Fines, Limited Liability and Fertility*

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Abstract

Pro-natal policies have been studied extensively and found effective in increasing fertility, but the effects of counter-natal policies have been largely ignored. Moreover, it is taken for granted that counter-natal policies such as fines should have a universally negative effect on fertility. This paper develops a theory on fines and fertility based on the unique case of rural China, where the government assigns birth quotas to households and above-quota births are fined. Treating children as an investment good and taking limited liability into consideration, we show that the effect of the fine on above-quota births differs substantially across wealth levels. Indeed, the fertility of poor households does not vary with the fine. The optimal fine to control birth should be significantly high. When the government also cares about fine revenues, however, it will set a lower fine to "encourage" above-quota births from rich households, who then "contribute" to the local government's discretionary revenue. For these households, the effect of the fine on fertility is negative but diminishes with wealth. Employing data from rural China, we find supporting evidence for our theory.

JEL Classification: J13, J18, K42

1 Introduction

In recent years, many empirical studies have examined the effect of pro-natal policies on fertility. Most find that subsidies have a positive effect on increasing fertility (see, e.g., Whittington et al. (1990) and Zhang et al. (1994)). However, the effect on fertility of explicit counter-natal policies, such as fines, has been largely ignored.[1] The use of such policies provides a unique opportunity to study their incentive or disincentive effect on family behavior and would certainly be an interesting issue for economists. The lack of previous study is mainly due to the rare occurrence of such policies and the lack of appropriate data.

Fines, together with other birth control policies, have been used for reducing fertility in China.[2] Households are assigned birth quotas, normally one and at most two (if the first child of a rural household is a girl), and "above-quota births" are fined. The presumed effect of fines on reducing fertility has gone unchallenged. If we treat the fine as the price of a child imposed by the government, then the demand for children should decrease as the fine increases.

The simple demand analysis, however, has overlooked two important facts about fertility decisions. First, the benefits of children to a household, such as the pleasure they bring to parents, their contribution to housework, the son's role of carrying on the family name, and providing parents with security in their old age, do not have a market value.[3] Moreover, many of these benefits can only be realized in the future, when children have grown up. Second, households assume limited liability, and they cannot borrow against the future to pay for fines (Birdsall, 1988). Since the benefits of bearing children do not have a market value and can only be realized in the future, they cannot be used directly to pay fines. When the fine is above a household's wealth level, the household uses all its wealth after having an above-quota child, and defaults on the rest of the fine.[4] Only those households whose wealth is above the fine will pay the whole fine.

Limited liability makes the effect of subsidies and fines asymmetric. The subsidies for having children increase a household's private value of a child, and thus increase its incentives to have more children. Theoretically, the subsidies could be as large as possible,

[1] The only noticeable exception is the study by McElroy and Yang (2000).

[2] Other methods of population control include birth control services, quotas, and rewards. The only other country that has used fines is Singapore (Johnson, 1994).

[3] See Becker (1991), Johnson (1994), Dasgupta (1995), and Ray (1998) for the arguments on the benefits of children in developing countries.

[4] As in the legal literature, a criminal will pay all his wealth when he cannot afford to pay the fine. See Polinsky and Shavell (1991) for a discussion on this.

and the government could choose a subsidy level that fulfills its fertility target. Fines, on the other hand, reduce a household's private value of a child, and thus reduce its incentive to have a child. The effect of fines, however, is limited by the household's wealth. Fines larger than a household's wealth cannot be successfully collected. This lower bound makes fines ineffective because the maximal fine may not reduce the private value of a child enough to stop a household from childbearing.

In this paper, we examine government fines and childbearing decisions by taking the non-market value of a child and limited liability into consideration. In our theoretical model, a fine for an above-quota child resembles a debt contract, in which childbearing is an investment, the fine is a debt payable to the government, and a household's wealth is collateral. In this model, the government chooses the size of the fine (debt) first, then the household decides whether or not to have a child (borrow), given that it assumes only limited liability, and finally the household pays the government either the fine or all of their wealth (collateral), whichever is lower, if it has an above-quota child. The value of a child (return on investment), however, can only be enjoyed by the household privately and cannot be used to repay the debt. Thus, a poor household may decide to have a child and then default if the return on a child is higher than the loss of the family's wealth.

Households differ in their wealth level, which depends on, among other things, inheritance, education, political power, and social connections. Households also differ in the value they generate from the investment of having an additional child. Richer households can generate higher values than poorer households, because they can provide children with better education and help them to find better jobs. However, like other investment vehicles, investment in a child may have a decreasing marginal return. Thus, the marginal value of wealth for a child may also decrease with wealth.

The fine that minimizes fertility should be as large as possible.[5] A large fine, however, can prevent the rich from childbearing, but not the poor. A fine can prevent a household from childbearing only if the expected return of a child is smaller than its wealth. Although poor households have a low return for a child, their wealth could be even lower. Thus, they are very likely to have an above-quota child. Rich households, on the other hand, may have a larger expected value for a child than poor households, but their wealth could be even larger than the expected value of a child. Thus, a very high fine can deter rich households

[5]In the legal context, Polinsky and Shavell (1991) argue that the optimal fine to deter harmful acts is also the highest possible fine.

that do not want to expend their wealth on an additional child.

At this level of fine, all poor households and some medium and rich households have above-quota children. While poor and medium households have children because of limited liability, rich households do so because they value a child more than the fine. Moreover, although fertility does not vary with either wealth or fines for poor households, it decreases with wealth for medium households and increases with wealth but decreases with fines for rich households.

The government, however, may not want to commit to a heavy fine policy because they are concerned about the total amount of the fine itself. In the case of China, the local governments (county, township governments, or village cadres) implement or even design birth control policies (Greenhalgh et al., 1994). In particular, local governments determine the size of the fine, collect fines, and have discretion in using fines. In this case, the revenue-constrained local governments may choose a fine level that allows some rich households to bear children so that they can collect more revenue. At this level of fine, all poor households and some rich households have above-quota children. While poor households have children because of limited liability, rich households do so because they value a child more than the fine. Moreover, although the fine has no effect on the fertility of poor households, it has a negative effect on that of medium and rich households. For rich households, the effect of the fine on reducing fertility decreases with wealth because the value of a child increases with wealth. The fine and fertility of the community in this case will depend on the weighting the government places on fertility and revenue respectively in its objective function. One might expect that the more the government cares about revenues, the lower the fine and the higher the fertility rate will be.

This paper provides a new way to model fines and fertility decisions, and also provides theoretical explanations for some empirical evidence in the literature. First, although it is well known in the literature that children can be an investment good, this paper, to the best of our knowledge, is the first to consider childbearing as an investment with non-market value, and to model fines and fertility with limited liability. Second, the theory explains why fines may not be an effective birth control policy, especially for the poor. Empirical research in China has provided overwhelming evidence that poor households have very high fertility (Johnson, 1994; Greenhalgh et al., 1994; Moore, 1998). If fines were indeed effective, the government could simply have imposed an extremely high one, which should have successfully prevented the poor from having above-quota children. Third, the theory explains why rich rural households may also have high fertility even when a fine is inevitable. When the government does not set a very high fine, the richer households that value an additional child more in an absolute sense will want more children. This argument is supported in an empirical study by McElroy and Yang (2000), who find that controlling for the size of the fine, fertility increases with household income.[6]

Our paper differs from the way in which fines are modeled in legal and public finance literature, which was pioneered by Becker (1968) and surveyed by Polinsky and Shavell (2000). First, in the legal literature, a social planner chooses the optimal fine to maximize a social welfare function, which is the difference between social benefits and social costs of crime. In our paper, the government maximizes its own utility, which could be maximal deterrence or a weighted function of deterrence and government revenues from fines. In the case of the government maximizing deterrence, the optimal fine is the largest possible fine since there is no cost of imposing a fine. When the government also cares about the amount of the fine itself, it will not set a very high fine because a high fine may reduce the number of above-quota births and thus the government's revenues. Second, jail is an alternative option of punishment for criminals besides fines. In the case of above-quota births in rural China, jail is not an option, since having above-quota births is not a crime. This makes fines the most serious punishment available, and the maximal punishment may not be enough to deter in some circumstances. Third, the probability of detection of an above-quota child in our paper differs from stochastic detection in the legal literature. The assumption of no uncertainty in detection is justifiable in the case of underdeveloped rural villages in China, where residents are in close contact with each other, and thus childbearing is very difficult to hide.[7]

Employing a dataset collected from China by the Carolina Population Center, we also empirically test some hypotheses generated from our model. Our empirical findings support our theory. We find that the fertility of poor households is not sensitive to fines, but that the fertility of medium and rich households decreases with fines. Moreover, the negative effect of fines on fertility decreases with income of rich households.

The rest of the paper is structured as follows. In Section 2, we briefly discuss fertility

[6]Our study differs substantially from that of McElroy and Yang (2000); see Section 4.3 for details.

[7]It is very costly to conceal childbearing in a remote location. Furthermore, China's powerful household registration system makes prolonged escape virtually impossible. For example, household registration is necessary to have access to identification (*hukou*) and school.

control policies in China, in particular, the role of fines. In Section 3, we build the model of fines and fertility. We first analyze the model in a deterministic setup, and then introduce uncertainty into the model. We also allow the child value and the fine to be different for poor and rich households, and examine how relaxing these assumptions affects the main predictions of the model. In the last part of this section, we consider a variation of the model in which the government is concerned about the amount of the fine, and conduct a comparative static analysis of the effect of the government's weight on revenues and value of birth control on fines and fertility. In Section 4, we test our model using China Health and Nutrition Survey data collected by the Carolina Population Center. Section 5 concludes the study.

2 Fertility in Rural China

China started its unique one-child-per-family policy in 1979. Under this policy, each household is allowed to have only one child, although subsequently this policy was relaxed in some rural areas to allow a second child if the first one was a girl. Households are given birth quotas, and births outside that quota, or "above-quota births," are penalized.[8]

Although the birth control policy has been very effective in reducing fertility in urban China, above-quota births in rural areas are not rare. Using a sample of 14,808 infants in rural Hebei, Li (1995) finds that 52 percent were above-quota births. In most cases of above-quota births in rural areas, households want a son. Sons are preferred in rural China, because they support and care for aging parents, continue the family name, carry out heavy farm work, and receive the family inheritance (Dasgupta, 1995; Graham et al., 1998). The policy that the second child is allowed if the first one is female in rural areas also reflects the fact that boys are preferred (Chow, 2002). There is also empirical evidence that once a household has a son, it is very likely to stop at the current parity (Zhang, 1994).

Fines have been the primary penalty for above-quota births in rural areas.[9] Various studies have shown that fines are heavy and vary a great deal across localities. The fine

[8]The reward system is relatively unimportant in rural areas. As documented in Li (1995), a monetary reward accounts for only 2 percent of the fine.

[9]Another penalty that applies to rural areas is no registration for above-quota births. Other penalties, such as demotion in a state-owned enterprise or withdrawal of the children's rights to go to school, are not very important in rural areas, because only urban residents are entitled to industrial jobs and substantial education subsidies in China (Short and Zhai, 1998). The only people who worry about careers in rural areas are government officials. We also control some of these other punishments in our empirical work, and do not find them to have a significant impact.

ranges from 20-200 percent of a household's annual income (Li, 1995; Short and Zhai, 1998; McElroy and Yang, 2000). This is very substantial, especially in light of the fact that many of these rural households (38 percent of our sample) still live below the poverty line. Many households default because they are unable to pay heavy fines. For example, Li (1995) finds in his sample that about 20 percent of households default on the fines for above-quota births. Anecdotal evidence suggests that when households cannot pay enough cash, local cadres take valuables or personal belongings to compensate for the fine. In this case, household wealth essentially becomes the collateral.

Local governments are given incentive contracts for birth control. They are given fiscal rewards for fulfilling the birth target, and are heavily penalized if they do not (Short and Zhai, 1998). Moreover, government officials can be demoted for having too many above-quota births in their community, which means that they will lose all future income and other benefits associated with government positions.

