Superstition, Fertility, and Interethnic Spillovers: Evidence from Peninsular Malaysia

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I. Introduction

Standard economic models of the family developed by Becker and Lewis (1973), among others, suggest that fertility decisions are influenced by economic factors that affect parents' and their children's well-being. Recent literature shows that parents also adjust their conception timing in response to anticipated variation in child outcomes induced by seasonal patterns of child mortality or religious calendars (Artadi 2005; Karimova 2015). Similarly, in this paper we document a strong correlation between fertility and superstition, focusing on a short-term change in fertility preferences induced by the Chinese lunar calendar among the Chinese ethnic diaspora in Malaysia. This superstitious belief has been shown to affect Chinese fertility across many countries (Goodkind 1991, 1993, 1995), and it affects children's as well as parents' later-life outcomes among Chinese families (Vere 2008; Do and Phung 2010; Johnson and Nye 2011).

In an ethnically diverse country such as Malaysia, however, this raises several important questions: (1) Do non-Chinese parents change their fertility in response to Chinese superstition? (2) Does this superstition affect economic outcomes among non-Chinese? (3) What economic mechanisms, if any, underlie these interethnic spillovers? (4) What role can the state play in mitigating these spillovers?

Social interactions within and across groups have been shown to affect fertility decisions through conformity to social norms and social influence on

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preferences (Fernández and Fogli 2006; Munshi and Myaux 2006). At the same time, sharp positive discontinuities in Chinese fertility may put pressure on public health and education resources. This pressure may raise the costs of childbearing and child investments for parents and affect a range of later-life economic outcomes for the exposed cohort (Welch 1979; Bound and Turner 2007; Saavedra 2012; Agarwal et al. 2017). Hence, non-Chinese parents may make an economic decision to not give birth during these years.[1] In this context, the impacts of such demographic pressures can be mediated by the state by determining the level of public investments and deciding how these resources are targeted.

We focus on the increase in Chinese births that occur in the lunar Year of the Dragon, believed to be an auspicious year of birth by Chinese in Malaysia. Malays, on the other hand, do not adhere to this belief. This makes it an ideal case to study the interethnic spillover effects of Chinese culture on Malay fertility and on the well-being of Malays born in dragon years. If such spillovers are partly due to economic factors, such as increased costs of childbearing during dragon years, we hypothesize that such costs should rise most in areas where pressure on public resources is greatest—such as areas with higher Chinese concentration or fewer resources—and that the propagation of targeted government policies that protect Malays against increased competition from Chinese can help mitigate the rising costs.[2]

Examining these interethnic spillovers can therefore help to better understand the nature of the ethnic interactions in societies with diverse populations that share common economic resources, as well as the role of the state in defining the level of competition between them. In Malaysia, the Malay ethnic group comprises the majority of this region's population (65%), while ethnic Chinese, who represent the largest minority, make up one-quarter of the population. This ethnic heterogeneity comes in part from the legacy of British

[1] Family economic models suggest that parental investment decisions reflect choosing investment to maximize a household utility function based on consumption and some measure of child well-being. Parental investment, along with initial endowments and public expenditures, determine children's economic outcomes (Becker and Tomes 1986; Cunha and Heckman 2007; Almond and Mazumder 2013). Moreover, such investment decisions can be affected by the availability of and substitutability between public and private resources. Fertility timing, which determines both private and public resources available for children as well as the returns to these investments, is therefore one of the first decisions parents may make to maximize their children's expected well-being. For general summaries of parents' investment decisions in children's health and education, see Glewwe and Miguel (2007).

