated, there is also some degree of complementarity between public education spending and household spending on textbooks and other learning materials. Changes in household spending are about 10% of their 2002 spending on textbooks and homogenous across income groups.

¹⁹ Results are robust to additional control variables such as local population, per-capita value-added of the local industrial and service sectors, a full set of interactions between control variables and household income quintile indicators. These results are available from the authors upon request.

These results are generally consistent with the theoretical predictions in Section 2.1 when households spend on tutoring both substitutable and complementary to school teaching. Higher public spending and better public school teaching are associated with lower spending on tutoring in basic materials that substitutes school teaching for all households, but the relationship with spending on complementary tutoring depends on household income. For high-income households, their spending on complementary tutoring may already be quite high, and additional spending only generates small gains in children's human capital; therefore the spending increase is minuscule and more than offset by the decrease in spending on classes substituting school teaching. By comparison, middle-income households may find it highly productive to substantially increase tutoring spending on classes complementary to public school teaching such as more advanced topics and a wider variety of subjects. In contrast, better public school teaching may reduce low-income households' demand for complementing tutoring if it sufficiently improves student learning. Overall, spending on tutoring services may decrease for low- and high-income households but remain unchanged for middle-income households. This interpretation is consistent with the spending pattern documented by Chi et al. (2011): In 2007, the wealthiest third of urban households spends about 50% more than the poorest third on after-school classes teaching basic school materials; in sharp contrast, the former spends almost three times more than the latter on classes for more advanced materials, music, or sports.

In Table 4, we assume that current-year public education spending is a good proxy for perceived quality of public school system by households. However, households may use more information such as historical information to gauge public school quality. To explore this possibility, we use the average of per student public education spending during the current year and the past two years to measure public school inputs. The estimate is indeed larger: on average, a 1000-Yuan increase in the three-year average public education spending is associated with a reduction in household spending of 128 Yuan, significant at the 5% level. The lowest-income households reduce spending by 180 Yuan which is significant at the 1% level; the second lowest and top income groups both experience a reduction of about 140 Yuan which is significant at the 5% level. Reduction in spending of other households is not precisely estimated. These suggest that using current-year public education

Table 3
Regression results for household per student spending on public school tuition and textbooks.

	Public school tuition				Textbooks	
	1	2	3	4	5	6
Per student pub edu spending	– 35.809 [12.648]**	– 25.329 [11.126]*	– 32.75 [10.894]**		14.39 [10.031]	
Per stu pub edu sp * avg HH inc			0.769 [0.626]			
Per stu pub edu sp * HH inc q1				– 35.734 [10.693]**		13.956 [10.082]
Per stu pub edu sp * HH inc q2				– 22.425 [11.357]*		13.958 [10.315]
Per stu pub edu sp * HH inc q3				– 20.03 [11.208] ⁺		16.002 [10.793]
Per stu pub edu sp * HH inc q4				– 19.073 [15.027]		13.708 [10.340]
Per stu pub edu sp * HH inc q5				– 28.584 [14.521]*		14.361 [10.561]
Avg HH disposable inc	1.993 [1.450]	2.285 [1.508]	1.241 [1.745]	1.67 [1.622]	8.04 [0.776]**	8.006 [0.989]**
Avg HH disposable inc ²	– 0.046 [0.018]*	– 0.049 [0.019]**	– 0.068 [0.034]*	– 0.041 [0.015]**	– 0.094 [0.018]**	– 0.093 [0.019]**
Fraction of students in HH	46.097 [71.745]	30.821 [71.776]	29.415 [71.939]	29.592 [72.206]	– 67.271 [39.785] ⁺	– 66.974 [39.644] ⁺
Avg age of students in HH	30.625 [2.359]**	30.024 [2.421]**	30.026 [2.426]**	30.007 [2.409]**	19.788 [1.028]**	19.784 [1.031]**
1(father edu = HS)	23.214 [10.472]*	25.124 [10.784]*	25.65 [10.768]*	24.196 [10.81]*	10.455 [4.939]*	10.414 [4.962]*
1(father edu > HS)	13.66 [11.815]	13.374 [12.079]	13.892 [12.104]	11.629 [12.259]	21.688 [5.427]**	21.632 [5.440]**
1(mother edu = HS)	13.215 [9.375]	9.618 [9.441]	10.424 [9.384]	8.556 [9.454]	20.19 [5.823]**	20.133 [5.828]**
1(mother edu > HS)	11.094 [13.069]	10.46 [13.571]	11.511 [13.645]	9.744 [13.434]	29.05 [7.049]**	29.085 [7.062]**
Local per capita GDP		1.057 [1.112]	0.913 [1.161]	1.034 [1.111]	0.707 [0.908]	0.703 [0.908]
Growth rate of stu number, %		0.098 [0.119]	0.099 [0.118]	0.098 [0.119]	– 0.134 [0.106]	– 0.134 [0.106]
Constant	790.23 [94.42]**	685.34 [109.84]**	701.80 [108.55]**	693.95 [111.10]**	– 169.46 [91.15] ⁺	– 168.64 [89.08] ⁺
Observations	19,302	18,531	18,531	18,531	18,531	18,531