However, these birth control incentives are compromised by the fiscal reform in China, which has given local governments strong incentives for generating their own fiscal revenues (Qian and Weingast, 1997). Fines for above-quota births have become a significant part of local fiscal revenues in some localities (Peng, 1996). According to a report from the Legal Daily of China, in one township of Southern Guizhou (one province in our sample), 28 percent of all fiscal incomes are from various types of fines, among which 68 percent are fines for above-quota births.[10] Ji (2001) finds that fines for above-quota births account for 30 percent of the total fiscal revenues in townships he has studied. Even if fines account for only a small proportion of the fiscal revenues in some localities, they are still very important for local officials because they are an important source of the extra-budgetary revenue, with which township officials have discretion.[11] According to Peng (1996) and Lin et al. (2001), fines as part of the local governments' extra-budgetary revenues are used mainly for paying the bonuses and perks of local officials (e.g., financing big dinners or buying gas for their

[10] The township is the lowest level government in rural China, with an average population of around 20,000. The township has its official public finance. An average township consists of 20 villages, which are the basic administrative unit of rural China. A village does not have its own government, but it has between five and ten party and government officials in charge of village administrative duties. The fines for above-quota births are collected by township and village officials. In order to encourage the collection of fines, some local governments have explicit sharing rules. For example, Wang and Wang (2003) find in their case studies that the village keeps 30 percent of the fines, and turns in 50 percent to the township government and 20 percent to the county government, which is the level immediately above the township.

[11] The other part of the fiscal revenue is the budgetary revenue, which is from formal taxes. Local (township) governments care less about the budgetary revenue because it is not directly linked to the budgetary expenditure of a township (Jin and Qian, 1998).

cars).[12]

3 The Model

In our model, a risk-neutral rural household possesses wealth, W. W is uniformly distributed on $[0, \overline{W}]$, with the poorest household having no wealth and the richest household having $\overline{W}$. This household does not have a boy, and a boy as an investment will generate a positive return. The (net) value of a boy to the household, $V(W)$, is a function of W. Assume all households have the same boy value function $V(W)$, where $V(W) > 0$, $V'(W) > 0$ and $V''(W) < 0$.[13] These assumptions mean that the value of a boy is positive, and it is increasing and concave in W.

In the case of rural China, a boy has two important values that increase with wealth. First, as an investment, a boy in rural China is for his parents' security in old age. Our study is of a very particular case of fertility: the second birth of a household who wants to have a boy. Having a boy is necessary for most households in rural China, because there is no social security for rural residents, and because it is the son's responsibility to support and care for aging parents according to the rural custom. Second, a boy can carry on the family name, which is very important in the rural culture.[14] In rural areas, households who do not have a son are discriminated against by friends and relatives because failure to carry on the family name is a serious sign of disrespect to ancestors.[15] Since richer people can raise a more highly educated and therefore potentially richer boy who will provide better security for his parents in their old age, and richer people place a higher value on their family name, the value of a son, in these terms, should increase with wealth (at least within a narrowly-defined income group). However, like other investment vehicles, the investment value of a child may have a decreasing marginal return. Thus, the marginal value of wealth

[12] There is a lot of discussion among Chinese researchers and the media about fines imposed on farmers. When we searched the Internet for the Chinese key words "fines" and "birth control" with the search engine Google, 12,000 items were found. When we added the additional key word "public finance," 4,360 items appeared. Many of these articles are case studies by Chinese scholars and the media. They almost exclusively hold the view that fertility fines were important for local governments' revenue and in particular for paying the bonuses and perks of local officials in the 1980s and 1990s.

[13] In Section 3.3, we will consider cases in which poor and rich households have different boy value functions. We show that this modification does not change the main features of the results.

[14] The role of the boy in carrying on the family name can be seen as either consumption or investment. Thus, we treat a boy as an investment good in a broad sense.

[15] There is a saying in Chinese that describes this vividly: "There are three disrespects we could have for our ancestors, not carrying on the family name is the biggest one" (*bu xiao you san, wu hou wei da*). The discrimination can also be shown by two other Chinese sayings: "no sons, no grandsons" (*duan zi jue sun*), and "extinction of descendants" (*jue hou*), which are extremely negative sayings about a family.

for a child may also decrease with wealth.[16]

Assume also that the value of a girl to the household is lower than $V(W)$, and let's normalize it to 0. So, if the chance of having a boy is one half, then the expected value of an above-quota child will be $V(W)/2$. A further assumption is that the value of an above-quota boy for the richest household is lower than its wealth value, or $V(\overline{W})/2 < \overline{W}$. This is a sufficient condition to guarantee that fines are effective.

Figure 1 describes the relationship between W and $V(W)/2$. We call W_0, the intersection of W and $V(W)/2$, the *breakeven* point. For households with wealth smaller than W_0, the expected value of a child is larger than their wealth; and for households with wealth larger than W_0, the expected value of a child is smaller than their wealth. Since all households have a positive value for an above-quota child, they will all want a child if there is no fine.

The local government imposes a fine, F, on households that have above-quota children, where F is the same for all households in a community.[17] Suppose a household has already used its quota for children (for example, it has two girls), and it needs to decide whether or not to have an above-quota child. Let's use a discrete variable $y(W, F)$, a function of the household's wealth and the level of fine, to represent the childbearing decision, with $y(W, F) = 1$ for an above-quota child and $y(W, F) = 0$ if not. Since children do not have a market value, they cannot be used to pay for the fine. The only way the household can pay the fine is with its wealth and current income. The household assumes "limited liability," which means that if $W < F$, the household will only have to pay W to the government for an above-quota child.[18] Thus, the *effective fine*, which is represented by the solid part of

[16] To justify our assumption, we ran a simple regression in which the dependent variable is the children's education, and independent variables are household income and its square. We find that income has a positive and significant coefficient, while the square term has a negative and significant coefficient. This simple exercise justifies our assumptions that the value of the child is increasing and concave in wealth. All our results should also hold if we have a linear value function with $V'(W) < 1$.

[17] For the reason of fairness, having different fines for different households in a community will not be acceptable in China's rural areas. From our reading of the literature on fertility (e.g., Li (1995) and Short and Zhai (1998)), the fine is also uniform for the rural communities they study. Our data also show that the level of fine is uniform in a village. Fairness is also the reason for a uniform fine in the legal literature (Polinsky and Shavell, 2000). Although the fine is sometimes proportional to the salary of workers in the industry and service sectors in urban areas, it is usually a fixed amount in rural areas. This is because most farmers are self-employed, and they do not have easily observable labor income. It is thus difficult to have fines proportional to their income or wealth. Although the monetary fine is uniform, other non-monetary penalties could vary with income or wealth. We allow the total penalty to be different for poor and rich households in an extension of the model in Section 3.3.

[18] We have implicitly assumed that W is observable to the government. This is justifiable in the small community of a village, where people know each other well. More accurately, W can be called observable wealth. As long as the more wealthy people have more observable wealth, then the arguments in this paper

the 45-degree line and the fine line in Figure 2, is $W \times J_{\{W \leq F\}} + F \times (1 - J_{\{W \leq F\}})$, where $J_{\{W \leq F\}} = 1$ if $W \leq F$ and $J_{\{W \leq F\}} = 0$ if $W > F$.

The government chooses F to minimize the number of above-quota births. This can be written as

$$\min_{\{F\}} \int_W y(W, F) dW. \tag{1}$$

The household maximizes its expected utility by choosing whether or not to have an above-quota child. The expected utility is, $\forall W$,

$$\max_{\{y\}} y(\frac{V(W)}{2} - W \times J_{\{W \leq F\}} - F \times (1 - J_{\{W \leq F\}})). \tag{2}$$

The timing of the model is as follows. The government first decides on the size of the fine, F. The household then decides whether it wants a child or not. Finally, the government takes the fine or the total wealth from the household if it has an above-quota child, or the household does not have an above-quota child and there is no fine.

We will solve the model in different proposed courses of action. In Section 3.1, we consider a deterministic model, the benchmark case. In Section 3.2, we introduce uncertainty into the model, and examine how the optimal fine and fertility change with the change of the setting. In Section 3.3, we allow the boy value function and the fine to be different for poor and rich households, and investigate how robust the predictions in Section 3.2 are to the changes in assumptions. Finally, in Section 3.4, we consider a case in which the government is concerned about both fertility and revenues from fines.

3.1 A Deterministic Model

We first establish the deterministic case as our benchmark model. The solution to the benchmark model is summarized in Proposition 1, proof of which is in Appendix 1.

PROPOSITION 1: *Poor households, whose wealth is below the breakeven point, have an above-quota child irrespective of the size of the fine. The government sets the optimal fine* $F^* \geq V(\overline{W})/2$. *At the optimal level of fine, households whose wealth is above the breakeven point do not have an above-quota child. Algebraically,* $y(W, F) = 1$ *for* $W \leq W_0$ *and for any* F*; and* $y(W, F^*) = 0$ *for* $W > W_0$.

should still hold. Another issue is whether the government could collect fines over several years so that limited liability may not hold. As we will show in the data section, this is unlikely to happen. It would take at least 20 years for most poor households to pay the fines using their savings, and would take about 100 years for the poorest households. Thus, limited liability is very likely to hold for them.

Proposition 1 shows that fines are only effective in deterring the rich from having above-quota births. For poor households, whose wealth is below the breakeven point, fines will not stop them from having a child because the largest fine they can afford is lower than the expected value of an above-quota child. For rich households, whose wealth is above the breakeven point, the fine, or else their total wealth, is larger than the value of a child. Fines that are larger than the expected value of a child will prevent them from having an above-quota child. Thus, the optimal fine should be at least as large as $V(\overline{W})/2$, which can prevent rich households from having above-quota children. If, for example, the fine is lowered to the level where $F = V(W_1)/2 < V(\overline{W})/2$, as in Figure 2, then households with wealth $W > W_1$ will have an above-quota child, since the expected value of a child is larger than the fine F, which they can afford to pay.

Proposition 1 indicates that fines may not be a good policy for reducing fertility. The objective of imposing fines is to reduce fertility, especially that of the poor. Proposition 1, however, shows that fines may not achieve this objective. Poor households, and only the poor households, have more children when there is a very large fine. This is consistent with empirical evidence that poor households in China tend to have high fertility (Johnson, 1994; Greenhalgh et al., 1994; Moore, 1998).

3.2 Uncertain Child (Boy) Value

In this subsection, we introduce uncertainty into the model. Suppose the value of a boy to a household is $\theta V(W)$, where θ is a random variable uniformly distributed on $[1-a, 1+a]$ and $a \leq 1$.[19] We describe θ as other factors that affect the household's value of a boy. Assume that θ is i.i.d. across households. Also assume that the expected value of a child to the richest household is never as large as its wealth, or $(1+a)V(\overline{W})/2 \leq \overline{W}$.

Since there is uncertainty, the probability of a household having an above-quota child depends on its wealth and the size of the fine. In Figure 3, we define W_2 as the solution to $(1+a)V(W)/2 = W$, and W_3 as the solution to $(1-a)V(W)/2 = W$. Let's call the households with $W \leq W_3$ poor households, those with $W_3 < W \leq W_2$ medium households, and those with $W > W_2$ rich households. We next discuss the probability of having an above-quota child when F is set in different ranges.

[19] We implicitly assume that the household's value of a child can at most be doubled, and at least be zero. Our main results will not change if we relax the assumption to let a take any value, or set a different upper and lower limit. The current assumptions about θ are only for analytical convenience.

When F is below W_3, it has no effect on the fertility decision for any household, and all households have above-quota children. Poor households with $W < F$ will have a child because their expected value of a child is larger than W, the most they could afford to pay. Other households with $W \geq F$ will have a child because their expected value of a child is larger than F, which they are able to pay.

When the fine is set at or above $(1+a)V(\overline{W})/2$, we have the optimal fine, F^{**}. As in the deterministic case, the optimal fine is at least the largest possible expected value of the richest household. We next calculate the probability of each household having an above-quota child, given this optimal fine.

Since F is set very high, a household will have an above-quota child if and only if $\theta V(W)/2 \geq W$. Thus, when $W_3 < W \leq W_2$, we have

$$Prob(y=1|W,F^{**}) = Prob(\frac{\theta V(W)}{2} \geq W) \tag{3}$$

$$= \frac{1+a}{2a} - \frac{W}{aV(W)}. \tag{4}$$

When W is very small such that $W \leq W_3$ (poor households), $Prob(y=1|W,F^{**}) = 1$, since the expected value of a child is always larger than the household's wealth, the most it is able to pay. When W is very large such that $W > W_2$ (rich households), $Prob(y=1|W,F^{**}) = 0$, since these households' expected value of a child is always smaller than the potential penalty.