[2] If Malays and Chinese workers are substitutes in the labor market, increased cohort sizes may also reduce the long-run labor market return to investments in health and education. Additionally, state policies that impose employment quotas for Malays in the public sector can reduce labor market competition between Chinese and Malays that can help to dampen the negative effects of a larger Chinese cohort on the labor market returns to investments for Malays.

colonial rule, under which there was a substantial flow of Chinese immigrants into Malaysia along with explicit economic segregation across ethnic lines. Since independence, the Malaysian government has made concerted policy efforts to allocate resources to aid the Malay population, which was historically disadvantaged relative to the Chinese, through ethnic-based quotas in higher education and public employment, along with preferential treatment for Malays in access to credit and ownership of business assets (Faaland, Parkinson, and Saniman 2003).

Using newly digitized district-level data that span two decades (1970–90) from the Malaysian *Vital Statistics*, we find that birth rates among ethnically Chinese Malaysians rose by 14.3% in dragon years (1976 and 1988). In contrast, ethnic Malays reduced their fertility by 1.9% in dragon years. This lunar year shock led to a net 3.1% increase in size and a 9.0% change in ethnic composition of each dragon year cohort.

The negative Malay fertility response was larger in Chinese-majority areas and in areas with relatively fewer public resources and investment, and it was smaller in areas that benefited from the implementation of the New Economic Plan (NEP) that favored Malays. These results suggest that economic factors such as the increased burden on resources brought on by the larger Chinese cohort were important drivers of the fertility spillovers we observe, and government policies that influence the access to these resources affect the scale of the Malay fertility response.

We also find a decrease in birth weights among Malay children born in dragon years and worse student test scores later in their lives. Both health and education effects highlight the economic impacts of Chinese cultural norms on Malays, insofar as early health and human capital have been shown to affect later-life outcomes, such as labor earnings (Behrman and Rosenzweig 2004; Black, Devereux, and Salvanes 2007). Moreover, the spatial heterogeneity in health effects that shows larger negative effects in regions with low resources and higher Chinese concentrations is consistent with an increased strain on health resources because of dragon years. We also find an overall increase in the student-teacher ratio for dragon cohorts entering primary school. Interestingly, we observe these negative health and education effects despite individual-level responses by Malay parents to lower fertility in dragon years, which likely lessened the demographic burden on resources. At the same time, state-level allocation of resources through programs such as the NEP may have also helped mitigate some of the negative effects on Malays.

Our results contribute to several strands of literature. Ethnic heterogeneity, both across and within countries, is often associated with lower levels of public goods provision (Alesina, Baqir, and Easterly 1999; Banerjee, Iyer, and Somanathan

2005), higher levels of political corruption and conflict (Padró i Miquel 2007; Esteban, Mayoral, and Ray 2012), and worse economic performance (Alesina and La Ferrara 2005). This heterogeneity can encourage citizens to sort into their respective group, first suggested by Tiebout (1956) as a solution, at least in theory, to the collective action failure and the heterogeneous preference problem associated with ethnic diversity. Many empirical studies have found evidence of self-segregation, mostly in terms of residential location and school choices, following increased interethnic interaction.[3] The impacts of segregation, however, have mostly been negative (Boeri et al. 2015; Douglas, Chay, and Greenstone, forthcoming),[4] and in particular, segregation has been shown to worsen ethnic inequality in education and health care (Card and Rothstein 2007; Rahman and Foster 2015). In Malaysia, we find evidence of self-sorting across birth cohorts through differential changes in annual birth rates between Malays and Chinese across the Chinese lunar calendar. This sorting occurred, in some part, because of Malay response to increased cost of childbearing, which may have also helped to lessen the negative impact of short-term fertility spikes due to Chinese adherence to their cultural norm.

