Are All Siblings Born Equal?[1]

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Abstract

Vietnam is characterized by a widespread belief that the year of birth predicts success: cohorts in auspicious years are 12 percent larger. Comparing siblings with one another, those of auspicious cohorts are found to have 2 extra months of schooling. The Vietnamese horoscope being gender-specific, this difference is proved to be driven by birth timing: children born in auspicious years are more likely to have been planned, thus benefiting from favorable growth conditions. Moreover, birth timing appears to matter more for credit-constrained families, as they are less able to cope with the income shock associated with an unexpected pregnancy.

Keywords: birth timing, child ability, resource allocation, schooling, horoscope, superstition.

JEL Codes: J13, O15

1 Introduction

Do children born to the same parents receive equal treatment? While Becker and Tomes (1976) provided theoretical insights into the sources of sibling heterogeneity, the related empirical literature has put a large emphasis on gender bias (Rosenzweig and Schultz, 1982; Behrman et al., 1986; Thomas, 1994; Duflo, 2003), and birth-order effects (Behrman and Taubman, 1986; Hauser and Sewell, 1985; Black et al., 2005).[1] A complementary body of work has looked at optimal birth timing issues: Goldin and Katz (2002) study the effect of access to birth control technologies on the career and marriage outcomes of American women; Rosenzweig (1986) and more recently Conde-Aguelo et al. (2006) instead documented the effect of birth spacing on child health. Another perspective on birth timing consists of investigating the consequences of unexpected pregnancies on mothers' educational and labor market outcomes (Angrist and Evans, 1999) as well as children's health and education (see Gipson et al., 2008, for a review of the literature).

The particular context of this paper allows us to address some new issues pertaining to sibling heterogeneity. In Vietnam, the country of interest in this paper, we observe that superstition is a widespread phenomenon characterized by two features relevant to this study. First, there is a commonly shared belief that the year of birth of an individual is a determinant of ability, success and character. We find a sharp fertility response, through which years that are considered auspicious are significantly larger. Moreover, children born in these years have more years of schooling and this result holds with family fixed-effects. Second, we observe that the Vietnamese horoscope differs between boys and girls. This feature allows us to demonstrate that the observed sibling heterogeneity is not due to the horoscope being accurate or self-fulfilled, but to birth timing, by means of which children born in auspicious years are more likely to have been planned by their parents, thus benefitting

[1] See also Behrman et al. (1982), Sheshinski and Weiss (1982), and Rosenzweig and Wolpin (1988) for theoretical discussions on intrahousehold human capital investments.

from favorable growth circumstances. We furthermore find evidence that household resource availability is a constraint that is likely to bind with an unexpected pregnancy, affecting the newborn's human development prospects.

The main finding of this paper, that observed differences in educational outcomes between children born in auspicious versus inauspicious years are in part driven by the income effect associated with an unexpected pregnancy, is related to the debate on child wantedness: do parents provide better care to children who have been "wanted"? We believe our findings to be a significant contribution to this body of research for at least three reasons. First, most studies in this field have relied on self-reported assessments of wantedness although these self-reports are likely to be biased (Rosenzweig and Wolpin, 1993; Bachrach and Newcomer, 1999).[2] In our case, the horoscope of the year of birth of a child carries information about whether or not she was planned by her parents. Second, identification of the wantedness effect is generally obtained out of comparison *between* rather than *within* families. This methodology is subject to a cohort-composition bias: if some unobserved parental characteristics drive both the likelihood of an unexpected pregnancy and the child growth environment, then such latent heterogeneity potentially biases estimates obtained from cross-sectional comparisons.[3] And finally, the literature on wantedness often assumes away the income effect associated with an unexpected pregnancy to privilege a preference-based interpretation of the observed heterogeneity in child outcomes. Our findings suggest that such assumption is not warranted, and this has implications for the interpretation of these earlier results and the formulation of policy prescriptions. To remind ourselves of this

[2] One exception is Joyce and Grossman (1990) who instead predict wantedness using observables in a two-step Heckman selection model. Their identification requires the joint distribution of error terms to be bivariate normal.

[3] Chalasani et al. (2007) also adopt a fixed-effect specification to compare siblings with varying degrees of wantedness. However, wantedness is measured based on self-reported assessments, and the authors do not control for birth order in their specifications.

identification problem, we henceforth use the expression birth *timeliness* rather than birth *wantedness*.

Yet, the concept of wantedness is at the heart of the abortion regulation debate. Taking reduced-form estimates of the impact of fertility planning policies on socioeconomic outcomes (e.g. Donohue and Levitt, 2001; Pop-Eleches, 2006) is however equally subject to a cohort-composition bias: mothers for whom family planning policies are binding differ from mothers for whom it is not in ways that might also affect child outcome. In particular, Gruber et al. (1999) find that poorer households or households receiving welfare are more likely to be affected by changes in abortion regulation. Explicitly controlling for observed confounders still leaves unaddressed the problem of unobserved heterogeneity such as parental valuation of time. For example, Cawley and Liu (2007) provide recent empirical evidence on the effect of the opportunity cost of time of mothers on the time spent on children home education. Going beyond reduced-form results would thus require making strong identification assumptions. We therefore believe this paper to shed new light on some of the mechanisms that could also be factors underlying the documented impact of abortion regulation on socioeconomic outcomes such as schooling and crime.

To conduct our empirical investigation, we use the Vietnam 1999 population census to compare birth cohort sizes across years. Years that are believed to bring good luck to either boys or girls have birth cohorts on average 12 percent larger. Besides, there is no evidence that sex ratios and astrology are correlated, which invalidates hypotheses of sex-selective abortion or gender-biased infant mortality rates being driven by the horoscope. When we turn to human development outcomes, we use data on education from the population census and on health from the 2001 Vietnam National Health Survey and find that children of auspicious cohorts have higher levels of education measured by the number of years spent in school. There is however no evidence of any difference in long-term health (measured by height-to-age). Admittedly, comparing children across families is subject to a similar

cohort-composition bias as the one mentioned above, whereby parents more responsive to the horoscope might have unobservable traits that also affect the quality of child rearing. We thus explicitly control for potential confounding factors, hardly affecting the observed correlation between the horoscope and educational outcomes. We then run family fixed-effect estimations, which indicate that a child born in an auspicious year for either boys or girls will attend school an extra 2 months or 0.06 standard deviations compared to his or her *sibling* born in a year auspicious for neither boys nor girls. In addition, cohort-size spillover effects are ruled out, as no association between cohort sizes and educational outcomes is detected in the data. We are then left with two potential mechanisms to explain the observed sibling heterogeneity. On the one hand, the *ability channel* postulates that children born in auspicious years are either truly more able, or the belief that they are is a sufficient condition for them to feel more confident or for their parents to dedicate more resources to their education when parental investments and child ability are complements. On the other hand, the *birth timeliness channel* argues that children born in auspicious years are more likely to have been planned by their parents, thus benefitting from more favorable affective or economic conditions for human development.

To disentangle these two channels, we rely on a second feature of Vietnamese astrology: the horoscope is different for boys and girls so that there are years that are auspicious for boys exclusively (and bad omen for girls), vice and versa, years that are auspicious for both boys and girls, and years that are auspicious for neither boys nor girls. Given that gender is not known at the time of the fertility decision, we can test whether differences in outcomes are driven by ex-ante planning (the birth timeliness channel) or ex-post horoscope (the ability channel). To illustrate the intuition, let's consider the following Vietnamese three-child family. Bao and Giang are twins; Bao is a boy, while Giang is a girl. They are born in a year that is auspicious for boys exclusively, i.e. bad omen for girls. Bao and Giang have a sister, Nga, who is born in a year that is auspicious for neither boys nor girls. According

to the horoscope, Bao is a *lucky* child, while his two sisters are both *unlucky*. By comparing the three siblings, we can assess the empirical relevance of ability versus birth timeliness in determining child outcomes. If ability is the driving force underlying sibling differences, we should observe better outcomes for *lucky* Bao compared to his *unlucky* twin sister Giang, while not find any difference between the two *unlucky* sisters Giang and Nga. On the other hand, if birth timeliness is the key determinant of sibling heterogeneity, we do not expect any difference between the two twins, while Giang should exhibit better human development outcomes than her sister Nga because she is more likely to have been planned by her parents who targeted an auspicious year for either boys or girls to give birth to her and her twin brother. Our empirical strategy does precisely that. We first look at children born in years auspicious for either boys or girls, and find no evidence of better outcomes for the child for whom gender and horoscope match (we actually find the opposite). We then restrict our sample to *unlucky* children: these are boys born in years auspicious for girls exclusively, girls born in years auspicious for boys exclusively and children born in years auspicious for neither. *Unlucky* children born in years auspicious for the other sex are still found to be doing better than *unlucky* children born in years auspicious for neither. Birth timeliness is therefore believed to be the main mechanism underlying the observed heterogeneity between children born in years of varying auspiciousness. Finally, we find that the effect of the horoscope on child outcome is stronger among groups such as ethnic minorities that are both less likely to believe in the Vietnamese horoscope and put an emphasis on child quality, but more likely to face financial constraints. Such results thus suggest that the inability to smooth an income shock associated with an unexpected pregnancy plays a role in explaining sibling outcome heterogeneity.