The intuition for the optimal fine is similar to the deterministic model. Lowering F to a level below F^{**} will only increase the probability of the medium and rich households having a child. At the same time, lowering F will not change the number of poor households who always want a child. Since lowering F^{**} can only increase fertility, the optimal fine should be set as large as possible. We summarize the above in Proposition 2 without a formal proof.

PROPOSITION 2: *When the value of a child is uncertain, the optimal fine is* $F^{**} \geq (1+a)V(\overline{W})/2$. *The probabilities of having an above-quota child are* $Prob(y=1|W \leq W_3, F^{**}) = 1$, $Prob(y=1|W_3 < W \leq W_2, F^{**}) = (1+a)/2a - W/aV(W)$, *and* $Prob(y=1|W > W_2, F^{**}) = 0$.

When the fine is set between W_3 and $(1+a)V(\overline{W})/2$, as in Figure 3, the effective fines are the solid part of the 45-degree line and the fine line. At this level of fine, the probability of having an above-quota child depends on both W and F.[20] There are three

[20] In Section 3.4, we show that the fine at such a level could be optimal for the local government.

cases, depending on the size of W relative to the size of F. First, when $W \leq W_3$, households will have an above-quota child with probability one, since their expected value of a child is larger than W, the most they could afford to pay. Let's call the probability in this case P_1, thus $P_1 \equiv Prob(y = 1|W < W_3, F) = 1$.

Second, when $W_3 < W \leq F$, a household will have an above-quota child if and only if $\theta V(W)/2 \geq W$, since it cannot afford to pay F. The probability of having a child is

$$P_2 \equiv Prob(y = 1|W_3 < W \leq F, F) = Prob(\theta V(W)/2 \geq W) \tag{5}$$

$$= \frac{1+a}{2a} - \frac{W}{aV(W)}. \tag{6}$$

Note that since $V(W)/W$ decreases with W, $\partial P_2/\partial W < 0$, or the probability, decreases with the household's wealth, W. The probability, however, does not vary with the level of fine in this range of wealth, simply because F cannot be imposed fully on these households due to limited liability.

Third, when $W > F$, households can afford to pay the fine, and thus they have an above-quota child if and only if $\theta V(W)/2 \geq F$. The probability of having an above-quota child is

$$P_3 \equiv Prob(y = 1|W > F, F) = Prob(\frac{\theta V(W)}{2} \geq F) \tag{7}$$

$$= \frac{1+a}{2a} - \frac{F}{aV(W)}. \tag{8}$$

The probability increases with the household's wealth, but decreases with the fine. Algebraically, $\partial P_3/\partial W > 0$ and $\partial P_3/\partial F < 0$. Moreover, the marginal effect of the fine in reducing the probability decreases with the level of wealth, or $\partial^2 P/\partial W \partial F > 0$. We summarize these into Proposition 3.

PROPOSITION 3: *When $W_3 < F < (1+a)V(\overline{W})/2$, we have the following properties for the probability of having an above-quota child on a different range of W. (a) For $W \leq W_3$, the probability of having an above-quota child is $P_1 = 1$. (b) For $W_3 < W \leq F$, the probability is $P_2 = (1+a)/2a - W/aV(W)$, which decreases with W, but does not vary with F. (c) For $W > F$, $P_3 = (1+a)/2a - F/aV(W)$, which increases with W, but decreases with F; moreover, the effect of F on reducing P_3 diminishes with W, or $\partial^2 P/\partial W \partial F > 0$.*

Proposition 3 has some important implications for empirical tests later. First, as indicated by Part (a), the probability of having above-quota births is not responsive to either wealth or the size of the fine for poor households. Second, according to Parts (b) and (c), the fine does not affect the probability of having above-quota births for the lower medium households ($W_3 < W \leq F$), but it has a negative effect on the probability for the higher medium households ($F < W \leq W_2$). Thus, taking all medium households together, the effect of the fine may be ambiguous or weakly negative. Finally, Part (c) implies that the fine has a negative effect on the probability for rich households, but the effect of the fine in reducing the probability diminishes with wealth. The predictions for medium and rich households are conditional on the size of the fine not being set too high, i.e., $F < (1+a)V(\overline{W})/2$.

The main mechanism behind Proposition 3 is limited liability. The probability of having above-quota births for poor households does not vary with wealth or with fines because poor households need not pay the full amount of fines due to limited liability, and because the value of a child to them is always larger than their wealth, the effective fine. The probability of the lower medium households does not respond to the fine because of limited liability, but it decreases with wealth because the probability that the value of an above-quota birth is larger than the wealth decreases with wealth. Finally, the probability of the upper medium and rich households decreases with the fine because limited liability is not operative for them and they have to pay the full amount of the fine. For these households, the effect of the fine in reducing the probability decreases with wealth because the value of a child increases with wealth.

3.3 Different Child Value Functions and Fines

In order to emphasize the role of limited liability, we have made some simplifying assumptions regarding both the child (boy) value and the fine. In particular, we have assumed that the child (boy) value function is the same for poor and rich households, and the level of the fine or penalty is uniform. We now discuss situations in which the child value function and the fine are different for poor and rich households.[21] We show that even if we allow for these variations, essentially all preceding results continue to hold.

The value of a boy may differ between poor and rich households for many reasons. For example, having a child may incur an opportunity cost because parents, and especially the mothers, need to spend time on childcare. This opportunity cost may be larger for rich

[21]We are indebted to an anonymous referee whose comments on an earlier version of the paper helped to motivate this subsection. Many examples in this subsection were also suggested by this referee.

households.[22] However, other things being equal, rich people may be willing to pay more for an additional child (boy) to carry on the family name as discussed earlier.[23] Therefore, theoretically, it is difficult to know how the child value function varies between poor and rich groups. Within a small enough income group (where the price effect is fairly constant), the child value function should increase with family wealth (due to a rather pure income effect). However, across income groups, price and income effects may work in different directions, and thus one may not be sure of how the child value function varies with income.

To allow for the possibility that the boy value function may be different for poor and rich households, we add a boy value shifter $A(W)$ to the boy value function, and the new child value function becomes $(1 + a)(V(W) + A(W))/2$. Without loss of generality, assume that $A(W) = A > 0$ for poor households and that $A(W) = 0$ for medium and rich households. Thus, as shown in Figure 4, the child value function for poor households is shifted upward.[24]

With the boy value so specified, the main results as stated in Proposition 3 remain. More specifically, fertility does not vary with wealth or with the fine for poor households; the fertility of rich households decreases with the fine, and the effect of the fine in reducing fertility decreases with wealth. This can be seen from Figure 4. First, poor households whose wealth is below W_4 will certainly have above-quota births, since their child value is even larger than that in Figure 3, while the effective fine for them remains the same as that in Figure 3. Second, since there is no change in the child value function and the effective fine for households with $W > W_4$, the parts of Proposition 3 regarding these households (including some poor households and all medium and rich households) still apply. Note that the fertility of poor households does not vary with the fine precisely because limited liability is at work. If there were no limited liability, poor households would pay the full amount of the fine, and the fertility of poor households should decrease with the fine.[25]

[22] There are also other direct costs of children, but those should be secondary compared to the opportunity cost.

[23] One may also wonder whether poor households, who have fewer assets when elderly, count more on boys for security in their old age. This might be true in other developing countries, but may not be true of rural China in the late 1980s, because farmers in China do not own lands (all lands are owned by the state), and there existed almost no paid or unpaid care from outside the family for the elderly in rural areas. Hence, the first boy is very valuable for both poor and rich households, and may be more valuable for rich households in monetary terms, since they demand a higher standard of care in old age.

[24] Assuming an upward shift of the child value curve for medium and rich households generates similar results.

[25] It can be seen from Figure 4 that if poor households pay the full amount of the fine, then the fine should have the same effect on poor households as that on rich households. Empirical analyses in Section 4 show that poor households are not able to pay the full amount of the fine, and the fertility of poor households does not vary with the fine. These findings suggest that limited liability is operative for poor households.

In Sections 3.1 and 3.2 we have also assumed that the fine is uniform for poor and rich households. This assumption is based on the empirical observation that the monetary fine is uniform in rural communities. Although the monetary fine is uniform in a community, other non-monetary "fines" or penalties may vary with wealth. For example, above-quota births may not be registered as residents and these children may not be allowed to enroll in school. If government officials have above-quota births, they may be demoted. Since rich households care more about their children's residence and education than poor households, these non-monetary penalties are greater for rich households.

In order to address the differential non-monetary penalties, we add a non-monetary term $P(W)$ to the fine, and call $F + P(W)$ the total fine. We normalize $P(W) = 0$ for poor households ($W \leq W_3$), and let $P(W) = P$ for medium and rich households. The model becomes more complicated with the addition of this non-monetary fine, but Proposition 3 still holds in this model. In Figure 5, we have a new line of total fine, $F + P$, for medium and rich households. Note first that since the effective fine for poor households is still the 45-degree line, the predictions in Proposition 3 for poor households continue to hold. The effective fines for medium and rich households as shown in Figure 5 differ from those in Figure 3. For lower medium households, the effective fine is $W + P$, and for higher medium and rich households, the effective fine is $F + P$. Thus, the effective fine has an upward shift of P for these households. With this shift, the probability of having above-quota children is smaller than before. However, qualitative predictions in Proposition 3 regarding the effects of wealth and the fine on fertility are still the same.

Finally, it may be useful to note briefly the relation of our analysis with Becker and related work on fertility. While Becker has emphasized the subtle effect of income on fertility due to complications associated with opportunity costs and/or quantity-quality interaction,[26] we emphasize fines on top of income, and show how the effect of fines varies across different

[26]The quantity-quality tradeoff may not be very strong in rural China. The classical theory proposed by Becker and Lewis (1973) suggests that the observed income elasticity could be negative even if the true income elasticity is positive because of the quality (price) effect. However, as Becker (1993) argues in the book "A Treatise on the Family", the quantity-quality tradeoff depends on the return of investing in children, with the tradeoff larger in more developed countries where investments in children have high rates of return. In developing countries, where child investments have low rates of return, the quantity-quality tradeoff may not outweigh the purely positive income effect. Becker (1993, page 154) states "A similar analysis that incorporates systematic differences in rates of return to different families in developed countries implies that richer families can have fewer children than poorer families, even though richer families in less developed countries have more children than poorer families." Most empirical studies using Chinese data find that the return on education is very low in China, especially in rural areas (deBrauw et al., 2002; Zhang et al., 2002). Hence, we believe Becker's argument regarding the low return on child investment and a positive income elasticity of child quantity should also apply to rural China (this indeed seems to be the case in our data).

income groups. The relation between fertility and income *per se* is not our emphasis. Moreover, it is not clear how fines should have a differential fertility effect across different income groups in Becker's models. Our simple yet unique model allows us to clearly examine the role of fines and how it varies across income groups. To put it simply, our work extends and complements Becker's insights.

3.4 Birth Control and Fiscal Revenue

Fertility control may not be the only consideration for local governments in reality. As shown in Section 2, a lot of anecdotal evidence shows that local governments in rural areas care about the amount of the fine itself (Ji, 2001; Lin et al., 2001; Peng, 1996). They care about fines because fines account for a significant proportion of the local extra-budgetary revenues, and because this part of the fiscal revenues is used to pay the bonuses and perks of local officials.

In this subsection, we consider a case in which the government is not only concerned about birth control, but also about the total amount of the fine itself. We will show, in this case, that the government sets F lower than F^*.

Let's go back to the deterministic setup. The government's utility, a weighted function of revenue and fertility, is supposed to take the following form,

$$U = \beta \int_0^{\overline{W}} F y(W, F) dW - (1 - \beta)\gamma \int_0^{\overline{W}} y(W, F) dW, \tag{9}$$

where the government puts weight β, $0 < \beta < 1$ on revenue generation and weight $1 - \beta$ on birth control, and γ is the monetary equivalence factor of above-quota births for the government.[27] Proposition 4 summarizes the solution and comparative statistics. The Proof is in Appendix 1.

PROPOSITION 4: *When $V(W_0) < 2\gamma(1-\beta)/\beta < V(\overline{W})$, there is a unique optimal fine F^* on $[W_0, V(\overline{W})/2]$. The optimal fine F^* decreases with the revenue incentive β, and increases with the monetary equivalence factor, γ, and the community's maximal wealth, $\overline{W}$; fertility increases with β, and decreases with γ and $\overline{W}$.*[28]

[27]Above-quota births can be converted into monetary equivalence in several ways. It can be monetary award or punishment directly, or the loss of future income or benefits associated with a government position indirectly if the probability of the official being demoted increases with above-quota births.