Our results also relate to a large literature on the economics of fertility decisions (Becker and Lewis 1973; Becker 1991). Just as families may weigh quantity-quality trade-offs to maximize the expected returns to childbearing, they may also aim to optimize the timing of their fertility decisions. Researchers have observed small movements in fertility timing in response to monetary incentives and tax benefits (e.g., Dickert-Conlin and Chandra 1999; Gans and Leigh 2009; LaLumia, Sallee, and Turner 2015) and school-entry age criteria (Deming and Dynarski 2008). The evidence around fertility timing at the point of conception is more limited, and it includes research regarding tax incentives and public policies (Kureishi and Wakabayashi 2008; Lichtman-Sadot 2014), seasonal labor market returns (Artadi 2005), and religious practices (Karimova 2015). Our paper finds that demographic pressures can also influence fertility timing at the point of conception, as families strategically avoid giving birth in years in

[3] Baum-Snow and Lutz (2011) find an increase in ethnic resorting of households, with whites moving out of inner cities and a decline in white public school enrollment following school desegregation in the United States. Using census track data from 1970 to 2000, Card, Mas, and Rothstein (2008) find that white migration in most US cities exhibits tipping-like behavior, with the distribution of tipping points ranging from a 5% to a 20% minority share. Fairlie and Resch (2002) find strong evidence of "white flight" from public to private schools in areas with larger concentrations of poor black children. Brunner, Imazeki, and Ross (2010) show that white households are more likely to support vouchers that expand school choices when their children attend schools with a larger minority concentration, suggesting their preference for ethnically segregated schools.

[4] On the other hand, Kerr and Mandorff (2015) find that sorting among immigrants can create a comparative advantage through occupational stratification.

which larger cohort sizes and a different ethnic composition place an additional burden on resources.

Last, a small body of literature uses superstition as a source of exogenous variation in fertility, which can affect sex ratios (Lee and Paik 2006), parents' investments in children (Do and Phung 2010), children's outcomes (Johnson and Nye 2011; Lau 2019), and parents' outcomes (Vere 2008) in the Chinese diaspora across different countries. To our knowledge, this is the first paper that examines the spillover effects of these fertility responses onto members of non-Chinese groups.

II. Background

A. Ethnic Heterogeneity in Malaysia

Malaysia is an ethnically diverse country. Two-thirds of the population is *bumiputera* ("sons of the soil"), which includes the Malay ethnic group along with smaller non-Malay indigenous groups.[5] Chinese form the largest minority group, making up nearly 25% of the population, and the remainder are Indian or members of other ethnic groups (Department of Statistics Malaysia 2015).

The present-day ethnic heterogeneity in part reflects the heritage of British colonial rule in Malaysia. Under British rule, the government allowed large-scale Chinese immigration into Malaysia to ensure a continuous supply of labor to the booming tin mines that drove trade in the Straits Settlements (Blythe 1947; Purcell 1948). Areas with large Chinese settlements eventually became important urban centers, and many became state capitals as well (Wong 1965). Apart from its impact on ethnic composition, the policy also meant that ethnic identity played a crucial role in determining where individuals lived and what jobs they held. By 1957, the year Malaysia obtained independence, the Chinese were slightly wealthier, working as merchants and traders and living primarily in urban areas, while the majority Malay population was poorer, more rural, and working primarily in agriculture (Department of Statistics Malaysia 1958, 1959).

After independence, Malays were afforded explicit protections in the new constitution in exchange for citizenship for Chinese and Indian residents. The NEP—introduced after the race riots in Kuala Lumpur in 1969—set out explicit aims to (1) "eradicate poverty irrespective of race" and (2) "restructure society to abolish the identification of race with economic function" (Government of Malaysia 1971). In practice, the NEP aimed to redress the economic position of the Malays relative to the non-Malays, and it became the central aspect of the government's development agenda under four successive 5-year

[5] We refer to all of the ethnic groups (Malays and non-Malay indigenous groups) classified as bumiputera as "Malays." In Peninsular Malaysia, the Malay ethnic group accounts for 98.5% of bumiputera.