Notes: Robust standard errors clustered at the city level are in brackets; all columns are estimated with a Tobit model. The sample includes households with only students at the compulsory education level (Grades 1–9). The omitted category for father's and mother's education is less than high school. Household income quintiles are defined by year and city of residence. All columns control for city and province–year fixed effects.

⁺ Significant at 10%.

* Significant at 5%.

** Significant at 1%.

spending is likely to lead to under-estimation of household responses as a result of measurement errors.

Household spending on private tutoring increases significantly with household disposable income – ceteris paribus, a 1000 Yuan increase in income is associated with about an 80 Yuan increase in spending on private tutoring, and the income elasticity is 0.9 when evaluated at the sample means.²⁰ Parents' education also has a positive and significant effect on tutoring spending, and college-educated mothers have a particularly strong influence compared to all other types of parents. Households with older children spend more, and those with more children spend less, which is consistent with a quantity–quality tradeoff (Becker and Lewis, 1973) and will be examined further in Section 5.4. Local per capita GDP has a negative and significant effect on tutoring spending, but the magnitude is small.

Columns 3–4 report results for per-student total household education spending. The pattern of responses by households of different incomes reflects largely that of private tutoring spending: The lowest-income group experiences a significant reduction in spending, and

households in the second-lowest and top quintiles of income distribution also reduce spending, which however is not precisely estimated. We focus on private tutoring spending for the remainder of the paper.

5.3. Robustness checks

We conduct robustness analysis to alleviate the concern that results of household tutoring spending may be driven by other simultaneous changes in local economy or government policies, which may not be fully captured by fixed effects or control variables.

First, we assess the possibility that the estimated reduction in household spending is due to intensified enforcement of government bans on school fee charges. In Table 5, we report results from a falsification test where we examine household spending on tuition and private tutoring separately for periods before (2002–2004) and after (2005–2006) the nationwide implementation of the one-fee policy. If there is a spillover impact of this policy on the enforcement of the ban on on-campus after-school classes taught by teachers, we expect more negative β for both tuition and private tutoring spending post the one-fee policy. Panels A and B report average estimates and estimates for each income group respectively; the estimates are less precise due to the reduced sample size. Household spending on public school tuition barely

²⁰ The spending on private tutoring starts to taper off when household disposable income reaches about 60,000 Yuan. However, less than 0.1% of households attain such high income level.

Table 4
Results for household per student spending on private tutoring and total education spending.

	Private tutoring spending		Total education spending	
	1	2	3	4
Per student pub edu spending	−36.236 [21.827] ⁺		−36.498 [19.105] ⁺	
Per stu pub edu sp * HH inc q1		−78.601 [28.553]**		−90.995 [26.427]**
Per stu pub edu sp * HH inc q2		−45.893 [29.994]		−46.462 [28.346]
Per stu pub edu sp * HH inc q3		14.656 [24.681]		11.989 [22.163]
Per stu pub edu sp * HH inc q4		−15.106 [28.180]		−8.539 [25.217]
Per stu pub edu sp * HH inc q5		−53.987 [31.846] ⁺		−46.506 [30.808]
Avg HH disposable inc	81.556 [5.752]**	77.342 [6.337]**	78.785 [4.805]**	72.059 [6.330]**
Avg HH disposable inc ²	−0.63 [0.122]**	−0.551 [0.104]**	−0.608 [0.088]**	−0.51 [0.083]**
Fraction of students in HH	−466.96 [176.40]**	−467.638 [172.82]**	−625.82 [166.37]**	−628.018 [163.52]**
Avg age of students in HH	50.329 [4.767]**	50.126 [4.720]**	88.131 [4.867]**	87.945 [4.819]**
1(father edu = HS)	102.148 [25.832]**	98.197 [25.364]**	92.953 [22.717]**	89.403 [22.144]**
1(father edu > HS)	165.528 [35.588]**	158.355 [35.142]**	150.421 [29.833]**	143.041 [29.816]**
1(mother edu = HS)	164.104 [23.726]**	159.696 [23.419]**	127.738 [21.697]**	123.7 [21.481]**
1(mother edu > HS)	310.83 [43.246]**	309.412 [43.272]**	271.451 [41.087]**	270.132 [41.206]**
Per capita GDP	−5.696 [2.378]*	−5.877 [2.426]*	−2.486 [2.079]	−2.636 [2.166]
Growth rate of stu number, %	−0.054 [0.231]	−0.058 [0.232]	−0.093 [0.148]	−0.094 [0.148]
Constant	96.785 [242.42]	155.87 [239.24]	1021.73 [213.34]**	1104.21 [211.41]**
Observations	18,531	18,531	18,531	18,531