[28]Note that the condition $V(W_0) < 2\gamma(1-\beta)/\beta < V(\overline{W})$ is a sufficient condition that guarantees that $F^* \in [W_0, \overline{W}]$. Also, since W is uniformly distributed in a community on $[0, \overline{W}]$, the average wealth is just $\overline{W}/2$.

Proposition 4 indicates that when the fiscal incentive is large enough, the government will set a small fine in order to collect a large revenue. The higher the revenue incentives, the lower the fine, and the higher the fertility. The logic is as follows. Since there is a fertility incentive, the government is not maximizing the fine revenue alone; rather, the fine must be set above the revenue maximizing level, because if the fine is below (or at) this level, increasing it will both increase (or not change) revenue and reduce fertility. When the revenue incentive weight, β, increases, the government wants to increase revenue so that it is closer to the maximized level (again the fine is not below the revenue maximizing level), which means that the fine will be smaller, and fertility will be higher. The argument for the change of γ is just the opposite.

The intuition for the effect of wealth change on the level of a fine is such. When the fine increases, there are three effects: an increase of revenue, because the government can collect more fines from rich households that continue to have above-quota children (marginal revenue); a decrease of revenue, because the marginal households will switch from having above-quota children to not having any at all (marginal cost); and the reduction of overall fertility (marginal revenue), because of the change of marginal households. The three effects should sum to zero at the optimal fine (the first order condition). When $\overline{W}$ increases, the latter two effects related to the marginal households will not change, but the first effect, or the increase of revenue, will be larger since there are more rich households now. To rebalance the first order condition, the fine has to increase due to the concavity of $V(W)$.

At the optimal level of fine, the revenue for the government is the triangle from poor households (below the 45 degree line and above the line OW_0 in Figure 2) and the square from rich households (between the line F and the line $W_1\overline{W}$). The only households that do not have an above-quota child are the medium households, with a wealth level of the range $[W_0, W_1]$.

4 Empirical Analysis

In this section we test our model using China Health and Nutrition Survey (CHNS) data. In particular, we examine whether fines reduce the probability of having above-quota births, and whether the effect of the fine on above-quota births varies with wealth level. According to Proposition 4, when local governments have revenue incentives, they will set the fine relatively low, and "encourage" some rich households to have above-quota births. At this low level of fine, according to Proposition 3, the household's above-quota birth decision will depend on wealth, the fine, and the interactive effect of wealth and the fine. The testable implications of these two propositions are that: the probability of having above-quota births is not responsive to either wealth or the size of the fine for poor households; the fine has a negative effect on the probability of having above-quota births for medium households, especially for the higher medium households; the fine has a negative effect on the probability for rich households, but the effect of the fine in reducing the probability diminishes with wealth.

4.1 Data and Quality

The CHNS data were collected by the Carolina Population Center (CPC) at the University of North Carolina at Chapel Hill, the Institute of Nutrition and Food Hygiene, and the Chinese Academy of Preventive Medicine. The survey was conducted by an international team of researchers whose backgrounds include nutrition, public health, sociology, Chinese studies, demography, and economics. The CPC has put a lot of effort into staff training and quality control to make sure that the data are of a high quality.[29]

The survey contains information on the number of children and birth control policy in each village (the unit of community in the empirical analysis), including the size of the fine and whether the second birth is allowed when the first child is a girl. It also has detailed information on household income and some community variables. The survey was conducted in 1989; the survey team randomly sampled 2,164 rural households in eight provinces, including rich ones such as Jiangsu and poor ones such as Guizhou,[30] and more information was collected on newborns up to 1997.

The sampled rural households had a median annual per capita household income of 677 *yuan* in 1989,[31] about 12 percent higher than the national average of 602 *yuan*. There is also a large variation, with a standard deviation of 983 yuan. The poorest 10 percent of households had an income of only 98 yuan, which amounts to 26 US$ by the official exchange rate of 3.8 at that time, while the richest 10 percent had an income of almost 30 times that of the poorest. Using the one US dollar per capita per day standard of the World Bank

[29]The data have been extensively used by demographers and nutritionists, but less so by economists. Please visit http://www.cpc.unc.edu/projects/china/ for a detailed description of the data and quality control procedures.

[30]The other six provinces are Liaoning, Shandong, Henan, Hubei, Hunan, and Guangxi.

[31]For brevity, in what follows, we will refer to "annual per capita household income" simply as "income."

(Stern, 2001), the poverty line of annual per capita income should be 511 *yuan* when using the purchasing power parity of 1.4 *yuan* per US dollar.[32] Even with such a low poverty line, 38 percent of our sampled rural households were below it in 1989.

Examining the data, we find that having above-quota children in rural China was still very common up to 1997, almost 20 years after the one-child policy was implemented. Of the 154 villages, 53 percent have strictly enforced the one-child policy, and the other 47 percent allow a second child if the first one is a girl. The survey instrument allows us to count above-quota births, which refer to those second or higher parity births between 1979 and 1997 for which there was no permission. Out of the 2,164 households in our sample, 31 percent have at least one above-quota child (Table 1). For those who have above-quota children, the average number is 1.5 per household, and the maximum is eight.

The data also show that fines were substantial for households in the sample. Moreover, although each village had a uniform fine for all households in the village, the fine varied greatly across villages (and households). Of the 154 villages for which we have information on the size of fine, only two did not impose a fine. The average fine was 1,627 *yuan*, which was more than double the median income of 677 *yuan*. The distribution of the fine across villages can be seen more clearly in Table 2. In the first column, we list the average levels of the fine for the 10 deciles across villages. The fine was only 147 *yuan* for the first decile, while it was as large as 4,842 *yuan* for the highest group, the tenth decile. The distribution of the fine across households is similar to that across villages (column 2). The fine as a percentage of income was also substantial and varies greatly (column 3). The fine was only 17 percent of income for the first decile, but was 39 times the average income for the tenth decile. On average, the size of the fine was about four times the income.

These fines should have a significant effect on household living standards, given that 38 percent of these rural households were below the poverty line in 1989. Moreover, it is almost certain that the poorest households were not able to pay the full amount of the fine with the fine as high as 39 times the per capita household income, or about 10 times the annual total household income. Even if they were allowed to pay the fine over many years, and even assuming that 10 percent of their annual income was available for paying the fine, it would take 100 years for them to pay the fine for one above-quota child. In reality, the amount of cash that was available for paying fines must have been lower than 10 percent,

[32]The poverty line is 1,387 *yuan* when using the official exchange rate of 3.8 *yuan* per US dollar, and 2,920 yuan when using the market exchange rate of 8.

because many households were living at or below the subsistence level and they barely had any cash income. Anecdotal evidence suggests that when households cannot pay enough cash, local cadres take valuables or personal belongings to compensate for the fine.[33] In this case, the household wealth becomes the collateral for the fine.

To match our theory, we divide the sample into three groups by the ratio of income to the fine, which is a measure of the relative wealth of a household. We call a household *poor* if the ratio is less than one third, *medium* if it is between one third and one, and *rich* if it is greater than one.[34] The summary statistics of the three income groups are reported in Table 3. Note firstly that the probability of having above-quota births is substantial for all income groups, with the probability ranging from 0.28 to 0.35 (row 3). The number of children per household is also well above one for all three groups, with poor households having an average of 2.41 children, medium households having an average of 2.33 children, and rich households having an average of 2.30 children. This means that fertility is substantially larger than one child per family for all income groups.

4.2 Regressions with the Pooled sample

In what follows, we will carefully analyze the determinants of the probability of having above-quota births and focus on testing our theoretical predictions. We employ Probit regressions with the dependent variable equal to 1 if a household has at least one above-quota child, and zero otherwise. The independent variables include whether or not a household has a within-quota boy, income, the size of the fine, an interaction term of income and the fine, the wife's age and its squared term, the wife's education, the household land holding, and provincial indicators. The key hypothesis is that the coefficient of the size of the fine is negative, while the interaction term is positive.

Define y_i^* as the latent net value of a child for household i, which is a linear function of our independent variables x_i, or $y_i^* = \alpha x_i$, where α is a vector of coefficients. Following

[33]There were incidences in which officials took grain away from households to compensate for the fine or even took houses down, but such cases are rare, probably because local officials did not want to starve poor households or make them homeless, and because there was strong resistance from poor farmers when their survival was threatened.

[34]Since we do not observe accurately the household's ability to pay a fine, or W, our empirical definitions of income groups may not match perfectly with the theoretical ones (poor, medium, and rich households). However, this does not prevent us from making statistical inferences, if we assume that households with a higher income to fine ratio are more likely to be able to afford to pay a fine. To check the robustness of results, we also tried a few other ways of classifying households, and obtained very similar results to those reported in the paper. In one classification, households were divided into three groups in terms of their income without reference to the size of the fine.

the notation in Greene (1993), the Probit model is expressed as

$$Prob(y_i = 1) = \Phi(\alpha x_i), \tag{10}$$

where y_i indicates whether household i has above-quota children, and Φ is the cumulative distribution function.

Note that our analysis differs substantially from that of McElroy and Yang (2000) in several important respects. First, they use ordinary least squares regressions, but we employ a Probit model to take into consideration the fact that the dependent variable is discrete. Second, they use the number of children per family, which is not an accurate measure for testing the effect of fines, because fines are only imposed on above-quota children. In order to measure the effect of fines accurately, we use an above-quota children indicator as the dependent variable. Third, in our regressions, we control for whether the households have a within-quota boy. This is important as many rural households have above-quota children because they want a boy. Failing to control for the sex of within-quota children, as in McElroy and Yang (2000), means that the household's willingness to have above-quota children and thus the effect of the fine cannot be accurately measured. Finally, and also most importantly, they use the pooled sample of households as one group in their estimations, which ignores the potentially different effects of fines on fertility across income groups. We will apply our models to sub-samples of households with different income levels in the next two subsections.

The first column of Table 4 reports maximum likelihood estimation results of a Probit model using the pooled sample, the sample with all households of different income levels. We report the marginal effect on the probability of each independent variable (dF/dx) rather than the estimated coefficient.[35] As expected, whether a household has a within-quota boy is a very important determinant of having above-quota children. The coefficient of the variable "no within-quota boy" is positive and significant at the one percent level. The magnitude of 0.069 means that when the household does not have a within-quota boy, the probability of having above-quota children increases by 6.9 percentage points, or 22 percent of the sample mean (0.308).

The regression using the pooled sample shows that the probability of having above-quota children does not vary with income or the fine. The coefficients on income or the fine are not significant. The finding that fertility does not decrease with income suggests that the

[35]The marginal effect on the probability of each independent variable is evaluated at the mean of the independent variables. Practically, we use the "dprobit" option in STATA to calculate these marginal probabilities. The standard errors are robust errors by using the STATA option "robust."

data pattern may not be fully explained by the opportunity cost, because the opportunity cost would predict a strong negative association between fertility and income. The finding is also consistent with the prediction of Becker (1993) on the income elasticity of fertility in developing countries. Even though the quantity-quality tradeoff tends to make the income elasticity more negative, it may not be large enough to overcome other counter-mechanisms, such as security in old age and carrying on the family name.

Next, we test whether income and fines have different effects on the probability of having above-quota births across income groups. To test these differences, we use interaction terms. Specifically, we add a medium household indicator, which equals one if a household belongs to the medium income group and equals zero otherwise, and its interactions with income and fine variables: medium*income, medium*fine, and medium*income*fine. Similarly, we also add a rich indicator and its interactions with the same variables, i.e., rich*income, rich*fine, and rich*income*fine. If the effects of income and fines for medium and rich households are different from those for poor households, then the medium and rich indicators and their interactions with other variables should be significant.