TABLE 1

CHARACTERISTICS OF MALAY AND CHINESE ETHNIC GROUPS, 1970 AND 1991 CENSUSES

	Malay		Chinese	
	1970 (1)	1991 (2)	1970 (3)	1991 (4)
	A. Characteristics of Population			
Total population (in thousands)	4,681	8,119	3,126	3,962
Share of population (%)	53.2	58.9	35.5	28.7
	B. Characteristics of Working-Age Group (%), Ages 15–54			
Primary education	42.1	83.0	48.6	82.5
Secondary education	4.1	36.2	8.0	26.0
Tertiary education	.5	7.0	1.2	6.5
Employment rate	56.4	57.8	57.2	61.2
Employed in high-skill occupation	4.6	11.9	8.7	15.7
Employed in modern sector	12.6	41.8	45.3	67.6
	C. Household Characteristics			
Urban residence (%)	20.5	46.7	71.9	85.7
Household size	4.6	4.8	4.9	4.7
Number of children	2.1	2.0	2.1	1.4
Female household head	19.3	17.9	23.7	20.2
Age of household head	41.8	43.8	43.7	46.8
Household wealth index	.3	.5	.4	.7
Modern cooking fuel (%)	21.1		27.6	

Note. The sample includes Peninsular Malaysia, and it also includes noncitizens in 1970 but not in 1991. "High-skill occupations" are managers, professionals, technicians, and associate professionals, as defined by major groups 1–3 of the International Standard Classification of Occupations 1988. "Modern sectors" are manufacturing, mining, commerce, and construction, which were explicitly targeted by the New Economic Plan to increase Malay participation. "Household wealth index" is the equally weighted mean of five indicator variables for whether the household owns any refrigerators, automobiles, phones, televisions, and radios. "Modern cooking fuels" are electricity, gas, or kerosene, as opposed to wood or charcoal.

Malaysia Plans from 1971 to 1990 (Faaland, Parkinson, and Saniman 2003). The NEP introduced quotas in higher education and public employment for Malays, set targets for Malay ownership share of private equities, and encouraged Malay employment in modern sectors such as manufacturing, mining, commerce, and construction, which were identified as initially having low Malay participation (Government of Malaysia 1976; Means 1986; Guan 2005).

Table 1 shows the large gaps in socioeconomic characteristics between Malays and Chinese in 1970 and the relative convergence by 1991, using the respective waves of the Malaysian census. In 1970, only 4.1% of working-age Malays (ages 15–54) had completed secondary education, compared with 8.0% of Chinese. Similarly, 4.6% of working-age Malays were employed in high-skill occupations,[6] compared with 8.7% of working-age Chinese.

[6] High-skill occupations are managers, professionals, technicians, and associate professionals, as defined by major groups 1–3 of the International Standard Classification of Occupations 1988.

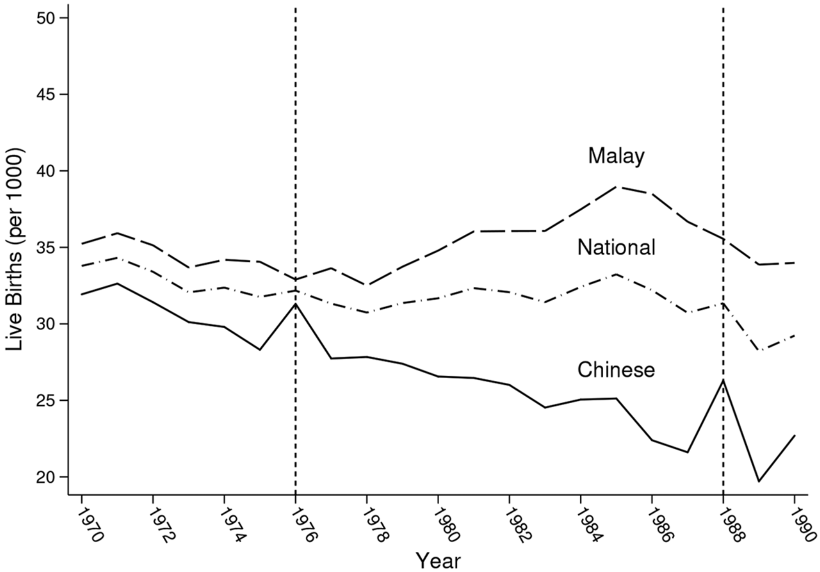

Figure 1. Annual birth rates by ethnicity, 1970–90. Birth rates are calculated by dividing the total number of live births by the estimated year × ethnicity population, calculated based on a linear interpolation of ethnicity population using the 1970, 1980, and 1991 Malaysia censuses. Dragon years (1976 and 1988) are indicated by a dotted line.