Notes: Robust standard errors clustered at the city level are in brackets; all columns are estimated with a Tobit model. The sample includes households with only students at the compulsory education level (Grades 1–9). The omitted category for father's and mother's education is less than high school. Household income quintiles are defined by year and city of residence. All columns control for city and province-year fixed effects.

⁺ Significant at 10%.

* Significant at 5%.

** Significant at 1%.

Table 5
Results for household per student spending on tuition and private tutoring for before and after nationwide implementation of the one-fee policy.

	Before the one-fee policy (2002–2004)		After the one-fee policy (2005–2006)	
	Tuition	Tutoring	Tuition	Tutoring
<i>Panel A:</i>				
Per student pub edu spending	4.374 [36.375]	−51.856 [58.446]	−23.03 [17.445]	−48.741 [24.597]*
<i>Panel B:</i>				
Per stu pub edu sp * HH inc q1	−8.071 [37.533]	−86.321 [61.152]	−34.959 [18.570] ⁺	−98.759 [32.870]**
Per stu pub edu sp * HH inc q2	3.324 [36.719]	−84.86 [61.235]	−18.352 [17.860]	−47.463 [36.137]
Per stu pub edu sp * HH inc q3	13.862 [35.494]	36.416 [62.447]	−20.627 [17.917]	−28.399 [28.739]
Per stu pub edu sp * HH inc q4	4.407 [37.061]	−71.949 [62.105]	−10.461 [20.232]	−3.77 [34.482]
Per stu pub edu sp * HH inc q5	5.927 [42.236]	−72.765 [63.369]	−30.129 [18.246] ⁺	−65.596 [35.398] ⁺
Observations	11,133	11,133	7398	7398

Notes: Robust standard errors clustered at the city level are in brackets; all columns are estimated with a Tobit model. The sample includes households with only students at compulsory education level (Grades 1–9). Control variables are the same as those in Table 4.

⁺ Significant at 10%.

* Significant at 5%.

** Significant at 1%.

Table 6
Results for household per student spending on private tutoring on data from three potential base samples.

	All years	2002–04	2003–05	2004–06
<i>Panel A:</i>				
Per student pub edu spending	–36.236 [21.827] ⁺	–51.856 [58.446]	–82.449 [61.731]	–39.95 [24.870]
<i>Panel B:</i>				
Per stu pub edu sp * HH inc q1	–78.601 [28.553]**	–86.321 [61.152]	–111.447 [73.001]	–91.161 [32.209]**
Per stu pub edu sp * HH inc q2	–45.893 [29.994]	–84.86 [61.235]	–94.038 [63.061]	–49.952 [34.902]
Per stu pub edu sp * HH inc q3	14.656 [24.681]	36.416 [62.447]	–11.378 [61.467]	12.55 [27.598]
Per stu pub edu sp * HH inc q4	–15.106 [28.180]	–71.949 [62.105]	–90.157 [56.857]	–10.058 [29.320]
Per stu pub edu sp * HH inc q5	–53.987 [31.846] ⁺	–72.765 [63.369]	–101.52 [73.550]	–57.873 [37.775]
Observations	18,531	11,133	11,219	11,175

Notes: Robust standard errors clustered at the city level are in brackets; all columns are estimated with a Tobit model. The sample includes households with only students at the compulsory education level (Grades 1–9). Control variables are the same as those in Table 4.