Regression results with income level interacted with income and fine variables are reported in the second column of Table 4. Note first that income, the fine, and income*fine are not significant, which means that income and fines have no effect on the probability of having above-quota births for poor households, the base group of the regression. The regression shows that the effects of income and fines for medium and rich households do indeed differ from those for poor households. The interaction terms medium*fine, medium*income*fine, rich*fine, and rich*income*fine are all significant. The signs of medium*fine and rich*fine are negative and those of medium*income*fine and rich*income*fine are positive. This means that compared to poor households, the fine has an additional negative effect on fertility for medium and rich households, and this additional effect diminishes with income. This finding shows that the effects of income and fines on the probability of above-quota births do indeed differ across income groups in the way that Proposition 3 predicts. Since these effects differ across groups, it is necessary to estimate the probability of having above-quota births for each income group separately.

Other control variables in regressions 1 and 2 in Table 4 have the expected signs. A woman's age has a positive but decreasing effect on fertility. The older a woman is, the longer she has been exposed to the chance of having children, and the more likely it is that she will have an above-quota child. As a woman ages, her reproductive ability decreases; consequently, the chance of having an above-quota child decreases. A woman's education does not have a significant coefficient. The household landholding has a positive effect on fertility, probably because more land can support more children.

4.3 Regressions with Different Income Groups

In Table 5, we report regressions for the poor, medium, and rich sub-samples. Notice that the coefficients on both the size of the fine and the interaction term differ across income groups. In particular, regressions 1-3 show that the size of the fine has no effect on the probability of having above-quota births for poor households; it has a negative effect on the probability for medium and rich households, and this effect decreases with income for rich households. The coefficients on the fine and the interaction term are not significant for poor households, but the coefficient on the fine is significant for medium households and both coefficients are significant for rich households. For medium households, the fine has a negative effect on fertility. When the fine increases by one standard deviation (1,499 yuan), the probability of having above-quota births for medium households decreases by nine percentage points. For rich households, the fine has a negative effect on the probability of having above-quota children (negative coefficient of the fine), but the effect diminishes with income (a positive coefficient for the interaction term). These findings support our theoretical predictions in Proposition 3. The average magnitude of the effect of the fine on fertility is -0.418 (i.e. $-0.593 + 0.109 \times 1.610$) for rich households, where we have included the average income of the rich household, 1.610.

Regressions 2-4 also show that the probability of having above-quota children does not vary with income for poor and medium households. For poor and medium households, the coefficients on both income and the interaction term are not significant. Thus, the net effect of income for these two groups is negligible. For rich households, however, the coefficient on the interaction term is positive and significant. This means that for rich households, the average income effect on fertility is positive. These findings provide further evidence for Proposition 3, which predicts that fertility does not vary with income for poor households, but increases with income for rich households.

In the second half of this subsection, we investigate several issues to check the robustness of the above results. More specifically, we examine whether the fine is picking up the effect of other omitted policy variables, and whether the interaction of income and fine is picking up the second order effects of income and the fine.

First, one may be concerned that fines might be associated with other penalties that increase with income. For example, communities having large fines may also have other serious punishments, such as demotion, no birth registration, or no school for children. If we do not control these other penalties in regressions, fines at different income levels may pick up the asymmetric effect of these other penalties. For example, government officials or rich people may care more about their jobs than do poor people. (See also footnote 9.) Rich people may also care more about whether their children can be registered as a resident and in school.[36]

In order to address the potential effect of these other policies, we add some variables to control them. First, to control the effect on fertility of being a government official, we add an official indicator, which equals one if a member of a household is a government official and zero otherwise, in our regressions. We also control the effect of child registration on fertility. The CHNS survey has a question on whether an above-quota child can be properly registered. Respondents in 80 percent of the villages answered "no" to this question. We use a registration indicator, which equals one if an above-quota child can be promptly registered and zero otherwise, to control the effect of this and other policies on the probability of having above-quota births.[37]

The main results regarding the income and fine variables in regressions with the added official and child registration indicators are similar to those without these indicators. The regression in Table 6 shows that income and fines have no effect on the probability of having above-quota births for the poor, but that fines have a negative and decreasing effect on the probability for the rich even after controlling for the potential effects of other fertility policies. Moreover, the official and child registration indicators do not have any significant effect themselves for all income groups. These findings suggest that fines may be the most significant and effective punishment in rural areas as documented by demographers (Li, 1995; Short and Zhai, 1998).

Second, the observed effect on the interaction term in Tables 5 and 6 may be biased

[36] The issue is raised and two examples are provided by an anonymous referee.

[37] The survey does not have information on school registration or other penalties to which rural households are subject. But other policies, such as school registration, even existing, should be highly correlated with the policy on child registration. Thus, the child registration indicator is still a good proxy variable for other policies.

upward for rich households. Since the effects of income and the fine on birth probability might diminish, if we add the squared terms of these two variables in the regressions, it is expected that they will have positive coefficients. However, if we do not control the second order effect of income and the fine, then the interaction of income and the fine, which is positively correlated with their squared terms, may be picking up the effect of the squared terms and thus its coefficient is biased upward. To address this issue, we estimate a regression with a generalized second order specification, which includes quadratic terms in income and the fine.[38]

Regression results of the generalized specification are consistent with the predictions of Proposition 3 (Table 7). The probability of having above-quota births for poor households is not responsive to income and fines since none of the income and fine variables is significant for this group. The probability for medium and rich households decreases with the fine, and the effect of the fine on the probability diminishes with income for rich households. These results indicate that the finding that income and fines have differential effects on the probability of having above-quota births across income groups is not a consequence of omitting the square terms.

4.4 IV Estimates

The above single equation model, however, could be subject to simultaneity problems because the size of the fine might be endogenous. As discussed before, it could be that the local government sets a large fine to control birth when there are a lot of above-quota births in a locality. In order to deal with the potential endogeneity of the fine, we use both community and provincial level variables as instrument variables (IVs).

Our theory in Section 3.3 provides some basis for selecting valid instrument variables. According to Proposition 4, the size of the fine (F) increases with the local government's incentives on birth control ($1-\beta$) and the monetary equivalence factor (γ); thus, any variables that are correlated with the government's incentives on birth control and monetary equivalence factors should affect the fine. Proposition 4 also predicts that the size of the fine increases with the community's maximum wealth level ($\overline{W}$). Assuming that a more developed community has a higher $\overline{W}$, then the size of the fine should increase with a community's development level.

[38]The solution is provided by an anonymous referee.

We use both community and provincial level variables as IVs. At the community level, we use the lagged population density as a proxy for the government's birth control incentives, $(1-\beta)\gamma$. We argue that governments in densely populated communities face higher pressure with regard to birth control, and thus are more likely to have a high fine policy. We also use the quality of road as a proxy for local economic development,[39] and we hypothesize that the more developed a locality, the higher the level of the fine will be. The quality of the road is a character variable, with four scales, 1-4, where quality increases with the scale.

At the provincial level, we have a wider choice of IVs. Specifically, we use the provincial population density, birth rate, and per capita income as IVs. These variables should correlate with the provincial birth control policies, which in turn affect the village level birth control policies, including the level of fines. As argued above, population density and income should correlate positively with fines. The provincial birth rate could be correlated with provincial policies in two ways. On one hand, we could observe a positive correlation between the fine and the provincial birth rate if high birth rates push provincial governments to choose tight policies. On the other hand, we could observe a negative correlation because lower birth rates could be a result of tighter policies. Since the sign of the correlation could go either way theoretically, it can only be determined empirically. Provincial level variables are better IVs than community level variables because community level variables are more likely to have some independent effect on fertility other than through the effect of the fine. Indeed, over-identification restriction tests show that the community population density cannot be excluded from the second stage regressions, while the other four variables, i.e., community road quality, provincial population density, birth rate, and per capita income can be excluded. Hence, we shall use the latter four IVs in estimations.[40]

One may be concerned with the properties of estimators derived using poor instruments in small samples (see, e.g., Nelson and Startz (1990), Bound et al. (1995)). In order to test Proposition 4, and to make sure our instruments are good, we check whether the instruments are "highly" correlated with the right-hand side endogenous variables in the first stage estimations. In the first stage regressions, we regress fine, fine squared, and income*fine on the four instrument variables and all other exogenous variables. As shown in Table 8, the signs of the four IVs in the first stage regressions are consistent with predictions from Proposition

[39]The survey did not collect information on the aggregate community income.

[40]We also conducted over-identification restriction tests on different combinations of the IVs. Any combinations without the community population density pass the tests.

4. The development variables, community road quality and provincial per capita income, and the population pressure variables, provincial population density and birth rate, are both positively correlated with the fine, fine squared, and income*fine. Equally important is that these IVs are jointly significant at the one percent level in all specifications of Table 8. The F-statistics of the joint test are very high (between 29.29 and 63.56). These results indicate that the four IVs, selected based on our theory, are also "good" statistically (Bound et al., 1995; Levitt, 1997).

We also employ a Hausman specification test to test whether the fine, fine squared, and income*fine are jointly endogenous (Hausman, 1983). In the test, we first generate residuals from the first stage regressions reported in Table 8. We then estimate a fertility equation with both the original fine, fine squared, and income*fine variables and the generated residuals for each of these potentially endogenous variables. If the residuals are jointly significant, then the null hypothesis that the suspected variables are exogenous is rejected. Our tests show that the income and fine variables are jointly endogenous for all specifications (Table 9), which means that at least one of these suspected variables is endogenous. The test results suggest that our early findings may only show a correlation between the probability of having above-quota births and the fine variables, but may not estimate the causal effect from the fine to fertility. This makes the IV estimation more important for testing the theory.

IV estimates are reported in Table 9, in which the t-statistics in parentheses are calculated by using bootstrapped standard errors with 200 replications. We estimate two specifications for each income group, one without the square terms of income and the fine, and one with them. Generally speaking, the IV estimates without the squared terms of income and the fine reported in Table 9 (columns 1, 2, and 3) are very similar to the non-IV estimates in Tables 5 and 6. Regression results of the IV method confirm our previous findings that income and the fine have no effect on the probability of having above-quota births for poor households, and that the fine has a negative effect on the probability for medium and rich households and this effect decreases with income for rich households.

IV estimations with the squared terms of income and the fine also support the main hypotheses (columns 4, 5, and 6 of Table 9). The results regarding poor and rich households are very similar to those without the square terms. Estimates regarding medium households, the "ambiguous group" as indicated by Proposition 3, are also consistent with the predictions in Proposition 3. While income and the fine are not significant, their squared terms become significant and have negative coefficients. Moreover, the interaction term turns positive. From these three significant coefficients of the medium group, we can infer that the probability of having above-quota births increases with income and decreases with the fine for medium households.[41]

Besides the fine, income could also be an endogenous variable. Households may make decisions on the number of children and labor supply simultaneously (Rosenzweig and Wolpin, 1980). To deal with the endogeneity of income variables, we use the non-labor income of a household and its squared term and the squared terms of the original four IVs as additional IVs. Since non-labor income, which mainly comprises transfers from individuals or governments to households, may not be affected by fertility, the assumption that it can be excluded from the second stage regression is reasonable.[42]

Finally, dividing the sample by a potentially endogenous variable, income, could cause problems. Essentially, partition based on an endogenous variable would lead to sample selection bias. To solve this endogeneity problem (or selection bias), we use the two-stage method developed by Vella (1993). In the first stage, we estimate an ordered probit model, in which the income level is the dependent variable (poor=1, medium=2, and rich=3). We obtain the generalized residuals from the estimated ordered probit model.[43] In the second stage, we estimate the IV-probit model for each income group by including the generalized residuals as an additional regressor, which can test and correct the selection bias.

The IV estimates that treat income variables as endogenous and take endogenous partition into account are reported in Table 10, in which the t-statistics in parentheses are calculated by using bootstrapped standard errors with 200 replications.[44] The IV estimates treating all income and fine variables as endogenous are very similar to those treating only the fine variables as endogenous. Regressions with or without square terms support the hypotheses that income and the fine have no effect on the probability of having above-quota births for poor households, while the fine has a negative but decreasing effect on the

[41]The effect of income is $-2*2.737*0.859+3.125*1.499=0.779$, and the effect of the fine is $-2*1.059*1.499+3.125*0.859=-0.491$, where we include the coefficients in column 5 and the average level of income (0.859) and the fine (1.499) of this group.

[42]To test whether our IVs can be excluded from the second stage regressions, we run a set of Hausman exclusion restriction tests using all IVs. Our IVs can be excluded from the second stage regressions, since the test statistics are smaller than the critical value for all regression specifications in Table 10.

[43]See Vella (1993, page 448) or Maddala (1983, pages 48 and 366) for the formula of generalized residuals. Intuitively, these generalized residuals are similar to the Inverse Mills ratio in a probit model.