By 1990, however, these interethnic differences had been either significantly reduced or eliminated, and for education they were reversed. The secondary-school completion rate in 1990 was 38.8% for Malays and 29.0% for Chinese. Among working-age Malays, the rate of employment in high-skill occupations increased to 11.9% (a 158% increase), compared with 15.7% for Chinese (an 80% increase).

B. Chinese Zodiac Calendar

The Chinese astrological system ascribes personal characteristics and destinies to a person's date of birth. Among its best-known aspects is the zodiac years, through which a person's birth year is associated with an animal; these rotate on a 12-year lunar calendar cycle. Dragon years (1964, 1976, 1988, 2000, 2012, etc.) are considered to be particularly auspicious years in which to be born (Goodkind 1991).

Researchers have documented large fertility shocks during dragon years across the Chinese diaspora, beginning in the mid-1970s (see Goodkind 1991, 1993, 1995).[7] Figure 1 plots the annual birth rates in Malaysia between

[7] Before 2000, birth shocks associated with the Chinese zodiac calendar had not been noted in mainland China, due, at least in part, to the one-child policy implemented throughout most of this period (from 1979 onward; Goodkind 1991).

1970 and 1990 and covers nearly two full cycles of the Chinese zodiac calendar. Chinese birth rates spiked in 1976 and 1988, in line with the Chinese zodiac year of the dragon. During the two dragon years, Chinese birth rates increased by 10.6% and 21.7%, respectively, relative to the birth rates in the previous year.

These Chinese birth patterns have not escaped the notice of the public. Numerous media reports highlight shocks to birth rates during dragon years, and, anecdotally, these shocks are believed to put additional constraints on resources. For instance, the Malaysian newspaper *The Star* published an article in January 2012 (the start of the dragon year), in which a student recalled that "school had to increase class size for the 1988 dragon baby boom," and relatives of children born in 1988 remembered "many hospitals being fully booked that year" (Lee 2012). Similarly, Goodkind (1991) cites Taiwanese newspaper articles before the 1988 dragon year that claimed that the 1976 boom led to higher maternal mortality because of increased pressure on health services and that the 1976 cohort faced overcrowded classrooms as a result of the boom.

III. Data

Our data come from multiple sources. We hand-enter and compile district-level birth and under-1 mortality records from the Peninsular Malaysian *Vital Statistics*. The *Vital Statistics* volumes provide information on the total number of live births, stillbirths, and infant deaths by district, year, and ethnicity as well as by state, month, and ethnicity from 1970 to 1990.[8] We also add *Vital Statistics* records on the share of newborns with very low birth weights (less than 1.5 kg) by state, ethnicity, and year, although these are available only from 1983 to 1990.

We focus on the 1970–90 period for two reasons. First, previous research finds no evidence of zodiac-based fertility decisions before 1970 in the Chinese diaspora, in part because of limited access to contraception (Sun, Lin, and Freedman 1978; Goodkind 1993, 1995). Second, district-level birth records by ethnicity are not available after 1990. We calculate birth rates by dividing the total number of births by the estimated population of each district × year × ethnicity cell, calculated by linearly interpolating district populations using the

[8] We exclude the states of Sabah and Sarawak and the federal territory of Labuan, all in East Malaysia. The *Vital Statistics* records for East Malaysia were reported separately, and our data are incomplete. Peninsular Malaysia includes 80% of the population of Malaysia. Moreover, East Malaysia is located more than 600 km away from the Malay Peninsula on the island of Borneo, is sparsely populated, and has a very different demographic structure compared with the rest of Malaysia, as more than half of its residents are members of one of several small indigenous tribes (non-Malay bumiputera).