In addition to the aforementioned literature, our paper is also related to the literature on the complementarities between parental investments and children's endowments. We effectively do not find evidence that parents invest either more or less in their child's human

capital depending on whether or not she is perceived to be more able. Becker and Tomes (1976), Behrman et al. (1982) and Sheshinski and Weiss (1982) discussed conditions for parental investments to reinforce or compensate sibling innate heterogeneity. Rosenzweig and Schultz (1982) find evidence of reinforcing allocations of parental resources in Indian context. In our paper, we make the assumption that the horoscope is not a predictor innate ability differences, so that observed heterogeneity in outcomes can be entirely attributed to parental investments; yet, we find no evidence of such mechanism to be operating. Admittedly, the interpretation of our results is subject to the caveat that the child's horoscope is only one aspect of her perceived ability. It is nevertheless important enough to trigger a 12 percent fertility response.[4]

The paper is organized as follows: section 2 sketches the cultural framework underlying astrology and superstition in Vietnam. In section 3, we lay out a simple model of parental resource allocation decision-making to guide our discussion, and after a description of the data in section 4, we present and discuss our results in section 5. Section 6 concludes.

2 A Short Overview of Vietnamese Astrology

In this section, we describe briefly the basis of Vietnamese astrology.[5] To the connoisseur, this overview will surely look over-simplified. At the root of Vietnamese superstition is the Chinese "Y King" (4000 years B.C.) whereby the Universe found its origin from a unique

[4] Our paper, by its cultural context, also relates to the literature on religion and beliefs. Goodkind (1991, 1996) and Lee and Paik (2006) document how the horoscope can influence birth timing among Chinese and Korean families respectively. The former finds evidence of a "dragon-year baby boom" among the Chinese populations of South-East Asia, while the latter shows that Korean families avoid the inauspicious year of the horse to have children. Vere (2008) exploits superstitious beliefs in Hong Kong to construct an instrument for fertility and looks at the impact of fertility on female labor participation.

[5] As Vietnamese astrology takes its root in Chinese astrology, names and references related to astrology will henceforth be in Chinese, with the exception of year names which are given in Vietnamese.

entity and from such entity, emerged two states, Yin and Yang. Yang is as positive, masculine, left, high and tough as Yin is negative, feminine, right, low and soft. Around 200 years B.C., during the Han dynasty, a school of thought built a theory according to which the tension between Yin and Yang was related to the five elements: Metal, Wood, Water, Fire and Earth. During the Tsong dynasty (10th century A.D.), Chen Ruan made this theory into the "Fengshui", which, among other things, predicted the destiny of an individual based on her date of birth. A year is actually viewed as the association between a terrestrial appellation (Zhi) and a celestial prefix (Gan). There are 12 terrestrial appellations also known as zodiac animals (Rat, Ox, Tiger,...), while a celestial prefix is a combination of Yin or Yang and one of the five aforementioned elements, yielding a total of 10 prefixes. The 12 zodiac animals are also in either Yin or Yang state. The Rat is Yang, while the Ox is Yin. As celestial prefixes and terrestrial appellations need to be in the same state (Yin or Yang), the Chinese and Vietnamese calendars are characterized by 60-year cycles.

The horoscope is then determined depending on the compatibility between the gender of the newborn, and the celestial and terrestrial attributes of the year of birth. For example, a year characterized by Yin is on average more compatible with girls than with boys, while the reverse holds for Yang years. On top of that, there are compatibilities based on the elements. Table A1 in the appendix displays the horoscope for the entire 60-year cycle. To read this table, let's consider the top-left corner, "Canh Ty", which corresponds to year 1960 (modulo 60). That year is an inauspicious year for boys and neutral for girls. A one-year increment would then consist of moving one cell (modulo 10) to the right, and one cell (modulo 12) down. Table 1 shows for the time period we are interested in, which years are auspicious, inauspicious, or neutral for boys and girls respectively. A complete astral theme would also look at parents' dates and times of birth and their compatibility with their child's to refine the horoscope.

3 Superstition, birth timing, and human development

We adopt a now standard Becker (1960) and Becker and Lewis (1973) model of household production, whereby parents have one child, and an endowment W that they allocate between a consumption good C and a child rearing good Z. One can also think of C and Z as time spent on domestic tasks and child rearing, respectively. Parents' utility has a simple Cobb-Douglas form:

$$U(Z,C) = Y^{\alpha}C^{1-\alpha}, \tag{1}$$

where Y is the child's human development outcome. We account for heterogeneity of outcomes across families and across siblings within a family by assuming the production of human capital Y to follow the rule:

$$Y = H(\theta)\,\Phi(N)\,R(Z,\gamma), \tag{2}$$

where θ is a household-specific time-invariant productivity parameter, i.i.d across households with mean $\bar{\theta}$ and cumulative distribution function $F(.)$, and $H(.)$ is increasing; N is the child's birth cohort size and $\Phi(.)$ captures cohort size spillover that can be either positive (Φ increasing) or negative (Φ decreasing); Z is the amount of education good consumed by the household, and γ is the innate ability of the child. We distinguish parental preferences (measured by α in parents' utility function defined in (1)) from returns and costs of investments in child rearing, captured by γ. $R(.)$ is increasing and concave in its two arguments and we set the following two inequalities:

$$\frac{Z}{R}R_Z\left[1-\frac{Z}{R}R_Z\right]+\frac{Z}{R}R_{ZZ} < 0 \tag{3}$$

$$\frac{R_Z R_\gamma}{R} - R_{Z\gamma} < 0 \tag{4}$$

The first inequality is a condition on the concavity of $R(.)$ with respect to Z that we assume to hold, and the second argues that the education good and child's innate ability

are "sufficiently" complement. Whether (4) should generally prevail is unclear (see Becker and Tomes, 1976; Behrman et al., 1982), and we remain agnostic about it. The first-order condition governing parental choices takes the form

$$\frac{1-\alpha}{\alpha}\Lambda = \frac{Z^*}{W - Z^*}$$

where $\Lambda = \frac{Z^*}{R} R_Z$ is (the inverse of) the relative price of education. Inequality (3) implies $\Lambda_Z < 0$ and $\Lambda_\gamma > 0$ if and only if and (4) holds.[6] Under "standard" regularity assumptions, the implicit function theorem implies that there exists a differentiable function $\xi(\alpha, W, \gamma)$ such that in equilibrium,

$$Z^* = \xi(\alpha, W, \gamma), \tag{5}$$

and $\xi(.)$ is increasing in α and W, and increases in γ if and only if (4) holds. Investments in child rearing increase if parents have a relatively higher preference for their child, or have higher income, or the net private returns to child rearing are larger. Plugging (5) into (2) and taking logs, we obtain

$$y = \rho[\xi(\alpha, W, \gamma), \gamma] + \eta(\theta) + \phi(N)$$

where $y \equiv \ln Y$, $\rho \equiv \ln R$, $\eta \equiv \ln H$, and $\phi \equiv \ln \Phi$.

We now turn to the fertility process. For each household, fertility is determined by the following stochastic process:

$$\begin{cases} \Pr(child|planned) = 1 \\ \Pr(child|unplanned) = 1 - \theta \end{cases} \tag{6}$$

where θ also captures the household's ability to control fertility. An unwanted child is born with probability $1-\theta$, while we assume that a child is always born when planned. To capture

[6] We need conditions (3) and (4) for the relative price effect to hold. These conditions are more stringent than a simpler concavity assumption ($R_{ZZ} < 0$) and a complementarity assumption ($R_{Z\gamma} > 0$) mostly due to the Cobb-Douglass specification that requires a monotonicity condition on the elasticity rather than the first-order derivative of $R(.)$.

the effect of astrology on fertility decisions, we assume that the fraction of parents wishing to have a child is $\beta \in [0,1]$. For simplicity, we restrict $\beta \in \{0,1\}$, so that all parents plan to have a child in auspicious years (and end up having one), while none do so in inauspicious years (but end up having one with probability $1-\theta$). Average outcome is equal to

$$\begin{cases} E(y|\beta=1) = \rho_h + \int \eta(\theta)\, dF(\theta) + \phi(1) \\ E(y|\beta=0) = \rho_l + \int \eta(\theta) \frac{1-\theta}{1-\bar{\theta}} dF(\theta) + \phi\left(1-\bar{\theta}\right) \end{cases},$$

where $\rho_h \equiv E\rho\left[\xi(\alpha, W, \gamma), \gamma | \beta = 1\right]$ and $\rho_l \equiv E\left[\xi(\alpha, W, \gamma), \gamma | \beta = 0\right]$. The difference in outcomes $\Delta E(y) \equiv E(y|\beta=1) - E(y|\beta=0)$ is thus

$$\Delta E(y) = (\rho_h - \rho_l) + \int \eta(\theta) \frac{\theta - \bar{\theta}}{1-\bar{\theta}} dF(\theta) + \left[\phi(1) - \phi\left(1-\bar{\theta}\right)\right]. \tag{7}$$