[44]We report first stage regression results in Table A1 in the appendix. We find that the IVs have the expected signs and are jointly significant at the one percent level in all specifications.

probability for rich households. The effects regarding medium households, the "ambiguous group," are more complicated, but they are in general consistent with the predictions in Proposition 3. The effect of the fine on fertility is negative for medium households as a whole (columns 2 and 5).[45] Note also that the variable, generalized residuals, is significant in two cases (columns 1 and 6), which suggests that there may indeed be selection bias when the partition is based on income.

To summarize, results from both the non-IV and IV estimates are consistent with our theory. In particular, regression results are robust regarding poor and rich households. Income and the fine do not have any effect on the fertility of poor households, while the fine has a negative effect on the fertility of rich households and this effect diminishes with income. For medium households, non-IV and IV models have different predictions, but they both show that the effect of the fine on fertility is negative for medium households as a whole, which is consistent with part (c) in Proposition 3.

5 Conclusions

In this paper, we have developed a theoretical model that explains why fines may not be an effective birth control policy for the poor when taking the private value of a child and limited liability into consideration. We first show that when the government's only objective is to control birth, it will set a heavy fine; at this level of fine, only poor households choose to have above-quota births. We then find that when the local government cares about both birth control and fiscal revenues it may set a relatively low fine in order to collect more fiscal revenues. At this level of fine, both poor and some medium and rich households could have above-quota births.

Employing the CHNS data for rural households, we empirically test some of the predictions of the theory. We find that the probability of having above-quota births for poor households is not very sensitive to fines, while the probability of having above-quota births for medium and rich households decreases with fines. Moreover, the effect of fines on reducing the probability decreases with income for medium and rich households.

The purpose of birth control is to enhance economic growth and increase household income. Ironically, the imposition of fines makes the poor poorer. When the poor have a lot

[45] The average effect of the fine on fertility is $-0.137 * 1.499 = -0.205$ (column 2) and $-2.446 * 0.859 * 2 + 2.742 * 1.499 = -0.092$ (column 5) respectively.

of children, the quality of life for the children must be low, and they will grow up still being poor. To a degree, this vicious circle will not only perpetuate inequality, but also exacerbate it.

Appendix 1

Proof of Proposition 1: Households with $W \leq W_0$ want a child no matter how large F is, so we only need to consider households with $W > W_0$. A fine high enough can prevent all households with $W > W_0$ from childbearing. The lowest such fine is $V(\overline{W})/2$. It is easily seen that if $F < V(\overline{W})/2$, fertility would be higher than the optimal case since the household with $\overline{W}$ will have an above-quota child. Q.E.D.

Proof of Proposition 4: We know households with $W < W_0$ will have a child no matter how large F is. So, for them, the optimal F should make them pay the most they can. Thus, F should be set at least as large as W_0. Households with $W \geq W_0$ will have a child only if $F < V(W)/2$, and we will solve for the optimal F. Ignoring the constant for $W \leq W_0$, the utility function becomes

$$\max_{\{F\}} \quad \beta F(\overline{W} - W_1) - (1-\beta)\gamma(\overline{W} - W_1) \tag{11}$$

$$\mathit{or} \max_{\{W_1\}} \quad (\tfrac{1}{2}\beta V(W_1) + \beta\gamma - \gamma)(\overline{W} - W_1) \tag{12}$$

where we have plugged $F = V(W_1)/2$ into (13). The first order condition is

$$\frac{1}{2}\beta V'(W_1)(\overline{W} - W_1) + (\gamma - \beta\gamma - \frac{1}{2}\beta V(W_1)) = 0, \tag{13}$$

and the second order condition is

$$\Delta = \frac{1}{2}\beta V''(W_1)(\overline{W} - W_1) - \beta V'(W_1) < 0. \tag{14}$$

Because we have a well-behaved objective function, there is a unique interior maximum. When $V(W_0) < 2\gamma(1-\beta)/\beta < V(\overline{W})$, the first order condition is positive at W_0 and negative at $\overline{W}$. Thus, the solution to Equation (15) is within the range $[W_0, \overline{W}/2]$.

Simple comparative statics will show that the optimal level of fine, F, increases with the fiscal incentives β. Since $\partial F/\partial\beta = (\partial F/\partial W_1)(\partial W_1/\partial\beta)$, and $\partial F/\partial W_1 = 1/2V'(W_1) > 0$, the sign of $\partial F/\partial\beta$ will be the same as $\partial W_1/\partial\beta$, which is negative because

$$\frac{\partial W_1}{\partial\beta} = \frac{\frac{1}{2}V'(W_1)(\overline{W} - W_1) - (\gamma + \frac{1}{2}V(W_1))}{-\Delta} \tag{15}$$

$$= \frac{\gamma}{\beta\Delta} \tag{16}$$

$$< 0, \tag{17}$$

where we get (18) by using the first order condition, or equation (15). It follows that fertility increases with β, since fertility increases when F decreases. Similarly, we can show that $\partial W_1/\partial\gamma = (1-\beta)/\Delta > 0$, and thus $\partial F/\partial\gamma > 0$, which means that the fine decreases with γ, and fertility increases with γ. Totally differentiating (15) with respect to $\overline{W}$, we get

$$\frac{\partial W_1}{\partial\overline{W}} = \frac{\beta V'(W_1)}{-2\Delta} > 0. \tag{18}$$

Thus, F increases with $\overline{W}$, and fertility decreases with $\overline{W}$. Q.E.D.

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Table 1: Descriptive Statistics of Fertility, Fines and Other Variables in Rural China (N=2164)

Variables	Mean	Standard Deviation	Min	Max
Number of children per household	2.35	1.40	0	9
Number of above-quota children per household	0.47	0.84	0	8
Number of above-quota children per household with at least one above-quota child	1.52	0.84	1	8
Percentage of households with above-quota children	0.308			
Fine (thousand *yuan*)	1.627	1.460	0	6.600
Household size	4.3	1.5	1	11
Age of the wife	41.8	13.1	19	84
Years of education of the wife	6.5	3.7	0	17
Annual per capita household income (thousand *yuan*)	0.944	0.983	0	17.333
Household landholding (*mu*)	3.76	3.26	0	40
Quality of village road (scale 1-4, with 4 the best)	2.9	1.3	1	4

Table 2: Distribution of Fines by Deciles

Deciles (from lowest to highest)	The average fine across villages (thousand *yuan*)	The average fine across households (thousand *yuan*)	The fine-income ratio across households
	(1)	(2)	(3)
1	0.147 (0.104)	0.155 (0.097)	0.172 (0.091)
2	0.325 (0.046)	0.324 (0.043)	0.451 (0.083)
3	0.568 (0.081)	0.570 (0.080)	0.756 (0.092)
4	0.850 (0.058)	0.851 (0.050)	1.103 (0.109)
5	1.000 (0)	1.000 (0)	1.535 (0.144)
6	1.255 (0.097)	1.256 (0.084)	2.063 (0.186)
7	1.513 (0.035)	1.514 (0.035)	2.867 (0.268)
8	2.204 (0.218)	2.203 (0.211)	4.278 (0.582)
9	3.000 (0)	3.000 (0)	7.101 (1.224)
10	4.842 (1.087)	4.821 (1.044)	38.876 (71.743)
All	1.627 (1.460)	1.627 (1.460)	4.078 (7.257)

Note: Numbers in parentheses are standard deviations.

Table 3: Fertility and Other Variables for Different Income Groups in Rural China

Variables	Poor	Medium	Rich
Number of observations	720	756	688
Per capita household income (thousand *yuan*)	0.398 (0.315)	0.859 (0.518)	1.610 (1.368)
Percentage of households with above-quota children	0.35	0.30	0.28
Number of children per household	2.41 (1.40)	2.33 (1.39)	2.30 (1.40)
Number of above-quota children per household with at least one above-quota child	1.53 (0.86)	1.48 (0.81)	1.53 (0.85)
Education level of children	5.29 (2.17)	5.35 (2.03)	5.34 (1.98)

Note: Numbers in parentheses are standard deviations.

Table 4: Probit Regressions on the Determinants of Having Above-Quota Births in Rural China Using the Pooled Sample

	Dependent variable: 1=having above-quota births, 0=not	
	Probit	Probit
Model	(1)	(2)
No within-quota boy indicator	0.069***	0.064***
	(4.18)	(3.97)
Income	-0.012	-0.034
	(-0.82)	(-0.32)
Fine	0.011	0.020
	(1.11)	(1.53)
Income*fine	-0.010	-0.035
	(-1.30)	(-1.37)
Medium households		
Medium indicator		0.013
		(0.24)
Medium*income		0.026
		(0.22)
Medium*fine		-0.094***
		(-2.90)
Medium*income*fine		0.058**
		(1.96)
Rich households		
Rich indicator		0.074
		(1.18)
Rich*income		-0.020
		(-0.18)
Rich*fine		-0.199***
		(-3.04)
Rich*income*fine		0.081**
		(2.46)
Control variables		
Woman's age	0.099***	0.100***
	(7.90)	(8.50)

Woman's age squared	-0.001***	-0.001***
	(-7.77)	(-8.35)
Woman's education	-0.001	0.0002
	(-0.29)	(0.07)
Land holdings	0.007***	0.006**
	(2.98)	(2.20)
Provincial indicators	Yes	Yes
R-squared	0.23	0.24
Model F-statistics	175.52***	235.98***
Observations	2164	2164

Notes: Numbers in parentheses are t-ratios. Significance levels 0.1, 0.05, and 0.01 are noted by *, **, and ***.

Table 5: Probit Regressions on the Determinants of Having Above-Quota Births in Rural China Using the Poor, Medium, and Rich Sub-samples

	Dependent variable: 1=having above-quota births, 0=not		
	Poor	Medium	Rich
Model	(1)	(2)	(3)
No within-quota boy indicator	0.085***	0.026	0.259**
	(3.92)	(1.24)	(2.15)
Income	-0.047	-0.003	-0.133
	(-0.60)	(-0.06)	(-1.55)
Fine	0.009	-0.060**	-0.593***
	(0.89)	(-2.51)	(-2.75)
Income*fine	-0.007	0.017	0.109*
	(-0.42)	(1.52)	(1.74)
Control variables			
Woman's age	0.104***	0.085***	0.339***
	(7.29)	(6.36)	(5.04)
Woman's age squared	-0.001***	-0.001***	-0.005***
	(-7.20)	(-6.38)	(-5.00)
Woman's education	0.004	-0.003	-0.001
	(1.22)	(-0.94)	(-0.03)
Land holdings	0.001	0.008**	0.020
	(0.47)	(2.26)	(1.05)
Provincial indicators	Yes	Yes	Yes
R-squared	0.33	0.25	0.22
Model F-statistics	125.39***	94.63***	99.01***
Observations	720	756	688

Notes: Numbers in parentheses are t-ratios. Significance levels 0.1, 0.05, and 0.01 are noted by *, **, and ***.

Table 6: Probit Regressions on the Determinants of Having Above-Quota Births in Rural China Using the Poor, Medium, and Rich Sub-samples (with official and register indicators)

	Dependent variable: 1=having above-quota births, 0=not		
	Poor	Medium	Rich
Model	(1)	(2)	(3)
No within-quota boy indicator	0.077***	0.025	0.262**
	(3.68)	(1.21)	(2.17)
Income	-0.050	-0.003	-0.135
	(-0.64)	(-0.07)	(-1.57)
Fine	0.012	-0.060**	-0.588***
	(1.23)	(-2.53)	(-2.72)
Income*fine	-0.009	0.017	0.111*
	(-0.51)	(1.52)	(1.78)
Control variables			
Woman's age	0.104***	0.084***	0.339***
	(7.32)	(6.36)	(5.03)
Woman's age squared	-0.001***	-0.001***	-0.005***
	(-7.24)	(-6.38)	(-4.99)
Woman's education	0.004	-0.003	0.0004
	(1.24)	(-0.97)	(0.02)
Land holdings	0.001	0.008**	0.020
	(0.46)	(2.21)	(1.03)
Official indicator	0.039	0.019	-0.004
	(0.56)	(0.36)	(-0.02)
Register indicator	-0.001	-0.013	-0.078
	(-0.05)	(-0.66)	(-0.58)
Provincial indicators	Yes	Yes	Yes
R-squared	0.33	0.25	0.22
Model F-statistics	122.29***	95.80***	99.48***
Observations	720	756	688

Notes: Numbers in parentheses are t-ratios. Significance levels 0.1, 0.05, and 0.01 are noted by *, **, and ***.