⁺ Significant at 10%.

* Significant at 5%.

** Significant at 1%.

changes with increases in public education spending before the one-fee policy but shows a sizable reduction after, indicating the importance of a concrete and enforceable policy. In contrast, household spending on tutoring decreases by similar magnitude in both the weak and strong enforcement regimes, suggesting that the stronger enforcement of tuition charges does not have a spillover effect, and our estimates on tutoring spending are unlikely driven by enforcement spillover.

Second, we deal with the concern that the new migrants to cities due to China's rapid urbanization may have lower preferences for children's education and hence spend less on private tutoring, which may not be fully captured by control variables. We believe that the bias due to this sample change is likely minor. Across municipalities, the common requirements for migrant workers to obtain the *Hukou* status since 2001 are a stable job, stable income, and stable residence for the past several years (Sun et al., 2011). Thus migrant workers who obtain *Hukou* and hence may be potentially included in the sample are those who have perhaps assimilated into the city life and have preferences similar to longer-term city residents. Nevertheless, we conduct further analysis taking advantage of the UHS sampling feature. Specifically, each year's sample is extracted from a larger base sample, which is fixed for three years before a new one is created; therefore estimates on data extracted from the same base sample are not subject to bias due to composition changes. Not knowing which three years come from the same base sample, in Table 6, we report estimates on data from three potential base samples (2002–2004, 2003–2005, and 2004–2006) for both the average effect and effects for different income groups. If composition changes drive the results, we expect estimates on the earliest 3-year period to be rather different from estimates on the latest 3-year period. F-tests however cannot reject the equality of estimates between the baseline and each of the three subsamples. This similarity mitigates the concern over sample composition and preference changes.

Third, we deal with the concern that other public expenditure policies, such as social security expansion (Mu and Du, 2012) and public health expenditure, may affect household budget constraint or expectations about future and hence spending on children's education, and these policies may also be residually correlated with public education spending. Our strategy is to examine how spending on total non-durable consumption and its various components respond to public education spending for households without school-aged (from kindergarten to college) children; consumption expenditure of these households should not be directly affected by public education spending. The results are reported in Table 7, where each cell represents the result for a

regression of household average expenditure on total non-durable consumption or its components.²¹ Every regression controls for household average disposable income and its square, household size, average age of household members, education level of household head, local per capita GDP, and city and province-year fixed effects. The estimate on public education spending is insignificant for either average total consumption or each of its components, consistent with our identification assumptions.

Overall, the above evidence raises our confidence that the main estimates for household tutoring spending capture the behavioral response to higher public education spending rather than confounding effects of other contemporary changes.

5.4. Heterogeneity by gender and schooling level

In this subsection we focus on households with only one child and examine how their responses in tutoring spending differ by child gender and schooling level. China starts to implement the one-child policy (OCP) in 1979, and the enforcement is quite strict in the urban area; 95% of households in our sample have only one child. Households with multiple children have lower average disposable income and lower parental education than only-child households; they are also more likely to be multi-generational and to live in smaller cities. Average household spending on private tutoring is 830 Yuan for only-child households compared to 390 Yuan for households with multiple children.

The first two columns of Table 8 report the estimated responses of household private tutoring spending to increases in public education spending of only-child households, overall and by income quintiles. All control variables in Table 4 are included; in addition, we are also able to control for the gender of the child. Estimates on public education spending and its interactions with income quintiles are negative but of smaller magnitude and less significant than those in the first two columns of Table 4. Nevertheless, the two sets of estimates are not significantly different from each other.

²¹ Total spending on service consumption is spending on the service component of food, apparel, health, entertainment, and dwelling categories. It is a subset of total non-durable consumption. Spending on dwelling includes that on rent, utility, gas and electricity, and minor repairs and does not include mortgage payment. Not reported in the table is the "other" category including spending on cosmetics, hairdressing etc., the estimate for the two samples in Panels A and B being 8.57 and 6.17 with standard deviation of 14.68 and 8.38.

Table 7

Non-durable consumption expenditure of households without school-aged (kindergarten to college) children.