The outcome difference $\Delta E(y)$ consists of three components:

- **Sibling heterogeneity**, $(\rho_h - \rho_l)$, can be formally decomposed into:

$$\rho_h - \rho_l \cong \underbrace{\rho_Z \cdot (\xi_\alpha\ \Delta\alpha + \xi_W\ \Delta W)}_{birth\ timeliness} + \underbrace{\left(\rho_Z \cdot \xi_\gamma + \rho_\gamma\right)\ \Delta\gamma}_{ability}. \tag{8}$$

  The difference in outcomes between siblings is driven by two main factors:

  - (i) *Birth timeliness:* parents might have an intrinsic preference for children who have been planned ($\Delta\alpha > 0$), leading to better treatment hence better outcomes $(\xi_\alpha, \rho_Z > 0)$. Alternatively, an unexpected birth might be associated with an income shock ($\Delta W > 0$) that in turn affects future human development $(\xi_W, \rho_Z > 0)$. Angrist and Evans (1999) actually document the effect of an unplanned pregnancy on mothers' schooling.[7]

[7] Alternatively, if means of birth control are normal goods, adverse conditions faced by the household might increase the likelihood of an unplanned pregnancy. These same adverse conditions in turn affect subsequent human development. In this paper, we do not attempt to disentangle these two mechanisms.

– (ii) *Ability*: children born in auspicious years might be truly more gifted ($\Delta\gamma > 0$), or are believed to be so, thus benefiting from better (resp. worse) treatment from their entourage in a world where higher (resp. lower) ability decreases (resp. increases) the relative price of education. Note that for this effect to hold, parental beliefs about their child's ability is sufficient: conditional on perceived ability, true ability does not matter for parental investments.

- **A cohort-composition effect**, $\int \eta(\theta) \frac{\theta-\bar{\theta}}{1-\bar{\theta}} dF(\theta)$, whereby changes in β can affect households differently, and this heterogeneity can also drive children's outcomes. If we suppose that $\eta(.)$ is monotonic, then the cohort-composition effect is positive if and only if $\eta(.)$ is increasing. There is therefore no such effect in the absence of heterogeneity, i.e. when $\eta(.)$ does not depend on θ. This effect has for example been documented by Gruber et al. (1999).

- **A cohort-size effect,** $\left[\phi(1) - \phi\left(1-\bar{\theta}\right)\right]$, which is either positive (peer effects, increasing returns) or negative (congestion, crowding out of common resources). Behrman and Birdsall (1988) find positive spillover among Brazilian male cohorts, arguing that larger cohorts increase the demand for skilled labor and thus the returns to schooling. On the other hand, Acemoglu, Autor and Lyle (2004) show that increased female labor supply after World War II had the effect of depressing female wages.

The expression derived in (7) also applies for the analysis of fertility planning policies and their impact on child human development outcomes.[8] The empirical specification used

[8] In the context of family planning impact evaluations, reduced-form estimates would be very similar to expression (7). For example, in assessing the impact of family size restrictions such as the One-Child policy in China (see Qian, 2008), β would instead capture the coerciveness of the regulatory regime. Similarly, a minor modification of our modeling assumptions would allow us to address the impact of abortion regulation on outcomes (assuming for example that $\Pr(child|\text{planned}) = 1$, and $\Pr(child|\text{unplanned}) = (1-\theta)(1-\beta)$, where $\beta \in \{0,1\}$ indicates the abortion regulatory regime: $\beta = 1$ if and only if abortion is legal).

in most contexts is the following difference-in-differences framework: $y_{ijkt} = \alpha_0 + \alpha_1\beta_{kt} + \alpha_2 f(X_{ijkt}) + \nu_t + \eta_k + \varepsilon_{ijkt}$, where y_{ijkt} is the outcome of child j born to household i in region k in year t. β_{kt} is a measure of family planning in region k in year t, while X_{ijkt} is a vector of characteristics that include child attributes (gender, age...), household-level time-invariant characteristics (parental education and age,...), and region-level time-varying information. As suggested by equation (7), the proposed econometric specification is a reduced-form estimate of the three forces at play described above. Little more can be said without making strong assumptions on the ability of observable variables X_{ijkt} to account for cohort composition.

The context of our paper is different and offers a lot of time variation in the horoscope: it is as if family planning policies – captured by β in equation (6) – were changing every year, becoming more liberal in auspicious years, while more restrictive otherwise. Thus every household is subject to high frequency changes in fertility incentives. This allows the use of household fixed-effects that control for both observables and unobservable time-invariant factors that drive the cohort-composition effect discussed so far. Our proposed specification is thus

$$y_{ijkt} = \alpha_0 + \alpha_1\beta_t + \alpha_2 f(X_{ijkt}) + g(t) + \eta_j + \varepsilon_{ijkt}. \tag{9}$$

The unobserved and time-invariant household variables that could be a threat to the identification of α_1 are now captured by fixed-effects η_j. On the other hand, because the horoscope is not region specific, the use of time fixed-effects is not feasible. Identification of the wantedness effect is therefore subject to the additional assumption that the time trend $g(t)$ is correctly specified and that cohort-size effects are not sizeable.[9]

[9] $\hat{\alpha}_1$ is an upward (resp. downward) estimate of α_1 in the case of positive (resp. negative) cohort-size spillovers. We will address this issue at a later stage in the paper.

4 Data

The main source of data is a 33 percent random subsample of the Vietnam 1999 Population Census, henceforth census. We use the census to construct cohort sizes. Due to the mismatch between lunar and solar calendars, years of birth have been re-computed so that say 1986 henceforth corresponds to the year of the Tiger (from February 9th, 1986 to January 29th, 1987). The year of birth of a child born in January 1986 will hence be coded 1985. We will focus solely on individuals born in and after 1977, as the country was still at war until April 1975, and we expect birth rates in 1976 to be driven by the return to peace rather than superstitious considerations. Moreover, birth timing is believed to be a fairly recent phenomenon when concerns for child quality started becoming more pressing. Goodkind (1991), while looking at whether fertility decisions during the auspicious year of the Dragon, concludes "that the Dragon Year was not a salient factor in Chinese fertility-timing decisions until 1976" (p. 666). We will also ignore observations corresponding to children born during the census year, as the timing of the survey would mechanically imply smaller observed cohorts in these years. We thus restrict our sample to birth cohorts spanning from 1977 to 1998.

To measure educational outcomes, we extract from the census the number of years of schooling the child completed at the time of the interview. Health outcomes on the other hand are obtained from the 2000-2001 Vietnam National Health Survey, henceforth VNHS. The survey was undertaken by the Ministry of Health and the General Statistics Office and interviewed a representative sample of the population consisting of 36 000 households. The 1999 Population Census was used as sampling frame for VNHS. Information collected includes anthropometric measures. Height is the adopted measure of long-term health. We take data on individual height to compute height-for-age z-scores using the UK reference growth charts. The computation follows Cole (1990). The measures hence obtained are arguably comparable across gender and age groups; even though the reference group consists

of British individuals, they apply to other countries as well (see Wagstaff et al., 2003 for an application to Vietnam).

Table 2 presents basic summary statistics of the variables used for the present analysis. An interesting fact to note is that, while the fraction of auspicious years for either boys or girls is 63.6 percent, 69.0 percent of children in the census are born in these auspicious years. This difference is a first indication of fertility decisions being influenced by the horoscope. The following section addresses this question formally.

5 Empirical Results

5.1 Astrology and birth timing

We first look at the extent to which fertility timing decisions are correlated with the Vietnamese horoscope by estimating the following equation:

$$\ln N_t = a_0 + a_1 t + a_2 t^2 + cG_t + e_t, \tag{10}$$

in which N_t is the national-level aggregate number of children born in year t, G_t is the dummy variable that is equal to 1 if year t is an auspicious year according to Vietnamese astrology, and 0 otherwise.

As discussed in Section 2, male are "Yang" and female are "Yin", so that horoscopes for boys and girls are likely to be different. We will thus adopt several specifications for variable G_t : (i) whether year t brings luck to boys, (ii) girls, (iii) both, or (iv) either. We will henceforth designate G_t^b, G_t^g, G_t^{and}, and G_t^{or} the dummy variables that are equal to 1 when year t is auspicious for boys, girls, both and either respectively, and 0 otherwise. The results of the estimation of (10) are shown in Table 3, panel A. The first column shows significantly larger cohort sizes in years that are auspicious for either boys or girls. The difference is estimated to 11.7 percent, which is similar to earlier estimates from Goodkind (1996) who

finds a 12 to 22 percent increase in fertility during the years of the Dragon (1976, 1988) among Chinese households in Singapore. Columns 2 and 3 suggest that this effect is not driven by the horoscope of a specific gender. It seems that parents seek years that are auspicious for either of the two genders rather than just for boys or just for girls. Furthermore, this phenomenon appears to hold in rural areas (column 5), among Christian and Muslim populations (column 6), and ethnic groups other than the Kinh and Chinese (column 7), although the coefficient in this case is smaller and marginally statistically significant. We also tested for first and second order serial correlation, and could not reject the null hypothesis of neither first nor second-order serial correlation of the error terms. We next investigate whether cohorts of boys and girls behave differently, as we might expect sex-selective abortion or gender-biased infant mortality rates. No evidence of such phenomenon is detected as documented in Table 3, panel B. Boys and girls cohorts respond similarly to the horoscope with no noticeable difference.