Table 7: Probit Regressions on the Determinants of Having Above-Quota Births in Rural China Using the Poor, Medium, and Rich Sub-samples (with squared terms)

	Dependent variable: 1=having above-quota births, 0=not		
	Poor	Medium	Rich
Model	(1)	(2)	(3)
No within-quota boy indicator	0.082***	0.024	0.073**
	(3.82)	(1.18)	(2.35)
Income	-0.042	0.036	-0.047
	(-0.41)	(0.49)	(-1.05)
Income squared	-0.009	0.042	-0.010
	(-0.09)	(0.61)	(-0.85)
Fine	0.006	-0.089**	-0.145*
	(0.24)	(-2.03)	(-1.90)
Fine squared	0.001	0.025	-0.080
	(0.17)	(1.01)	(-1.42)
Income*fine	-0.007	-0.050	0.098*
	(-0.21)	(-0.61)	(1.69)
Control variables			
Woman's age	0.106***	0.085***	0.085***
	(7.31)	(6.41)	(4.95)
Woman's age squared	-0.001***	-0.001***	-0.001***
	(-7.22)	(-6.43)	(-4.89)
Woman's education	0.004	-0.004	0.0005
	(1.26)	(-1.01)	(0.09)
Land holdings	0.002	0.008**	0.006
	(0.58)	(2.28)	(1.14)
Provincial indicators	Yes	Yes	Yes
R-squared	0.33	0.25	0.24
Model F-statistics	124.74***	97.21***	105.34***
Observations	720	756	688

Notes: Numbers in parentheses are t-ratios. Significance levels 0.1, 0.05, and 0.01 are noted by *, **, and ***.

Table 8: Ordinary Least Squares Regressions on the Determinants of Fine and Income Variables (the first stage of our two-stage regressions)

	Dependent variables				
	Fine	Income*Fine	Fine	Fine squared	Income*fine
Model	(1)	(2)	(3)	(4)	(5)
IVs					
Community road quality	0.080***	0.100***	0.080***	0.355***	0.098***
	(3.66)	(3.56)	(3.67)	(2.85)	(3.61)
Provincial population density	0.374**	-0.008	0.378***	1.961***	-0.117
	(3.37)	(-0.05)	(3.39)	(2.80)	(-0.76)
Provincial birth rate	0.003***	0.006***	0.003***	-0.001	0.005***
	(2.75)	(4.49)	(2.75)	(-0.26)	(4.31)
Provincial per capita income	0.001***	0.001***	0.001***	0.006***	0.001***
	(12.68)	(10.01)	(12.67)	(9.45)	(10.21)
Other exogenous variables					
No within-quota boy indicator	-0.009	-0.051	-0.010	-0.117	-0.022
	(-0.15)	(-0.61)	(-0.17)	(-0.35)	(-0.29)
Income	-0.016	1.463***	-0.033	-0.203	1.902***
	(-0.66)	(8.18)	(-0.76)	(-0.87)	(11.66)
Income squared			0.002	0.014	-0.058**
			(0.68)	(0.94)	(-2.09)
Woman's age	0.014	0.054	0.014	0.106	0.010
	(1.09)	(0.77)	(1.11)	(1.49)	(0.70)
Woman's age squared	-0.0001	-0.0001	-0.0001	-0.0009	-0.0001
	(-0.61)	(-0.75)	(-0.62)	(-1.18)	(-0.38)
Woman's education	0.002	0.018*	0.002	-0.009	0.014
	(0.20)	(1.71)	(0.21)	(-0.18)	(1.32)
Land holdings	0.028***	0.017	0.028***	0.103*	0.031***
	(2.91)	(1.32)	(2.83)	(1.94)	(2.86)
Joint significance test of IVs					
F-statistics	63.56	29.29	63.26	44.98	33.14
p-value	<0.01	<0.01	<0.01	<0.01	<0.01
R-squared	0.14	0.46	0.14	0.12	0.48
Model F-statistics	32.40***	31.22***	29.46***	20.21***	35.50***
Observations	2164	2164	2164	2164	2164

Notes: Numbers in parentheses are t-ratios. Significance levels 0.1, 0.05, and 0.01 are noted by *, **, and ***.

Table 9: Probit Regressions on the Determinants of Having Above-Quota Births in Rural China (IV method)

	Dependent variable: 1=having above-quota births, 0=not					
	Poor	Medium	Rich	Poor	Medium	Rich
Model	(1)	(2)	(3)	(4)	(5)	(6)
No within-quota boy indicator	0.072***	0.024	0.028	0.076***	0.079***	0.065*
	(3.09)	(1.13)	(0.83)	(3.24)	(2.66)	(1.79)
Income	0.033	0.868***	-0.363***	-0.007	0.428	-0.479***
	(0.26)	(4.46)	(-3.26)	(-0.02)	(0.83)	(-3.98)
Income squared				-0.013	-2.373*	-0.005
				(-0.13)	(-1.75)	(-0.67)
Fine	-0.089	-0.196	-1.276***	-0.215	0.074	-0.809**
	(-1.07)	(-1.06)	(-3.87)	(-0.58)	(0.18)	(-1.96)
Fine squared				0.017	-1.059**	-0.488**
				(0.32)	(-2.45)	(-2.01)
Income*fine	-0.075	-0.162**	0.417**	-0.030	3.125**	0.648***
	(-0.87)	(-2.09)	(3.52)	(-0.22)	(2.00)	(4.03)
Control variables						
Woman's age	0.117***	0.082***	0.091***	0.116***	0.081***	0.090***
	(6.27)	(5.43)	(3.49)	(6.03)	(4.59)	(3.85)
Woman's age squared	-0.002***	-0.001***	-0.001***	-0.002***	-0.001***	-0.001***
	(-6.20)	(-5.64)	(-3.31)	(-5.88)	(-4.50)	(-3.58)
Woman's education	0.005	-0.006	0.007	0.005	0.005	0.008
	(1.30)	(-1.47)	(1.21)	(1.25)	(1.07)	(1.29)
Land holdings	0.005	0.012***	0.006	0.006*	0.006	0.012
	(1.49)	(2.97)	(0.94)	(1.90)	(1.37)	(1.61)
Over-identification restriction test						
Test statistics (chi-squared)	8.34	12.89	6.08	9.32	4.37	0.25
Critical value	14.07	14.07	14.07	11.07	11.07	11.07
Joint exogeneity test (all fine and income variables)						
Test statistics (chi-squared)	24.70	8.04	6.05	17.07	7.08	6.21
Critical value	3.00	3.00	3.00	2.60	2.60	2.60
Model Chi-squared statistics	110.92***	67.60***	40.44***	113.70***	69.63***	54.34***
Observations	720	756	688	720	756	688

Notes: Numbers in parentheses are t-ratios. Significance levels 0.1, 0.05, and 0.01 are noted by *, **, and ***. We treat fine, fine squared, and income*fine as endogenous variables, and use community road quality, provincial population density, provincial birth rate, and provincial per capita GDP as IVs.

Table 10: Probit Regressions on the Determinants of Having Above-Quota Births in Rural China (IV method - correcting selection bias)

	Dependent variable: 1=having above-quota births, 0=not					
	Poor	Medium	Rich	Poor	Medium	Rich
Model	(1)	(2)	(3)	(4)	(5)	(6)
No within-quota boy indicator	0.074***	0.026	0.041	0.035	0.039*	0.034
	(2.83)	(1.14)	(1.13)	(1.40)	(1.68)	(0.99)
Income	0.039	-0.064	-0.186*	0.017	0.459	-0.428***
	(0.48)	(-0.22)	(-1.87)	(0.08)	(0.66)	(-4.30)
Income squared				0.039	-2.446*	0.007
				(1.02)	(-1.66)	(0.37)
Fine	0.024	0.216	-0.609***	-0.102	0.345	-0.781***
	(0.43)	(1.33)	(-3.08)	(-0.66)	(1.24)	(-2.86)
Fine squared				0.005	-0.886*	-0.118
				(0.23)	(-1.92)	(-0.60)
Income*fine	-0.112	-0.137*	0.181**	-0.096	2.742*	0.399**
	(-1.56)	(-1.88)	(2.48)	(-1.55)	(1.75)	(2.12)
Control variables						
Woman's age	0.120***	0.088***	0.093***	0.108***	0.089***	0.100***
	(6.60)	(5.44)	(4.12)	(6.76)	(5.44)	(4.56)
Woman's age squared	-0.002***	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***
	(-6.51)	(-5.35)	(-4.00)	(-6.53)	(-5.32)	(-4.29)
Woman's education	0.003	0.002	0.005	0.006	0.005	0.001
	(0.78)	(0.35)	(0.80)	(1.45)	(0.96)	(0.16)
Land holdings	-0.003	0.003	0.005	0.0002	-0.004	0.004
	(-0.66)	(0.78)	(0.72)	(0.03)	(-0.66)	(0.78)
Generalized residuals	-0.073**	0.022	-0.210	-0.045	-0.117	-0.587**
	(-2.14)	(0.38)	(-0.62)	(-0.52)	(-1.09)	(-2.11)
Model F-statistics	88.76***	68.87***	42.93***	140.92***	65.60***	180.32***
Observations	720	756	688	720	756	688

Notes: Numbers in parentheses are t-ratios. Significance levels 0.1, 0.05, and 0.01 are noted by *, **, and ***. We treat income, income squared, fine, fine squared, and income*fine as endogenous variables, and use household non-labor income, community road quality, provincial population density, provincial birth rate, provincial per capita GDP, and their square terms as IVs. We correct the selection bias by including the generalized residual from Ordered Probit regressions with wealth levels as the dependent variable and all exogenous variables as independent variables.

Table A1: Ordered Probit Regressions on Income Groups and Ordinary Least Squares Regressions on the Determinants of Fine and Income Variables

	Dependent variable					
	Ordered probit	OLS	OLS	OLS	OLS	OLS
	Income group (1=poor, 2=medium, 3=rich)	Fine	Fine squared	Income	Income squared	Income *Fine
Model	(1)	(2)	(3)	(4)	(5)	(6)
IVs						
Community road quality	-0.996***	0.933***	1.958***	-0.154	-0.693	0.865***
	-7.17	(7.41)	(3.67)	(-1.17)	(-0.46)	(3.08)
Community road quality squared	0.173***	-0.168***	-0.310***	0.029	0.112	-0.154***
	6.35	(-6.71)	(-2.85)	(1.14)	(0.39)	(-2.73)
Provincial population density	-5.833**	5.674**	18.228*	-0.781	-26.923	5.971
	-2.20	(2.51)	(1.78)	(-0.41)	(-1.43)	(1.59)
Provincial population density squared	2.673**	-2.192**	-6.345	0.622	12.314	-2.057
	2.39	(-2.30)	(-1.46)	(0.77)	(1.57)	(-1.30)
Provincial birth rate	0.008	-0.055***	-0.335***	-0.028***	-0.125***	-0.065***
	1.21	(-6.55)	(-6.59)	(-5.83)	(-2.67)	(-4.90)
Provincial birth rate squared	0.0001	0.0002***	0.001***	0.0001***	0.0005**	0.0002***
	0.05	(6.60)	(6.98)	(5.01)	(2.32)	(4.59)
Provincial per capita income	0.002*	-0.002	-0.008	-0.001	0.007	-0.005***
	1.75	(-1.38)	(-1.45)	(-1.37)	(0.75)	(-2.82)
Provincial per capita income squared	-0.001**	0.001**	0.004**	0.001	-0.002	0.002***
(times 0.001)	-2.01	(2.12)	(2.13)	(1.61)	(-0.64)	(3.68)
Household non-labor income	0.390***	-0.160***	-1.054***	0.280***	0.535	0.028
	6.40	(-3.38)	(-4.48)	(4.52)	(0.83)	(0.21)
Household non-labor income squared	-0.017**	0.030***	0.158***	0.005	0.132	0.098***
	-2.15	(5.18)	(5.28)	(0.49)	(1.35)	(3.07)
Other exogenous variables						
No within-quota boy indicator	-0.125**	-0.031	-0.184	-0.061	0.053	-0.174*
	-2.49	(-0.53)	(-0.56)	(-1.52)	(0.12)	(-1.77)

Woman's age	0.016	0.007	0.054	0.023***	0.045	0.039**
	1.51	(0.55)	(0.77)	(3.01)	(0.77)	(2.09)
Woman's age squared	-0.0002*	-0.00001	-0.0004	-0.0002***	-0.0005	-0.0004*
	-1.76	(-0.08)	(-0.47)	(-3.22)	(-0.94)	(-1.88)
Woman's education	0.018**	0.002	-0.009	0.022***	0.102**	0.051***
	2.31	(0.18)	(-0.18)	(4.22)	(2.06)	(3.63)
Land holdings	-0.061***	0.024***	0.099*	-0.046***	-0.131***	-0.056***
	-5.11	(2.59)	(1.91)	(-6.42)	(-4.62)	(-3.72)
Joint significance test of IVs						
F-statistics	292.16	55.85	35.54	19.86	9.25	22.94
p-value	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
R-squared	0.08	0.17	0.14	0.12	0.03	0.13
Model F-statistics	415.3***	49.89***	31.12***	18.52***	7.55***	18.12***
Observations	2164	2164	2164	2164	2164	2164

Notes: Numbers in parentheses are t-ratios. Significance levels 0.1, 0.05, and 0.01 are noted by *, **, and ***. Column 1 reports the ordered probit regression that generates the generalized residuals. Columns 2-5 use IVs and other exogenous variables to predict all the endogenous variables for the above-quota birth equation (Table 10).