	1	2	3	4	5	6	7
	Total non-durable consumption	Total service consumption	Food	Apparel	Health	Entertainment	Dwelling
Per student pub edu spending	−29.15 [69.81]	7.197 [41.574]	−14.564 [23.603]	−13.016 [12.021]	−6.781 [30.685]	11.737 [25.644]	−10.306 [23.460]
Observations	32,476	32,476	32,476	32,476	32,476	32,476	32,476

Note: Spending on dwelling includes that on rent, utility, gas and electricity, and minor repairs and does not include mortgage payment. Columns 5 and 6 are estimated with a Tobit model, other columns are estimated with a linear model. Control variables include household average income and its square, household size, average age of household members, education level of household head, local per capita GDP, and city and province-year fixed effects.

Table 8

Heterogeneity: results for household per student spending on private tutoring for only-child HH, by gender, and schooling level.

	1	2	3	4	5	6	7	8
	Only-child households							
	All schooling levels				Primary school		Middle school	
Per student pub edu spending	−26.258 [22.066]		−42.052 [24.653] ⁺		−25.027 [33.551]		−60.648 [37.902]	
1(girl = 1)	134.627 [20.608]**	135.464 [20.668]**	91.811 [27.331]**		143.848 [36.431]**		7.791 [39.108]	
Per stu pub edu sp * 1(girl = 1)			31.057 [17.953] ⁺		6.611 [25.365]		65.919 [28.180] [*]	
Per stu pub edu sp * HH inc q1		−69.103 [28.925] [*]		−93.871 [30.686]**		−66.776 [39.849] ⁺		−114.746 [44.203]**
Per stu pub edu sp * HH inc q2		−39.42 [30.351]		−65.447 [28.356] [*]		−50.024 [35.803]		−78.854 [43.637] ⁺
Per stu pub edu sp * HH inc q3		25.941 [25.025]		−4.148 [30.186]		−33.883 [41.734]		24.173 [36.087]
Per stu pub edu sp * HH inc q4		−5.317 [28.502]		−11.33 [24.796]		6.687 [37.357]		−24.675 [45.160]
Per stu pub edu sp * HH inc q5		−41.114 [31.772]		−92.508 [35.826]**		−96.841 [40.241] [*]		−87.739 [47.821] ⁺
Per stu pub edu sp * HH inc q1 * 1(girl = 1)				54.803 [22.214] [*]		68.137 [41.645]		46.544 [28.357]
Per stu pub edu sp * HH inc q2 * 1(girl = 1)				53.671 [27.595] ⁺		3.004 [30.770]		106.53 [46.880] [*]
Per stu pub edu sp * HH inc q3 * 1(girl = 1)				66.474 [38.164] ⁺		75.956 [57.268]		55.842 [41.539]
Per stu pub edu sp * HH inc q4 * 1(girl = 1)				12.684 [43.917]		21.44 [45.833]		−9.012 [60.430]
Per stu pub edu sp * HH inc q5 * 1(girl = 1)				104.83 [30.496]**		86.225 [60.897]		139.562 [38.109]**
Observations	17,679	17,679	17,679	17,679	9587	9587	8092	8092

Notes: Robust standard errors clustered at the city level are in brackets; all columns are estimated with a Tobit model. The sample includes households with only one child. Control variables are the same as those in Table 4.

⁺ Significant at 10%.

^{*} Significant at 5%.

^{**} Significant at 1%.

More interestingly, households with an only-girl spend on average 130 Yuan more on tutoring than households with an only-boy, and the estimate on the girl indicator is significant at the 1% level. This finding appears to be contradictory to the common perception that OCP leads to biases against girls (for example Ebenstein, 2010); however it is indeed consistent with two interpretations. First, under the OCP, urban households generally do not have a strong preference for boys as opposed to girls and are roughly equally likely to have a boy or a girl – of the only-child sample, 53% are boys and 47% are girls, leaving a sex ratio of 110 boys per 100 girls, which is within the normal range; thus, they have little incentive to discriminate against girls in their educational investment. Moreover, given the prevalence of discrimination against women in the labor market, households may invest more on girls' education to improve their future competitiveness. This pattern has been documented in small surveys such as Fong (2002) and Tsui and Rich (2002).²² Second, households may save more and

bequest more physical capital to their only boys such as in the form of marital houses but invest more on their only girls in the form of human capital, consistent with the traditional arrangement in Chinese marriages (Wei and Zhang, 2011).²³

Given the significant gender difference in household tutoring spending, we are interested in whether only-boy and only-girl households also respond differentially to changes in public education spending. In Column 3 we interact public education spending with the girl indicator; the result suggests that while only-boy households reduce spending on tutoring when public education spending is higher, households with an only-girl display no change in their tutoring spending – the sum of estimates on public education spending and its interaction with girl indicator is not significantly different from zero. Perhaps girls have a more cooperative attitude toward schooling and tutoring, and hence marginal spending on education is more productive for girls than for boys, as

²² Yamauchi and Tiongco (2013) find that parents in the Philippines tend to invest more on daughters' education in response to the labor market discrimination against women.