Graphically, the effect of astrology is illustrated in Figure 1. The horizontal axis represents time. The smooth line predicts birth rates at the national level (predicted value of the regression of the logarithm of cohort size on a quadratic time trend), while the connected line shows actual country-level cohort sizes. We first notice a sharp fertility transition since the end of the 1980s, coinciding with the beginning of the "Doi Moi", or transition towards a market economy. The results found above indicate that most auspicious years (for boys, for girls, or both) are above the predicted line. Although Vietnamese, Chinese and Korean horoscope are similar, we can see graphically that Vietnamese data exhibit neither a "dragon-year baby boom" in 1988, nor a "horse-year baby bust" in 1978 or 1990 contrary to the findings of Goodkind (1996) and Lee and Paik (2006) respectively. One reason for this, is that according to Vietnamese astrology, the year of the dragon is not systematically an auspicious year and neither is the year of the horse always bad omen as shown in Table 1. Moreover, our field experience suggests that Vietnamese people know little about astrology,

but rely on fortune-tellers when it comes to fertility timing. They are then likely to be advised according to the full horoscope rather than the sole zodiac animal as has been reported for the cases of Chinese or Korean populations. Yet, some zodiac animals (Zhi) are never good omen (Snake), while others are never bad omen (Goat or Pig). We might then expect large fertility responses during these years. Appendix Table A2 does not show any evidence of a Goat-year or Pig-year "baby boom" (column 1) but some indication of a Snake-year "baby bust" (column 2).

5.2 Reduced-form results

We now test the hypotheses discussed in the previous section. We estimate a parametric version of equation (9):

$$y_{ijt} = a_0 + a_1 t + a_2 t^2 + cG_{ijt} + X_{ijt}b + e_{ijt}, \tag{11}$$

in which y_{ijt} is the outcome of interest (education and health) for child i born in year t into family j, and X_{ijt} includes individual, household and commune-level controls. Our main specification consists of considering G^{or}_{ijt}, the dummy variable which is equal to 1 if child $i's$ year of birth t is auspicious for either boys or girls, and 0 otherwise. Standard errors are clustered at the year-of-birth level.

Table 4 shows the result from the estimation of (11). Column 1 shows that a child born in an auspicious year is likely to stay 0.3 more years in school. No comparable effect is detected when looking at long-term health, measured by height-to-age (column 4). We include household, parental and commune-level controls in the estimation of (11). The results in columns 2 and 5 show smaller coefficients, yet qualitatively similar to the estimates provided in the regressions without controls. Although parents' socioeconomic background might affect child's educational outcome, controlling for observable characteristics does not affect dramatically the observed positive correlation between astrology and schooling.

To control for the cohort-composition effect, we add family-level fixed effects to equation (11):

$$y_{ijt} = a_0 + a_1 t + a_2 t^2 + cG_{ijt} + X_{ijt} b + \eta_j + u_{ijt} \tag{12}$$

Education policies and infrastructure are largely determined at the provincial level, so we cluster standard errors at the province level in education regressions, and at the commune-level for health regressions.[10] The results are presented in columns 3 and 6. The results are consistent with the ones presented previously. While no significant difference in height is detected, children born in auspicious years report higher levels of schooling than their *siblings* born in non-auspicious years (column 3). Thus, we draw the conclusion that the observed difference in schooling is not entirely driven by a selection bias whereby parents better able to time fertility in tune with the horoscope are also better able to invest in their children's human capital. Given that the cohort-composition effect has been dealt with, we are then left with fewer alternative mechanisms to which we now turn.

5.3 What are the mechanisms at work?

First, *the cohort-size channel* assumes that the horoscope affects education through increased birth cohort sizes. In this context, this would mean that larger cohorts generate positive spillovers. Second, the *ability* channel, whereby children born in auspicious years are intrinsically more gifted or beliefs that they are so induce better treatment, assuming resources and ability are complements. Finally, the *birth timeliness* channel: in an auspicious year, children are more likely to have been planned, so that financial or affective conditions for their future growth are likely to be more favorable.

[10] The commune is the smallest administrative unit in Vietnam. The country consists of 10 090 communes grouped into 589 districts that form 58 provinces as of 1999.

5.3.1 Cohort size

We first attempt to rule out cohort-size effects. Controlling for cohort size in equation (12) does not allow identification of c as larger cohorts are also better-off cohorts. We nevertheless add measures of cohort size in equation (12), with the expectation that the estimate of c is going to be biased downward. In Table 5, column 1 reproduces the result of Table 4 column 3 for comparison. Columns 2-4 control for commune, district and province-level cohort sizes respectively. While the "auspicious-year" coefficient effectively drops, it remains positive and statistically significant. An alternative approach is to instead estimate the following regression:

$$y_{ijkt} = a_0 + gN_{kt} + X_{ijkt}b + \eta_j + \nu_t + u_{ijt} \tag{13}$$

where y_{ijkt} is educational outcomes for child i born to household j in region k and year t. Family and year-of-birth fixed effects are controlled for and g therefore captures the extent of cohort size spillover. Results are presented in Table 5, columns 5-7: cohort sizes at the commune, district or province-level do not show any statistically significant association with educational outcomes. We therefore rule out cohort-size effects whereby the horoscope affects outcomes through the effect of larger birth cohorts (see Behrman and Birdsall, 1988).

5.3.2 Explaining sibling heterogeneity: child ability or birth timeliness?

We are now left with two remaining channels that rely on a differential treatment of children within families: child ability versus birth timeliness.

As discussed earlier, there are two dimensions of child ability: *true* and *perceived* ability. The child's true ability has a direct effect on his or her subsequent human development, while his/her perceived ability (whether it reflects the truth or not) affects the relative price of education, that in turn determines parental investments and eventually child outcomes. We then make the assumption that being born in an auspicious year does not determine true ability but only perceived ability. Under this assumption, we will be able to assess the extent

to which differences across siblings are driven by initial differences in (perceived) ability that are then exacerbated by parents' allocation of resources across children.

The alternative mechanism has to do with birth timing: child outcomes are driven by parental socioeconomic conditions at the time of birth and also by their intrinsic preference for the newborn, irrespectively of his or her gender, birth order or other attributes discussed above. Untimely pregnancies can lead to worse human development outcomes if these are associated with an adverse income shock, or by parental "aversion" vis-à-vis a child born unplanned.

In order to disentangle these two channels, we observe that the gender of the future child is not known when the fertility decision is made, and that auspicious years for boys usually differ from auspicious years for girls. We can then see whether ex-ante planning or ex-post horoscope matter for subsequent human development outcomes. If ability is the driving force behind our results, then a boy must be born in an auspicious year for boys, and a girl must be born in an auspicious year for girls in order to be privileged. On the other hand, in the birth timeliness scenario, irrespective of gender, being born in an auspicious year for either boys or girls is the only thing that matters. We thus construct the variable *born-lucky* defined by $g_{ij} = gender_{ij} G^b_{ij} + (1 - gender_{ij}) G^g_{ij}$, where $gender_{ij}$ is equal to 1 if i (in family j) is a boy, and 0 otherwise and estimate equation (12) with both variables G^{or}_{ij} and g_{ij} on the right-hand side. Results are presented in Table 6, columns 1 and 2. The results suggest that most difference in education are driven by fertility planning rather than the self-fulfilling horoscope. Admittedly the two variables G^{or}_{ij} and g_{ij} are highly correlated with a correlation coefficient of 0.75, making a definitive interpretation of the results difficult.

To address this issue further, let's come back to our two twins, Bao (a boy) and his sister Giang and let's have a look at figure 2 that illustrates what the two hypotheses, ability versus birth timing, predict. Recall that Bao and Giang are born in an auspicious year for boys exclusively. The *ability* channel predicts that Bao will do better than his sister because

he is a *lucky* child while his sister is not. On the other hand, the *birth timeliness* channel tells us that Bao and Giang were both planned by their parents, and after controlling for gender, there should not be any difference in schooling outcomes between the two twins. Thus, if we restrict to birth cohorts born in auspicious years for either boys or girls, the *ability* hypothesis (Figure 2, upper panel) predicts that *lucky* children (blank areas: boys born in years auspicious for boys and girls born in years auspicious for girls) will have better outcomes than their *unlucky* counterparts (shaded areas). On the other hand, the *birth timeliness* hypothesis predicts no difference between these two groups as they have both been planned hence benefitting from comparable conditions for human development. Table 6, columns 3 and 4 show the results of the comparison of these two groups, and if anything, among birth cohorts born in auspicious years, being *lucky* is negatively correlated with schooling outcomes. However, given the gender-biased nature of the horoscope (there are twice as many years auspicious for boys than years auspicious for girls), the negative coefficient also reflects the fact that overall, boys have fewer years of schooling than girls born in the same year (cf. table 4). We nevertheless leave open the possibility that the negative coefficient reflects parental compensation for *unlucky* children.