Figure 1: Household Wealth and the Value of Children

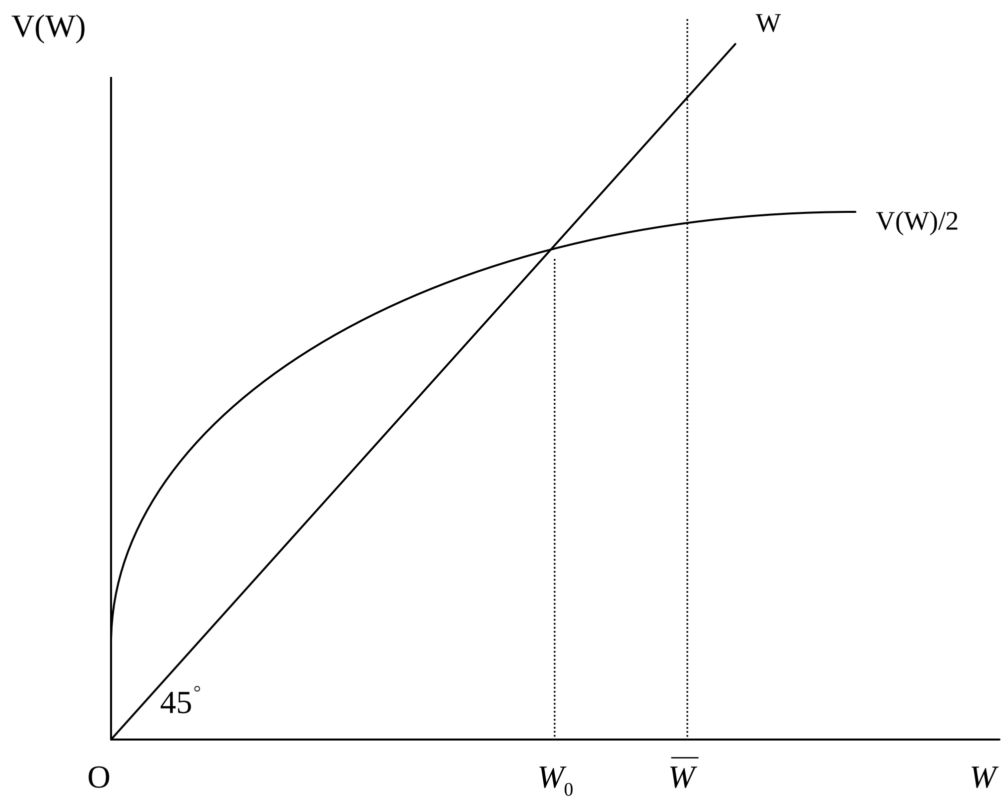

Figure 2: Household Wealth, the Value of Children, and Fines

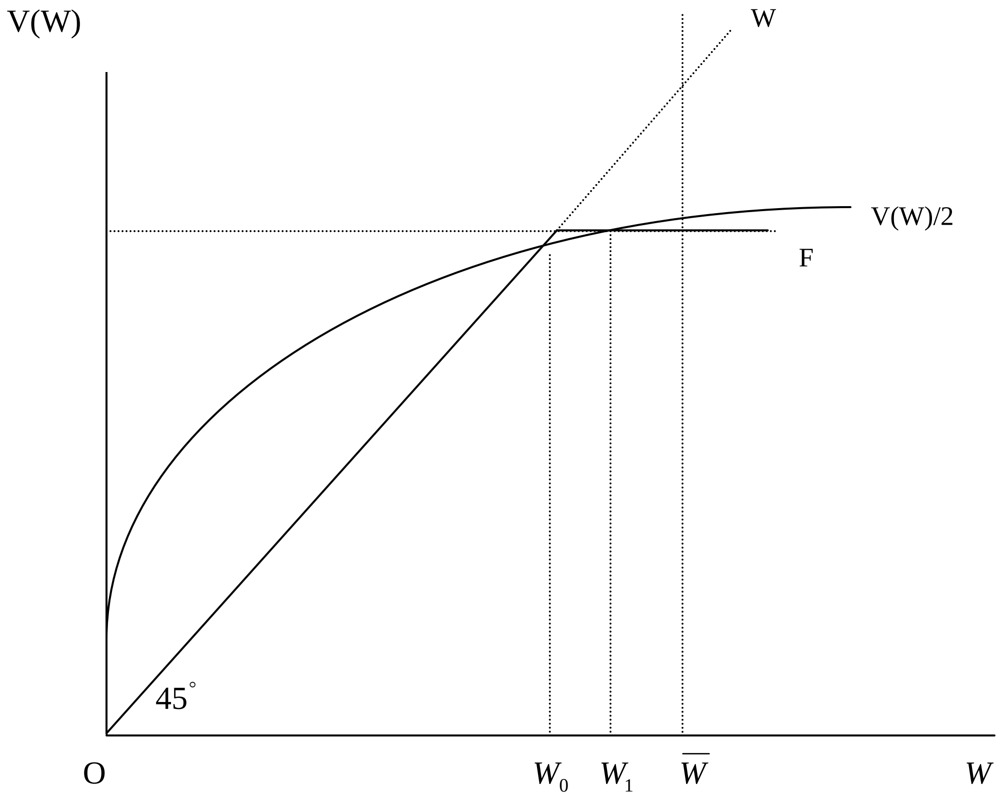

Figure 3: Household Wealth and the Uncertain Value of Children

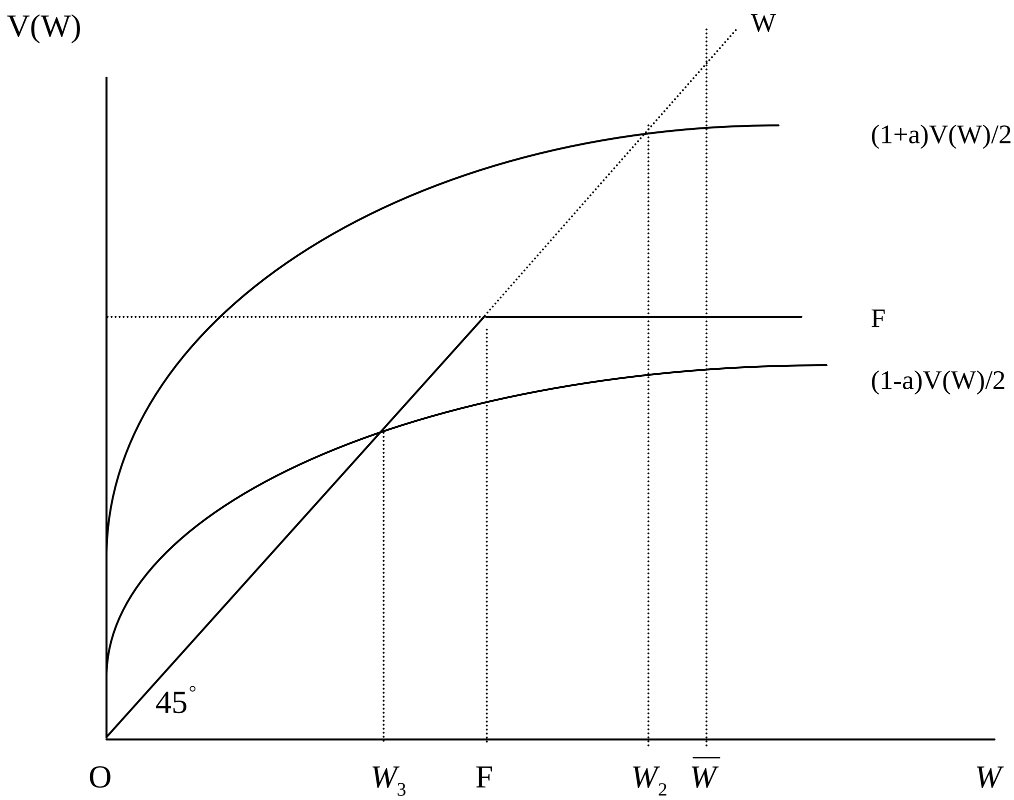

Figure 4: Different Boy Value Function for Poor and Rich Households

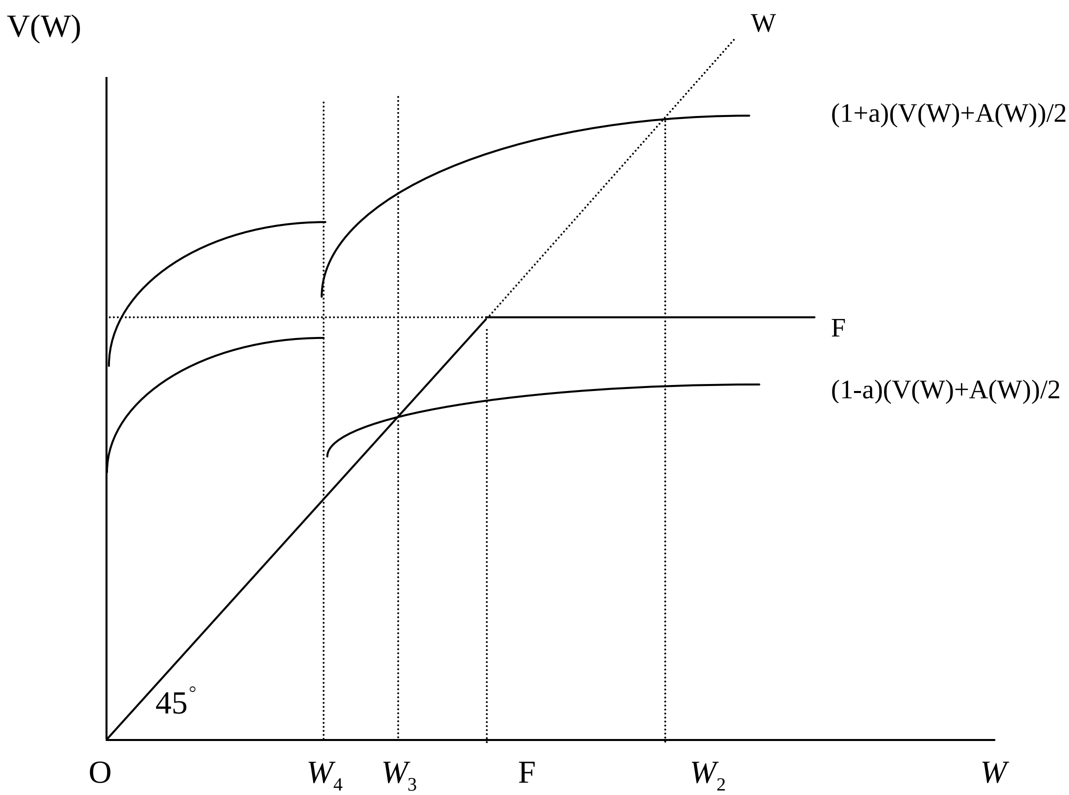

Figure 5: Different Penalties for Poor and Rich Households