²³ When restricting the sample to only-child households, family size no longer has a significant effect on household tutoring spending, reflected by the insignificant estimate on fraction of students in household. Full estimate results are available from the authors.

suggested by Lai (2010). Column 4 interacts public education spending with both girl indicator and income quintile indicators. Both the lowest (bottom two quintiles) and highest income households with an only-boy display significant reduction in tutoring spending when faced with higher public education spending, and there is virtually no change in spending by the middle two income quintiles, largely consistent with the pattern in Table 4. In contrast, only-girl households show no response in their tutoring spending except for the middle-income group, who actually increases significantly their tutoring spending.

In the last four columns of Table 8, we report the results for households with a child in primary school and middle school separately. On average, households spend 150 Yuan more on middle school students than primary school students. The regression results are generally consistent with those in Columns 3 and 4; however, interesting differences between the two schooling levels are worth noting. First, households spend significantly more on girls in primary school but equally on girls and boys in middle school. This may be related to the different admission rules for middle school and high school. Policy requires that students be assigned to the nearest *middle school* by computerized randomization; in practice many open seats in prestigious middle schools are filled based on unspecified merits. To gain an advantage in this process parents enroll their primary school-aged children in a variety of extracurricular classes including both academic such as English and non-academic such as music and sports; many of the music classes popular among girls are much more costly than other activities (Tsui and Rich, 2002). By comparison, *high school* admission is solely based on performance in the city-wide high school entrance exams in a few academic subjects; therefore, middle-school students regardless of gender tend to take similar after-school classes in these subjects. Second, the reduction in tutoring spending by the lowest income only-boy households is much larger at the middle school level than at the primary school level; additionally, lowest income households with an only-girl in middle school also appear to reduce their tutoring spending (significant at the 12% level). These results suggest that household spending at the middle school level is more substitutable to school teaching and are also consistent with the above discussion of school admission policies.

6. Conclusion

This paper documents robust evidence that household spending on children's education responds to differences in public education

spending in urban China. Most importantly, we find that higher public education spending is associated with significantly smaller household spending on private tutoring. While we are not able to rule out all confounding factors that are related to both public and household education spending, this result echoes the theoretical analysis of the importance of controlling for household responses when estimating the impact of public education policies on student outcome.

We find that reductions in household tutoring spending and hence total spending are the largest for the lowest-income households, both in absolute amount and percentage; therefore, increases in public education spending reduce to the largest extent the burden on the lowest-income households. Additionally, human capital accumulation of children from these households may also increase if school teaching is more productive than tutoring. However, the gap in human capital accumulation between low-income households and higher-income households remains and may even enlarge, as increases in public education spending do not displace private education spending of the latter. The fact that low-income households continue to spend a significant amount of disposable income on private tutoring suggests that greater redistribution can be achieved through further efforts of government to improve the public school system.²⁴

We find differential patterns of tutoring spending and responses to public education spending between households with an only boy and those with an only girl, and between households with a child in primary school and those with a child in middle school. In particular, households with an only girl spend more on tutoring than those with an only boy, and reduction in tutoring spending when public education spending is higher concentrates on households with an only boy, consistent with observations of discrimination against women in the labor market. Further research is needed to establish causal relationships between education spending on girls, their educational attainment, and labor market outcomes.

While our results on household tutoring spending are suggestive of school quality variations, our data do not contain information on student academic performance and do not allow us to estimate the efficiency of public school spending and hence infer whether further increases in spending is likely to improve school quality. Future work will investigate the efficiency of public education spending and how it varies with local circumstances such as transparency of public sector administration (Reinikka and Svensson, 2004) and constraints on teacher resources (Kremer et al., 2005).