An alternative approach consists of comparing Bao and Giang with Nga, their sister who is born in a year that is auspicious for neither boys nor girls. Recall that Bao and Giang are two twins born in a year that is auspicious for boys exclusively. The Vietnamese horoscope predicts that Giang is not a *lucky* child, because she is a girl born in a year auspicious for boys exclusively, i.e. bad omen for girls. The ability hypothesis, irrespective of whether parental investments are complement or substitute for child ability, predicts that Giang and Nga should not have different schooling outcomes as they are both *unlucky* children. The birth timeliness hypothesis however indicates that Nga is more likely to have been the outcome of an unplanned pregnancy, so that she should show a lower achievement than Giang does. We thus compare children born in years auspicious for nobody on the one

hand (dotted area in figure 2), and the group of children that consists of boys born in years that are auspicious for girls exclusively, and girls born in years that are auspicious for boys exclusively on the other hand (shaded areas in figure 2). Under the *ability* hypothesis (figure 2, upper panel), no difference should be observed between the two groups, while the *birth timeliness* hypothesis (figure 2, lower panel) predicts that the former would exhibit higher levels of human development than the latter would. Column 5 in table 6 shows that among *unlucky* children, those who were born in a year auspicious for either boys or girls are doing better than otherwise; even though the horoscope is not favorable to these children, being the fruit of fertility planning translates into better schooling outcomes.

The results presented here suggest that the intra-household allocation of resources does not depend on parental perceived innate ability of the child. Thus, differences in outcomes between siblings is not driven as much by a relative price effect of education as it is by an income effect or an intrinsic difference in taste for children who are planned versus their siblings who are not.

5.3.3 More on birth timeliness

Given that birth timing seems to be central in explaining differences in outcomes between siblings, we come back to the question of child wantedness. As we mentioned in the introduction, we did not refer to wantedness throughout the paper because we believed that the literature on wantedness had largely been assuming away the income effect that accompanies an unplanned pregnancy, and reduced its interpretation to a preference argument: unwanted children are worse-off because parents intrinsically value them relatively less than their "wanted" siblings. Our results so far do not allow us to disentangle these two alternative explanations of birth timeliness. Looking at the heterogeneity of the effect of the horoscope on educational attainment might nevertheless allow us to push the analysis further. Comparing the effect of the horoscope across groups of individuals is however a reduced-form

effect of:

(i) Varying prevalence of superstitious beliefs across groups: if parents are not superstitious, the distinction between auspicious and non-auspicious years is irrelevant. One expects a larger "auspicious-year" effect among superstitious parents.

(ii) Varying preference over offspring quality versus quantity: under the assumption that higher offspring quality also requires more careful planning, the difference in outcomes between planned and unplanned siblings will be larger for families that, *ceteris paribus*, put higher emphasis on quality vs. quantity.

(iii) Varying ability to cope with unexpected pregnancies: if prior investments play an important part in educational outcomes, an unexpected pregnancy comes with liquidity needs that some families will find more difficult to fulfill if they face more stringent credit constraints.

Thus, evidence of resource constraints should be sought after among groups that are both less superstitious and put relatively lower value on quality when facing the quantity-quality tradeoff. We estimate (11) with family fixed-effects and interaction terms. Table 7 displays the regression results. Birth timeliness seems to affect boys more than girls. Moreover, the results indicate that birth timeliness matters less for first-born children, as we expect the first child in the family to be expected eventually (column 1). Columns 2 to 7 document how household characteristics affect the relationship between astrology and schooling. Column 2 documents a larger effect of birth timeliness in smaller families, which are believed to put stronger emphasis on quality versus quantity of children. Column 3 presents the estimation of interaction terms with parental education and some indicators of asset holding, which are positive and significant. While more educated and wealthier parents are not necessarily less superstitious (nor are they more likely to be credit constrained), they are believed to put more emphasis on quality versus quantity, so that resource constraints are more likely to bind

for unplanned children in these families. The negative coefficient on the interaction with the urban/rural dummy variable (column 4) indicates that while urban populations might be more inclined to invest more in fewer kids, the effect of an unplanned pregnancy is lower presumably because of easier access to credit markets in urban setting, making coping with an unplanned pregnancy easier. However the urban/rural effect changes sign when controlling for the interaction with assets (column 5). This result reinforces the presumption that credit constraints are playing a role in explaining the birth timeliness effect. Besides, column 6 indicates a larger effect of the horoscope on educational outcomes among ethnic minorities (non-Kinh and non-Hoa): while ethnic minorities are less likely to adhere to Vietnamese astrology (as suggested in the fertility response regressions, Table 3, panel A), and put relatively less emphasis on quality versus quantity of children, the negative interaction term suggests that more restricted access to credit markets however makes it more difficult to cope with an unplanned pregnancy. Credit constraints therefore seem to explain part of the observed differences in educational attainment between planned and unplanned children.

6 Conclusion

Superstition in Vietnam seems pervasive. Years that might bring luck to girls or boys have birth cohorts 12 percent larger on average over the period 1977-1998. We find that overall, being born in these years does not have an effect on health but increases years of schooling by 2 months or 0.06 standard deviations. Our findings suggest that birth timing plays an important role in explaining the observed differences: children that have been planned are born in economic and emotional environments that are more conducive to human development. We find evidence that financial conditions at the time of birth matter. One question yet remains: what explains the persistence of superstition? If the persistence of superstitious beliefs is driven by observational data, why don't parents factor out the effects described in the paper? This remains a puzzle to us.

References

[1] Acemoglu, D., Autor, D., and D. Lyle, "Women, War, and Wages: The Effect of Female Labor Supply on the Wage Structure at Midcentury", The Journal of Political Economy, 112(3): 497-551. 2004.

[2] Angrist, J., and W. Evans, "Schooling and Labor Market Consequences of the 1970 State Abortion Reofrms", Research in Labor Economics, 18: 75-113. 1999.

[3] Bachrach, C., and S. Newcomer, "Intended Pregnancies and Unintended Pregnancies: Distinct Categories or Opposite Ends of a Continuum?", Family Planning Perspectives, 31(5): 251-2. 1999.

[4] Becker, G., "An Economic Analysis of Fertility", in Demographic and Economic Change in Developing Countries, Princeton University Press: Princeton NJ. 1960.

[5] Becker, G., and H. G. Lewis, "On the Interaction between the Quality and Quantify of Children", The Journal of Political Economy, 81(2): 279-288. 1973.

[6] Becker, G., and N. Tomes, "Child endowments and the quantity and quality of children", The Journal of Political Economy, 84(4): 143-62. 1976.

[7] Behrman, J., "Intrahousehold Distribution and the Family," in M. Rosenzweig and O. Stark eds., Handbook of Population and Family Economics. Amsterdam: Elsevier Science. 1997.

[8] Behrman, J., and N. Birdsall, "The Reward for Good Timing: Cohort Effects and Earnings Functions for Brazilian Males", Review of Economics and Statistics, 70(1): 129-35. 1988.

[9] Behrman, J., R. Pollack, and P. Taubman, "Parental Preferences and Provision for Progeny", The Journal of Political Economy, 90(1): 52-73. 1982.

[10] Behrman, J., R. Pollack, and P. Taubman, "Do Parents Favor Boys?", International Economic Review, 27(1): 31-52. 1986.

[11] Behrman, J., and P. Taubman, "Birth Order, Schooling, and Earnings", Journal of Labor Economics, 4(3): 121-45. 1986.

[12] Black, S., P. Devereux and K. Salvanes, "The More the Merrier? The Effect of Family Size and Birth Order on Children's Education", Quarterly Journal of Economics, 120(2): 669-701. 2003.

[13] Cawley, J. and F. Liu, "Mechanisms of the Association Between Maternal Employment and Child Cognitive Development", NBER Working Paper No. 13609. 2007.

[14] Chalasani, S., J. Casterline, M. Koenig, "Consequences of Unwanted Childbearing: A Study of Child Outcomes in Bangladesh", manuscript, 2007.

[15] Cole, T., "The LMS method for constructing normalized growth standards", European Journal of Clinical Nutrition, 44: 45-60. 1990.

[16] Conde-Agudelo, A., A. Rosas-Berumdez, and A.C. Kafury-Goeta, "Birth Spacing and Risk of Adverse Perinatal Outcomes. A Meta-Analysis", Journal of the American Medical Association, 295(15): 1809-23. 2006.

[17] Donohue, J., and S. Levitt, "The Impact of Legalized Abortion on Crime", Quarterly Journal of Economics, 116(2): 379-420. 2001.

[18] Duflo, E., "Grandmothers and Granddaughters: Old-Age Pensions and Intrahousehold Allocation in South Africa", World Bank Economic Review, 17(1): 1-25. 2003.