TABLE 2

SUMMARY STATISTICS OF *VITAL STATISTICS* AND *SOCIAL STATISTICS BULLETIN*, 1970–90

	National (1)	Malay (2)	Chinese (3)
Mean birth rate	31.8	35.2	26.9
Mean cohort size	350,727	219,302	96,030
Mean share of cohort (%)	100.0	62.0	27.8
Mean under-1 mortality rate	40.3	45.9	25.4
Very low birth weight rate	4.8	4.9	3.6
Mean number of students enrolled in first grade	30,262		
Mean number of primary school teachers	7,475		
Mean student-teacher ratio	4:1		
Mean share of students who passed:[a]			
All five subjects (%)	18.4		
At least four subjects (%)	52.8		
At least three subjects (%)	72.2		

Note. The sample includes Peninsular Malaysia only. National statistics in col. 1 include all Malaysian nationals, including those who do not belong to the Malay and Chinese ethnic groups. "Under-1 mortality rate" is the sum of stillbirths and infant deaths divided by 1,000 live births. "Very low birth weight" is the number of children born weighing less than 1.5 kg divided by 1,000 live births. Education variables are based on unweighted averages by state from 1977 to 1996.

[a] Sijil Tinggi Persekolahan Malaysia (or Malaysian Higher School Certificate) is a preuniversity national examination taken by students in Malaysia, which is equivalent to completing a high school degree.

integrated public-use microdata samples (IPUMS) of the 1970, 1980, and 1991 Malaysian censuses (Minnesota Population Center 2015).[9]

Table 2 presents peninsular-level means from the *Vital Statistics* in column 1, and columns 2 and 3 show these means separately for Malay and Chinese ethnic groups, respectively. Between 1970 and 1990, the average birth rate among Malays was 35.2 births per thousand, about 30% higher than the average Chinese birth rate of 26.9. Malay newborns made up 62.0% of the birth cohort each year, on average, while 27.8% of newborns were Chinese. The stillbirth and infant death rates were also higher for Malays compared with Chinese. The under-1 mortality rate (the sum of stillbirth and infant death rates) was 45.9 deaths per thousand live births for Malays and 25.4 deaths per thousand live births for Chinese. On average, 4.8 newborns per thousand weighed less than 1.5 kg at birth, and this rate is slightly higher for Malays than for Chinese.

We obtain administrative data on education from the *Social Statistics Bulletin*. These annual records are available by state but not by ethnicity. They include information on the total number of students enrolled in grade 1 and the total number of primary school teachers from 1977 to 1996, which covers the

[9] The boundaries of some districts have changed over this period, mostly because of districts splitting into two or more districts. We merge districts that have split during the 1970–90 period to create a set of adjusted districts that are constant over time, so that the adjusted districts closely match the district boundaries in 1970. For a detailed description of which districts were merged, see table A1 (tables A1–A10 are available online).

period during which the 1970–89 birth cohorts were expected to enter primary school, as well as the preuniversity national exam (Sijil Tinggi Persekolahan Malaysia [STPM]) results for the 1974–90 birth cohorts.[10] Peninsular-level means of these education variables are reported in table 2. On average, 30,262 new students enroll in grade 1 each year, with 7,475 primary teachers available in each state: the ratio of students to all teachers is 4 : 1. The share of students in the preuniversity national exam who passed all five subjects was 18.4%, whereas 52.8% of them passed at least four out of five subjects, and 72.2% passed at least three subjects.

We obtain regional data on ethnic heterogeneity, resources, and public expenditures from several sources. We use the 1970 census to construct district-level measures of Chinese concentration, average household wealth, the fraction of households using modern fuel for cooking, per capita teachers, per capita health workers, and the fraction of working-age individuals employed in modern sectors. The state-level total social development expenditure between 1976 and 1985, which includes all NEP-related education and health programs during this period, is obtained from the midterm reviews of the Third and Fourth Malaysia Plans (Government of Malaysia 1979, 1984). Table A2 contains the definition of each measure and its source. Figure 2 shows the regional distribution of these measures.