Appendix A. Comparative static analysis for low- and middle-income households

Plugging the budget constraints into the parent utility function, we can rewrite the optimization problem as

$$\max_{\{q,b,s\}} u_p = u_1(w_p h_p - s - q) + u_2(s(1+r) - b + P) + \delta u_k(w_k h_k + b) \quad (\text{A1})$$

$$s.t. s \geq 0, q \geq 0, b \geq 0 \quad (\text{A2})$$

and form the Lagrangian:

$$\mathcal{L} = u_1(w_p h_p - s - q) + u_2(s(1+r) - b + P) + \delta u_k(w_k h_k + b) + \pi s + \lambda q + \mu b.$$

The first order conditions are:

$$q : \frac{\partial u_p}{\partial q} = -u'_1 + \delta u'_k w_k f_q + \lambda = 0$$

$$s : \frac{\partial u_p}{\partial s} = -u'_1 + (1+r)u'_2 + \pi = 0$$

$$b : \frac{\partial u_p}{\partial b} = -u'_2 + \delta u'_k + \mu = 0$$

and

$$s \geq 0, b \geq 0, q \geq 0, \pi \geq 0, \lambda \geq 0, \mu \geq 0, \pi s = 0, \lambda q = 0, \mu b = 0.$$

Low-income households: $s = 0, b = 0$.

The first order condition with respect to q is: $\frac{\partial u_p}{\partial q} = -u'_1 + \delta u'_k w_k f_q = 0$. Taking derivative of q with respect to g , we have:

$$\frac{\partial q}{\partial g} = -\frac{u_{qg}}{u_{qq}}$$

where:

$$\begin{aligned} u_{qq} &= u''_1 + \delta \cdot u''_k \cdot w_k^2 \cdot f_q^2 + \delta \cdot u'_k \cdot w_k \cdot f_{qq} < 0 \\ u_{qg} &= \delta u'_k w_k f_{qg} + \delta w_k^2 u''_k f_q f_g. \end{aligned}$$

Thus the sign of $\frac{dq}{dg}$ is determined by the sign of the numerator, which is the sum of the direct effect ($\delta \cdot u''_k \cdot w_k^2 \cdot f_q \cdot f_g$) and indirect effect ($\delta \cdot u'_k \cdot w_k \cdot f_{qg}$), with the former being negative and the sign of the latter depending on whether the public education spending and household spending are substitutes ($f_{qg} < 0$) or complements ($f_{qg} > 0$).

Middle-income households: $s > 0, b = 0$.

The first order conditions are:

$$\begin{aligned} q : \frac{\partial u_p}{\partial q} &= -u'_1 + \delta u'_k w_k f_q = 0 \\ s : \frac{\partial u_p}{\partial s} &= -u'_1 + (1+r)u'_2 = 0. \end{aligned}$$

Taking a derivative of q and s with respect to g and rearranging terms, we have:

$$\begin{bmatrix} u''_1 + \delta u'_k w_k f_{qq} + \delta w_k^2 u''_k f_q^2 & u''_1 \\ u_1 & u''_1 + u''_2(1+r)^2 \end{bmatrix} \begin{bmatrix} \frac{dq}{dg} \\ \frac{ds}{dg} \end{bmatrix} = - \begin{bmatrix} \delta u'_k w_k f_{qg} + \delta w_k^2 u''_k f_q f_g \\ 0 \end{bmatrix}.$$

It follows that:

$$\frac{dq}{dg} = \frac{- \begin{vmatrix} \delta u'_k w_k f_{qg} + \delta w_k^2 u''_k f_q f_g & u''_1 \\ 0 & u''_1 + u''_2(1+r)^2 \end{vmatrix}}{|J_2|}.$$

or,

$$\frac{dq}{dg} = \frac{-(u''_1 + u''_2(1+r)^2) \cdot (\delta u'_k w_k f_{qg} + \delta w_k^2 u''_k f_q f_g)}{(u''_1 + \delta u'_k w_k f_{qq} + \delta w_k^2 u''_k f_q^2) \cdot (u''_1 + u''_2(1+r)^2) - (u''_1)^2}.$$