[19] Gipson, J., M. Koenig, and M. Hindin, "The Effects of Unintended Pregnancy on Infant, Child, and Parental Health: A Review of the Literature", Studies in Family Planning, 39(1): 19-38. 2008.

[20] Goldin, C., and L. Katz, "The Power of the Pill: Oral Contraceptives and Women's Career and Marriage Decisions", The Journal of Political Economy, 110(4): 730-70. 2002.

[21] Goodkind, D., "Creating New Traditions in Modern Chinese Populations: Aiming for Birth in the Year of the Dragon", Population and Development Review, 17(4): 663-86. 1991.

[22] Goodkind, D., "Chinese Lunar Birth Timing in Singapore: New Concerns for Child Quality Amidst Multicultural Modernity", Journal of Marriage and the Family, 58(3): 784-95. 1996.

[23] Gruber, J., P. Levine, and D. Staiger, "Abortion Legalization and Child Living Circumstances: Who is the "Marginal Child"?", Quarterly Journal of Economics, 114(1), 263-92. 1999

[24] Hauser, R. and W. Sewell, "Birth Order and Educational Attainment in Full Sigships", American Educational Research Journal, 22: 1-23. 1985.

[25] Joyce, T. and M. Grossman, "Pregnancy Wantedness and the Early Initiation of Prenatal Care", Demography, 27(1): 1-17. 1990

[26] Lee, J., and M. Paik, "Sex preferences and Fertility in South Korea during the Year of the Horse", Demography, 43(2). 2006.

[27] Pop-Eleches, C. "The Impact of an Abortion Ban on Socioeconomic Outcomes of Children: Evidence from Romania", The Journal of Political Economy, 114(4): 744-73. 2006.

[28] Qian, N., "Quantity-Quality and the One Child Policy: The Only-Child Disadvantage on School Enrollment in Rural China", manuscript, 2008.

[29] Rosenzweig, M., "Birth spacing and sibling inequality: asymmetric information within the family", International Economic Review, 27(1): 55-76. 1986.

[30] Rosenzweig, M., and K. Wolpin, "Maternal Expectations and Ex Post Rationalizations: The Usefulness of Survey Information on the Wantedness of Children", The Journal of Human Resources, 28(2): 205-229. 1993.

[31] Rosenzweig, M, and P. Schultz, "Market Opportunities, Genetic Endowments, and Intrafamiliy Resource Distribution: Child Survival in Rural India", American Economic Review, 72(4): 803-15. 1982.

[32] Sheshinski, E., and Y. Weiss, "Inequality Within and Between Families", The Journal of Political Economy, 90(1): 105-17. 1982.

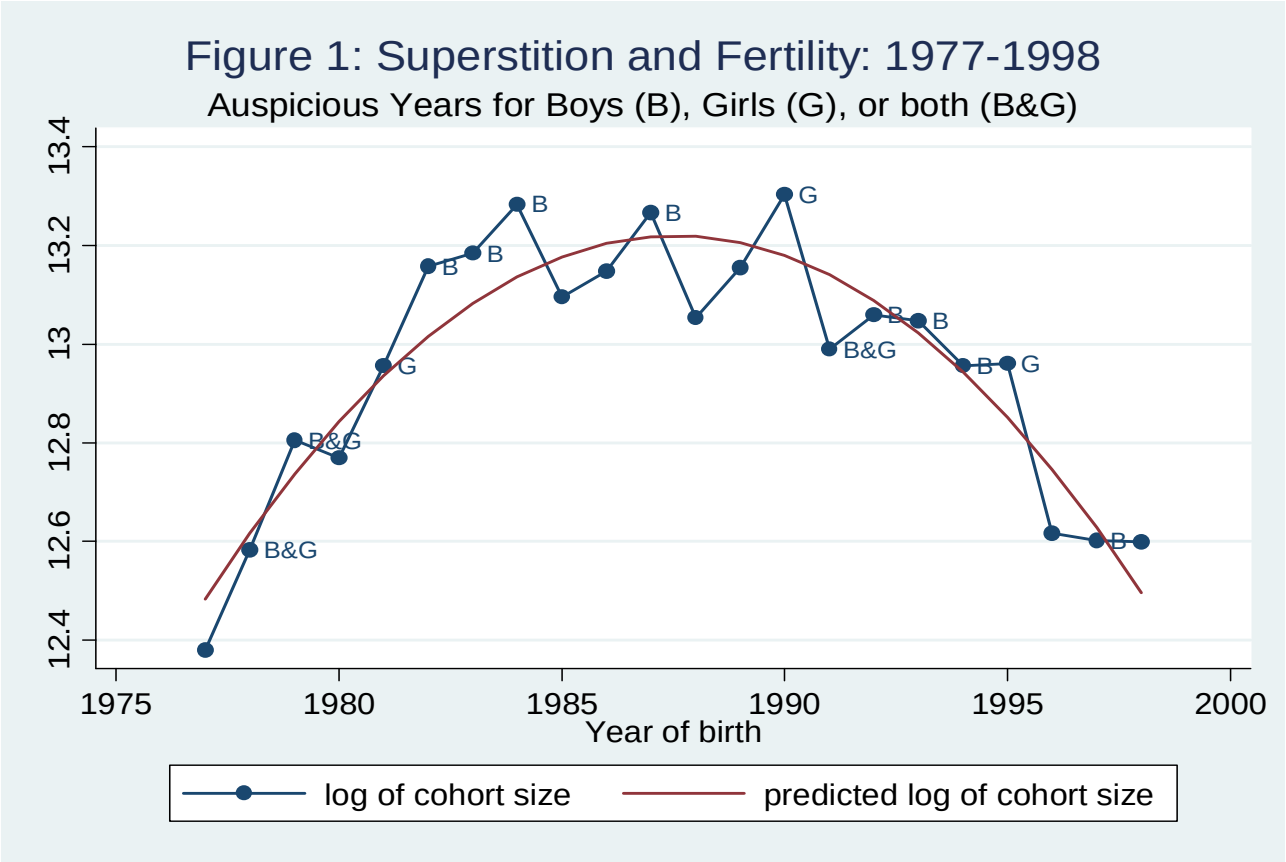
[33] Strauss, J. and D. Thomas, "Human Resources: Empirical Modeling of Household and Family Decisions", in J. Behrman and T.N. Srinivasan eds., Handbook of Development Economics, Amsterdam: Elsevier Science. 1995.

[34] Thomas, D., "Like Father, Like Son; Like Mother, Like Daughter. Parental Resources and Child Height", Journal of Human Resources, 29(4): 950-88. 1994.

[35] Vere, J., "Dragon Children: Identifying the Causal Effect of the First Child on Female Labor Supply with the Chinese Lunar Calendar", Oxford Bulletin of Economics and Statistics, forthcoming. 2008

[36] Wagstaff, A., E. van Doorslaer, and N. Watanabe, "On decomposing the causes of health sector inequalities with an application to malnutrition inequalities in Vietnam", Journal of Econometrics, 112(1): 207-223. 2003.

Figure 1: Superstition and Fertility: 1977-1998



Data source: 1999 Population Census.

Figure 2: Ability versus Birth Timeliness

Ability Hypothesis

	Auspicious year for boys exclusively	Auspicious year for girls exclusively	Auspicious year for neither
Boys	+	--	--
Girls	--	+	--

Birth Timeliness Hypothesis

	Auspicious year for boys exclusively	Auspicious year for girls exclusively	Auspicious year for neither
Boys	+	+	--
Girls	+	+	--

Table 1: Vietnamese horoscope 1977-1998

Birth year	Name of year*	Boy	Girl
1977	Dinh Ty	Neutral	Bad omen
1978	Mau Ngo	Good omen	Good omen
1979	Ky Mui	Good omen	Good omen
1980	Canh Than	Bad omen	Bad omen
1981	Tan Dau	Neutral	Good omen
1982	Nham Tuat	Good omen	Bad omen
1983	Quy Hoi	Good omen	Neutral
1984	Giap Ty	Good omen	Bad omen
1985	At Suu	Bad omen	Bad omen
1986	Binh Dan	Neutral	Bad omen
1987	Dinh Mao	Good omen	Bad omen
1988	Mau Thin	Neutral	Neutral
1989	Ky Ty	Bad omen	Neutral
1990	Canh Ngo	Neutral	Good omen
1991	Tan Mui	Good omen	Good omen
1992	Nham Than	Good omen	Bad omen
1993	Quy Dau	Good omen	Bad omen
1994	Giap Tuat	Good omen	Neutral
1995	At Hoi	Neutral	Good omen
1996	Binh Ty	Neutral	Neutral
1997	Dinh Suu	Good omen	Bad omen
1998	Mau Dan	Neutral	Bad omen