Figure 2*a* presents the spatial distribution of the Chinese population in Malaysia. The median district in Malaysia is 31% Chinese (restricting to only Chinese and Malays, ranging from 0.8% to 80%), and in 16 out of 64 districts, Chinese residents outnumber Malay residents (we refer to these as "Chinese-majority" districts). Figure 2*b* shows district-level variation in the resource index, which we calculate by normalizing an equally weighted mean of the standardized distributions of four resource measures: household wealth, use of modern fuel, teachers per capita, and health workers per capita. The spatial correlation between Chinese concentration and the resource index is positive and large (0.67).

[10] The STPM (Malaysian Higher School Certificate) examination is roughly equivalent to the British A-levels; it is a national exam that serves as one of three major pathways to tertiary education in Malaysia. This exam is administered to students completing a 2-year STPM program (also known as Form 6). Alternatively, students may instead complete a 1–2-year matriculation program (90% of matriculation slots are reserved for Malays), or students may proceed to vocational/technical education directly. We identify dragon cohorts on the basis of the predicted year of school entry and exam-taking. Students start grade 1 after reaching the age of 6 (Ministry of Education Malaysia 2020), and a typical student who completes 2 years of Form 6 would complete 13 years of schooling before taking the STPM. The missing data on examination results for earlier birth cohorts (1970–73) is due to a different reporting scheme used in the *Social Statistics Bulletin* in earlier years.