Since the denominator $|J_2| > 0$, the sign of $\frac{dq}{dg}$ is determined by the sign of the numerator. Furthermore, the first term of the numerator $-(u''_1 + u''_2(1+r)^2) > 0$, and thus the sign of $\frac{dq}{dg}$ is determined by that of $(\delta u'_k w_k f_{qg} + \delta w_k^2 u''_k f_q f_g)$, which depends on the sum of the direct and indirect effects of a change in g , as in the analysis for the low-income households. Similarly,

$$\frac{ds}{dg} = \frac{\begin{vmatrix} u''_1 + \delta u'_k w_k f_{qq} + \delta w_k^2 u''_k f_q^2 & -(\delta u'_k w_k f_{qg} + \delta w_k^2 u''_k f_q f_g) \\ u''_1 & 0 \end{vmatrix}}{|J_2|},$$

where the numerator equals $u''_1(\delta u'_k w_k f_{qg} + \delta w_k^2 u''_k f_q f_g)$. It follows that the signs of $\frac{dq}{dg}$ and $\frac{ds}{dg}$ are exactly opposite.

High-income households: $s > 0, b > 0$.

The first order conditions are:

$$\begin{aligned} q : \frac{\partial u_p}{\partial q} &= -u'_1 + \delta u'_k w_k f_q = 0; \\ s : \frac{\partial u_p}{\partial s} &= -u'_1 + (1+r)u'_2 = 0; \\ b : \frac{\partial u_p}{\partial b} &= -u'_2 + \delta u'_k = 0. \end{aligned}$$

It follows immediately that $f_q = \frac{1+r}{w_k}$. Applying the implicit function theorem, we have: $\frac{\partial q}{\partial g} = -\frac{f_{qg}}{f_{qq}}$. The sign of $\frac{\partial q}{\partial g}$ only depends on whether the public education spending and household spending are substitutes or complements.

We can also derive the direction of changes in saving and bequest by the following comparative static analysis:

$$\begin{bmatrix} u_1'' + \delta u_k' w_k f_{qq} + \delta u_k'' w_k^2 f_q^2 & u_1'' & \delta u_k' w_k f_q \\ u_1'' & u_1'' + u_2''(1+r)^2 & -u_2''(1+r) \\ \delta u_k' w_k f_q & -u_2''(1+r) & u_2'' + \delta u_k'' \end{bmatrix} \cdot \begin{bmatrix} \frac{dq}{ds} \\ \frac{dg}{ds} \\ \frac{db}{dg} \end{bmatrix} = - \begin{bmatrix} \delta u_k' w_k f_{qg} + \delta u_k'' w_k^2 w_k f_q f_g \\ 0 \\ \delta u_k' w_k f_g \end{bmatrix}$$

For saving:

$$\frac{ds}{dg} = \frac{\begin{vmatrix} u_1'' + \delta u_k' w_k f_{qq} + \delta u_k''(1+r)^2 & \delta u_k' w_k f_{qg} + \delta u_k'' w_k f_g(1+r) & \delta u_k''(1+r) \\ u_1'' & 0 & -u_2''(1+r) \\ \gamma u_k''(1+r) & \delta w_k u_k' f_g & u_2'' + \gamma u_k'' \end{vmatrix}}{|J_3|}$$

The denominator is negative, and the numerator equals to $-\left[\delta u_k' w_k f_{qq} u_2''(1+r) \delta w_k u_k' f_g\right] + \left[\delta u_k' w_k f_{qg} \left(u_1''(u_2'' + \delta u_k'') + \delta u_k'' u_2''(1+r)^2\right)\right]$. Thus, $\frac{ds}{dg} < 0$ if $f_{qg} > 0$, but the sign of $\frac{ds}{dg}$ is indeterminate if $f_{qg} < 0$.

Similarly for bequest,

$$\frac{db}{dg} = \frac{\begin{vmatrix} u_1'' + \delta u_k' w_k f_{qq} + \delta u_k''(1+r)^2 & u_1'' & \delta u_k' w_k f_{qg} + \delta u_k'' w_k f_g(1+r) \\ u_1'' & u_1'' + u_2''(1+r)^2 & 0 \\ \delta u_k' w_k f_q & -u_2''(1+r) & \delta w_k u_k' f_g \end{vmatrix}}{|J_3|}$$

The denominator is negative, and the numerator equals to $-\left[\delta u_k' w_k f_{qq} \left(u_1'' + u_2''(1+r)^2\right) \left(\delta u_k'' w_k f_g\right)\right] - \delta u_k' w_k f_{qg}$. Thus, $\frac{db}{dg} < 0$ if $f_{qg} > 0$, but the sign of $\frac{db}{dg}$ is indeterminate if $f_{qg} < 0$.

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