* Name of year is given in Vietnamese

Data source: see Table A1

Table 2: Summary statistics

	N.	mean	std dev.	min	max
Cross sectional data 1977-1998 (1999 Population Census)					
Individual-level characteristics					
Number of years of schooling	7,026,416	5.472	3.072	0	14
Gender (1:boy,0:girl)	9,261,468	0.519	0.500	0	1
Year of birth	9,261,468	1,987.121	5.453	1,977	1,997
Birth order	9,261,468	2.239	1.316	1	15
Year of birth is auspicious for either boys or girls (1:yes,0:no)	9,261,468	0.690	0.463	0	1
Year of birth is auspicious for boys (1:yes,0:no)	9,261,468	0.533	0.499	0	1
Year of birth is auspicious for girls (1:yes,0:no)	9,261,468	0.274	0.446	0	1
Year of birth is auspicious for both boys and girls (1:yes,0:no)	9,261,468	0.118	0.323	0	1
Household-level characteristics					
Number of siblings	3,863,389	2.671	1.385	1	15
Age of mother in 1999	3,784,783	38.057	9.794	15	77
Mother's number of years of schooling	3,392,138	7.110	3.020	0	14
Age of father in 1999	3,436,940	40.410	10.487	16	96
Father's number of years of schooling	3,147,216	7.606	2.982	0	14
Ethnicity (1:Kinh or Chinese, 0:others)	3,863,389	0.872	0.334	0	1
Religion (1: Christian or Muslim;0:others)	3,863,389	0.092	0.289	0	1
Household lives in urban area (1:yes,0:no)	3,863,389	0.216	0.411	0	1
House is permanent or semi-permanent (1:yes,0:no)	3,860,048	0.614	0.487	0	1
House area (sq m)	3,845,053	268.598	402.913	1	999
Household has running or rain water (1:yes,0:no)	3,861,060	0.761	0.426	0	1
Household has electricity (1:yes,0:no)	3,859,989	0.214	0.410	0	1
Household has flush toilet (1:yes,0:no)	3,858,770	0.152	0.359	0	1
Household has a TV (1:yes,0:no)	3,856,586	0.552	0.497	0	1
Household has a radio (1:yes,0:no)	3,859,059	0.456	0.498	0	1

Table 2 (cont'ed): Summary statistics

	N.	mean	std dev.	min	max
Time series data 1977-1998 (1999 Population Census)					
Cohort size (all individuals)	22	435,461	105,406	238,105	599,368
Cohort size (boys)	22	225,731	51,111	141,846	307,552
Cohort size (girls)	22	209,730	54,683	96,259	291,816
Cohort size (urban areas)	22	79,495	18,036	45,624	111,448
Cohort size (rural areas)	22	355,966	89,464	180,234	500,213
Year of birth is auspicious for either boys or girls (1:yes,0:no)	22	0.636	0.492	0	1
Year of birth is auspicious for boys (1:yes,0:no)	22	0.500	0.512	0	1
Year of birth is auspicious for girls (1:yes,0:no)	22	0.273	0.456	0	1
Year of birth is auspicious for both boys and girls (1:yes,0:no)	22	0.136	0.351	0	1
Cross sectional data 1977-2000 (2000-2001 Vietnam National Health Survey)					
Individual-level characteristics					
Height (cm)	58,883	136.161	23.461	60.0	186.6
Height to age (z-score)	55,246	-1.710	1.057	-8.613	7.383
Gender (1:boy,0:girl)	61,586	0.531	0.499	0	1
Year of birth	61,586	1,988.720	5.785	1,977	2,000
Birth order	61,586	2.046	1.173	1	11
Year of birth is auspicious for either boys or girls (1:yes,0:no)	61,586	0.630	0.483	0	1
Year of birth is auspicious for boys (1:yes,0:no)	61,586	0.491	0.500	0	1
Year of birth is auspicious for girls (1:yes,0:no)	61,586	0.241	0.428	0	1
Year of birth is auspicious for both boys and girls (1:yes,0:no)	61,586	0.102	0.303	0	1
Household-level characteristics					
Number of siblings	26,549	2.443	1.222	1	11
Age of mother in 1997-1998	26,134	40.356	9.624	18	84
Mother's number of years of schooling	24,220	7.040	3.937	0	15
Age of father in 1997-1998	23,636	42.542	10.045	18	86
Father's number of years of schooling	22,719	7.813	3.788	0	15
Household lives in urban area (1:yes,0:no)	26,549	0.219	0.414	0	1
Ethnicity (1:Kinh or Chinese, 0:others)	26,549	0.773		0	1
Religion (1: Christian or Muslim;0:others)	26,549	0.197	0.398	0	1
Per capita expenditures ('000 VND)	26,507	3,811	4,358	199	389,507

Notes: statistical weights applied to observations from VNHS

Table 3, panel A: Fertility response to the Vietnamese horoscope (1977-1998)

	Dependent variable logarithm of birth cohort size						
	All				rural area	Christian or Muslim	non-Kinh and non-Chinese
Independent variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Year is auspicious for either boys or girls (1:yes,0:no)	0.111***				0.105***	0.087***	0.075*
	(0.035)				(0.038)	(0.032)	(0.042)
Year is auspicious for boys (1:yes,0:no)		0.056					
		(0.042)					
Year is auspicious for girls (1:yes,0:no)			0.033				
			(0.055)				
Year is auspicious for both boys and girls (1:yes,0:no)				-0.051			
				(0.069)			
Year	25.746***	26.164***	26.511***	25.948***	27.046***	19.819***	26.476***
	(2.324)	(2.408)	(2.506)	(2.707)	(2.517)	(2.175)	(2.737)
Year squared	-0.006***	-0.007***	-0.007***	-0.007***	-0.007***	-0.005***	-0.007***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Durbin Watson test of first-order serial correlation	1.863	2.125	1.956	2.082	1.871	2.053	2.157
Durbin test of second-order serial correlation (chi squared)	0.594	1.207	0.588	2.132	0.723	1.650	3.922
Durbin test of second-order serial correlation (P-value)	0.743	0.547	0.745	0.344	0.697	0.438	0.141
Number of observations	22	22	22	22	22	22	22
Adjusted R-squared	0.891	0.855	0.845	0.846	0.889	0.842	0.909

Note: Constant not reported. Robust standard errors in parentheses. The symbols *, **, and *** indicate that the coefficient is statistically significant at the 10, 5, and 1 percent level respectively.

Table 3, panel B: Gender-specific fertility response to the Vietnamese horoscope (1977-1998)

	Dependent variable: logarithm of birth cohort size							
	Boys	**Girls**	**Boys**	**Girls**	**Boys**	**Girls**	**Boys**	**Girls**
Independent variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Year is auspicious for either boys or girls (1:yes,0:no)	0.107***	0.117***						
	(0.033)	(0.042)						
Year is auspicious for boys (1:yes,0:no)			0.055	0.057				
			(0.039)	(0.047)				
Year is auspicious for girls (1:yes,0:no)					0.034	0.033		
					(0.053)	(0.062)		
Year is auspicious for both boys and girls (1:yes,0:no)							-0.040	-0.061
							(0.060)	(0.086)
Year	23.355***	28.641***	23.752***	29.086***	24.106***	29.438***	23.615***	28.800***
	(2.048)	(2.855)	(2.105)	(2.980)	(2.146)	(3.159)	(2.242)	(3.495)
Year squared	-0.006***	-0.007***	-0.006***	-0.007***	-0.006***	-0.007***	-0.006***	-0.007***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Test of difference in slopes boys/girls	-0.010		-0.002		0.002		0.020	
	(0.023)		(0.021)		(0.028)		(0.039)	
Number of observations	22	22	22	22	22	22	22	22
Adjusted R-squared	0.889	0.882	0.850	0.849	0.839	0.841	0.837	0.843

Note: Constant not reported. Robust standard errors in parentheses. The symbols *, **, and *** indicate that the coefficient is statistically significant at the 10, 5, and 1 percent level respectively. The test is constructed by regressing the logarithm of the sex ratio on the same set of independent variables and by taking the coefficient on the auspicious year dummy variable

Table 4: Astrology and human development outcomes

	Dependent variables:					
	Education (years)			Height to age (z-score)		
Independent variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Year of birth is auspicious (1:yes,0:no)	0.291**	0.242**	0.206***	-0.004	-0.017	0.009
	(0.130)	(0.115)	(0.018)	(0.039)	(0.041)	(0.014)
Gender (1:boy,0:girl)	-0.119***	-0.067***	-0.008	-0.075***	-0.052**	-0.050***
	(0.016)	(0.020)	(0.028)	(0.024)	(0.024)	(0.014)
Mother's age (years)		0.006***			-0.001	
		(0.001)			(0.002)	
Mother's education (years)		0.086***			0.029***	
		(0.017)			(0.006)	
Father's age (years)		0.007***			0.011***	
		(0.002)			(0.002)	
Father's education (years)		0.112***			-0.013*	
		(0.020)			(0.007)	
Ethnicity (1:Kinh, Chinese, 0:others)		0.323***			0.044**	
		(0.065)			(0.019)	
Religion (1:Christian or Muslims;0:others)		-0.112***			-0.019	
		(0.039)			(0.021)	
Household socio-economic status	no	yes	no	no	yes	no
Family size dummies	yes	yes	no	yes	yes	no
Family fixed-effects	no	no	yes	no	no	yes
Cluster	year of birth	year of birth	province	year of birth	year of birth	commune
Number of observations	7,026,416	5,461,074	7,026,416	55,246	43,795	55,246
Adjusted R2	0.596	0.701	0.782	0.051	0.120	0.712

Note: Standard errors in parentheses, clustered at the year-of-birth level (columns 1-2, 4-5), the province level (column 3) or the commune level (column 6). The symbols *, **, and *** indicate that the coefficient is statistically significant at the 10, 5, and 1 percent level respectively. All regressions include a constant, a quadratic time trend, a set of month of birth and birth order dummies. Socio-economic status is captured by assets (Census, columns 1-3) and per capita expenditure (Survey, columns 4-6)

Table 5: Cohort-size effects

	Dependent variable: Education (years)						
Independent variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Year of birth is auspicious (1:yes,0:no)	0.206***	0.176***	0.173***	0.215***			
	(0.018)	(0.019)	(0.037)	(0.051)			
Logarithm of commune-level birth cohort size		0.200			0.183		
		(0.131)			(0.138)		
Logarithm of district-level birth cohort size			0.216			0.178	
			(0.281)			(0.320)	
Logarithm of province-level birth cohort size				-0.057			-0.176
				(0.367)			(0.468)
Year of birth fixed-effects	no	no	no	no	yes	yes	yes
Number of observations	7,026,416	7,026,416	7,026,416	7,026,416	7,259,248	7,259,248	7,259,248
Adjusted R-squared	0.782	0.782	0.782	0.782	0.785	0.785	0.785

Note: Standard errors in parentheses, clustered at the province level. The symbols *, **, and *** indicate that the coefficient is statistically significant at the 10, 5, and 1 percent level respectively. All regressions include a constant, a quadratic time trend, family fixed-effects, a gender dummy, and a set of month of birth and birth order dummy variables.

Table 6: Ability versus birth timeliness

	Dependent variable: Education (years)				
	Full sample		Auspicious year cohorts		"Unlucky" child sample
Independent variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
Child is born lucky (1:yes;0:no)	0.043***	-0.149***	-0.211***	-0.408***	
	(0.009)	(0.006)	(0.014)	(0.029)	
Interaction Gender * Child is born lucky				0.434***	
				(0.045)	
Year of birth is auspicious (1:yes,0:no)		0.292***			0.230***
		(0.020)			(0.022)
All siblings are born in auspicious year (1:yes,0:no)					
Gender (1:boy;0:girl)	-0.020	0.030	0.102**	-0.166***	-0.103***
	(0.029)	(0.029)	(0.041)	(0.029)	(0.024)
Family fixed-effects	yes	yes	yes	yes	yes
Cluster	province	province	province	province	province
Number of observations	7,026,416	7,026,416	4,582,366	4,582,366	4,221,978
Adjusted R2	0.780	0.782	0.793	0.793	0.771

Note: Robust standard errors in parentheses, clustered at the province-level. The symbols *, **, and *** indicate that the coefficient is statistically significant at the 10, 5, and 1 percent level respectively. Regressions 1 to 5 include a constant, a quadratic time trend, a set of birth order dummies, and month of birth dummies and family fixed-effects. Columns 3-4 restrict to years that are inauspicious to both boys and girls. Column 5 restrict to boys born in years inauspicious for boys and girls born in years inauspicious for girls.

Table 7: Heterogeneity in response to the horoscope

	Dependent variable: Education (years)						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Main effect							
Year of birth is auspicious for either boys or girls (1:yes,0:no)	0.122***	0.314***	-0.073*	0.386***	-0.118**	0.341***	-0.039
	(0.022)	(0.025)	(0.038)	(0.030)	(0.051)	(0.055)	(0.073)
Interaction of auspicious year dummy variable with:							
Gender (1:boy,0:girl)	0.062***	0.049***	0.058***	0.049***	0.058***	0.048***	0.058***
	(0.012)	(0.011)	(0.012)	(0.011)	(0.012)	(0.011)	(0.012)
Birth order	0.022***	0.078***	0.088***	0.077***	0.088***	0.079***	0.088***
	(0.005)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Number of siblings		-0.082***	-0.064***	-0.081***	-0.064***	-0.083***	-0.063***
		(0.007)	(0.006)	(0.007)	(0.006)	(0.008)	(0.007)
Mother's education (years of schooling)			0.019***		0.019***		0.018***
			(0.003)		(0.003)		(0.003)
Father's education (years of schooling)			0.023***		0.023***		0.023***
			(0.002)		(0.002)		(0.002)
Household lives in permanent or semi-permanent home (1:yes,0:no)			0.047***		0.045***		0.053***
			(0.016)		(0.016)		(0.015)
Household has running water (1:yes,0:no)			-0.024		-0.022		-0.006
			(0.018)		(0.018)		(0.017)
Household has electricity (1:yes,0:no)			-0.010		-0.007		0.000
			(0.015)		(0.015)		(0.015)
Household has flush toilet (1:yes,0:no)			0.041**		0.056***		0.060***
			(0.019)		(0.016)		(0.017)
Household has a TV (1:yes,0:no)			-0.005		-0.004		0.004
			(0.010)		(0.010)		(0.010)
Household has a radio (1:yes,0:no)			0.000		-0.000		-0.005
			(0.008)		(0.008)		(0.007)
Household lives in an urban area (1:yes,0:no)				-0.041**	0.031***		0.030**
				(0.017)	(0.012)		(0.012)
Ethnicity (1:Kinh or Chinese;0:other)						-0.072**	-0.113***
						(0.029)	(0.025)
Religion (1:Christian or Muslim;0:other)						0.043	0.027
						(0.048)	(0.033)
Number of observations	7,026,416	7,026,416	5,482,348	7,026,416	5,482,348	7,026,416	5,482,348
Adjusted R2	0.782	0.782	0.785	0.782	0.785	0.782	0.785

Note: Robust standard errors in parentheses clustered at the province level. The symbols *, **, and *** indicate that the coefficient is statistically significant at the 10, 5, and 1 percent level respectively. All regressions include a constant, a quadratic time trend, a set of birth order dummies, month of birth dummies, and family fixed-effects.

Appendix Table A1: the Vietnamese horoscope cycle

	Canh		Tan		Nham		Quy		Giap		At		Binh		Dinh		Mau		Ky	
	Boy	Girl	Boy	Girl	Boy	Girl	Boy	Girl	Boy	Girl	Boy	Girl	Boy	Girl	Boy	Girl	Boy	Girl	Boy	Girl
Ty	Bad	Neutral			Neutral	Bad			Good	Bad			Neutral	Neutral			Neutral	Good		
Suu			Neutral	Neutral			Neutral	Bad			Bad	Bad			Good	Bad			Bad	Neutral
Dan	Neutral	Bad			Good	Bad			Good	Neutral			Neutral	Bad			Neutral	Bad		
Mao			Good	Neutral			Neutral	Bad			Bad	Neutral			Good	Bad			Neutral	Good
Thin	Neutral	Bad			Good	Neutral			Good	Neutral			Neutral	Bad			Neutral	Neutral		
Ty			Bad	Neutral			Neutral	Bad			Neutral	Neutral			Neutral	Bad			Bad	Neutral
Ngo	Neutral	Good			Good	Bad			Good	Neutral			Neutral	Good			Good	Good		
Mui			Good	Good			Good	Good			Good	Good			Good	Neutral			Good	Good
Than	Bad	Bad			Good	Bad			Neutral	Bad			Bad	Bad			Bad	Bad		
Dau			Neutral	Good			Good	Bad			Bad	Neutral			Good	Bad			Bad	Neutral
Tuat	Neutral	Neutral			Good	Bad			Good	Neutral			Neutral	Bad			Bad	Good		
Hoi			Good	Good			Good	Good			Neutral	Good			Good	Neutral			Good	Good

Data Source: *Lich Van Nien* (Nha Xuat Ban Dan Toc Publishing house, 1999)

Appendix Table A2: Fertility response to the horoscope

	Dependent variable logarithm of birth cohort size					
	All		1977-1994			
Independent variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Year of the Goat or Year of the Pig (1:yes,0:no)	0.039					
	(0.064)					
Year of the Snake (1:yes,0:no)		-0.091**				
		(0.038)				
Year is auspicious for either boys or girls (1:yes,0:no)			0.148***			
			(0.029)			
Year is auspicious for boys (1:yes,0:no)				0.101**		
				(0.045)		
Year is auspicious for girls (1:yes,0:no)					0.016	
					(0.061)	
Year is auspicious for both boys and girls (1:yes,0:no)						-0.041
						(0.070)
Year	26.336***	25.927***	31.143***	30.941***	29.095***	28.126***
	(2.460)	(2.240)	(1.984)	(2.092)	(3.514)	(3.986)
Year squared	-0.007***	-0.007***	-0.008***	-0.008***	-0.007***	-0.007***
	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)
Number of observations	22	22	18	18	18	18
Adjusted R-squared	0.845	0.853	0.917	0.869	0.821	0.824

Note: Constant not reported. Robust standard errors in parentheses. The symbols *, **, and *** indicate that the coefficient is statistically significant at the 10, 5, and 1 percent level respectively.