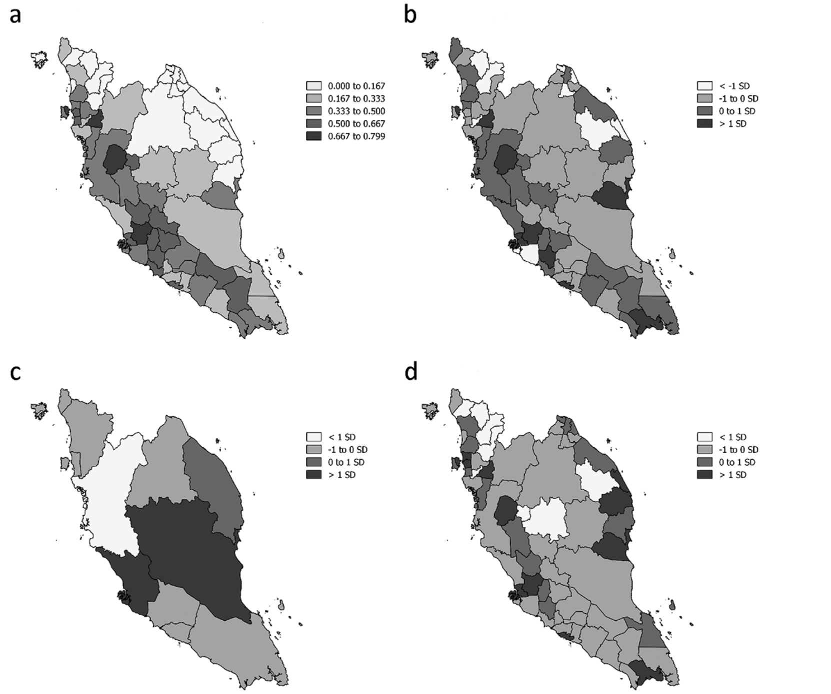

Figure 2. Regional distribution of Chinese ethnicity, resources, and public expenditures. *a*, Chinese concentration, 1970. Mean: 0.327, median: 0.317, SD: 0.212. Chinese concentration is the Chinese share of the population of Chinese and Malays. Source: Malaysian census, 1970. *b*, Resource index, 1970. Mean: 0.000, median: −0.031, SD: 1.000. The resource index is an equally weighted sum of four standardized measures of resources. See table A2 (available online) for more details. Source: Malaysian census, 1970. *c*, Social development expenditure per capita, 1976–85. Mean: 0.878, median: 0.762, SD: 0.341. Social development expenditures are the revised amount of federal public development expenditures allocated to states. See table A2 for more details. Source: *Mid-Term Review of the Third Malaysia Plan*, *Mid-Term Review of the Fourth Malaysia Plan*. *d*, Modern sector intensity, 1970. Mean: 0.185, median: 0.150, SD: 0.115. Modern sector intensity is the share of employed individuals working in the manufacturing, mining, construction, or commerce sector. See table A2 for more details. Source: Malaysian census, 1970. A color version of this figure is available online.

Figure 2*c* and 2*d* show the state-level variation in social development expenditure and the district-level intensity of modern sector employment, respectively. In figure 2*d*, districts such as Kinta and Kuantan, which are historically productive tin mining districts in northeast and central Malaysia, show the highest intensity of modern sector jobs in 1970 (53% and 47%, respectively) and are therefore likely to benefit in later years from the NEP's focus on modern sector expansion.

IV. Empirical Strategy

To estimate the change in fertility in dragon years using the *Vital Statistics*, we estimate the following equation as our baseline specification:

$$\begin{aligned}\ln(\text{birth rate}_{e,dy}) = {} & \alpha + \beta\text{DragonYear}_y + \delta\text{DragonYear}_y \cdot \text{Chinese}_e \\ & + \gamma\text{Chinese}_e + \theta_1\text{Year7081}_y + \theta_2\text{Year7081}_y^2 \\ & + \theta_3\text{Year8290}_y + \theta_4\text{Year8290}_y^2 + f_d + \epsilon_{e,dy},\end{aligned} \tag{1}$$

where the outcome variable is the log of birth rate measured at the ethnicity-district-year (*e-d-y*) level.[11] DragonYear is a binary variable equal to one in 1976 and 1988. Chinese is a binary variable equal to one for Chinese-ethnicity cells. All specifications include quadratic year trends (one for 1970–81 and one for 1982–90 to allow for additional flexibility) and district-level fixed effects (f_d).[12]

Our estimated coefficients of interest are $\hat{\beta}$, the differential change in log birth rates in dragon years among Malays, and $\hat{\delta}$, the differential change in log birth rates in dragon years among Chinese relative to the change among Malays. The sum of the coefficients $\hat{\beta} + \hat{\delta}$ estimates the differential change in log birth rates in dragon years for the Chinese. We cluster our standard errors at the district level to allow for arbitrary correlations between years within districts.[13]

We add increased flexibility to our model by including additional controls in the baseline specification. First, we allow fertility patterns to evolve differently for Malay and Chinese ethnic groups by adding ethnicity-specific quadratic year trends. We add one set of trends for 1970–81 and a second set for 1982–90 to allow additional flexibility.[14] Second, we include ethnicity × district fixed effects and ethnicity × district quadratic year trends to control for ethnicity-specific fertility trends separately by district.

The main threat to the empirical strategy is that idiosyncratic calendar year shocks could be correlated with the two dragon years and bias our estimates. To address this concern, we exploit the difference between the calendar year and the Chinese zodiac year. The 1976 dragon year started on January 31, 1976, and ended on February 17, 1977, while the 1988 dragon year spanned February 17, 1988, to February 5, 1989. We use the state-month-ethnicity-level data and estimate the following equation:

[11] We exclude two district-ethnicity-year cells with zero births.

[12] We also add an indicator for post-1981 births to account for a change in definition from place of occurrence to place of residence.

[13] We also test the robustness of our estimates to two-way clustering by district and years. Although our estimates are less precise, the main results remain statistically significant.

[14] Table A5 shows that our specifications are robust to using a single quadratic trend.

$$\ln(\text{birth rate}_{e,sym}) = \alpha + \beta\text{DragonYear}_{ym} + \delta\text{DragonYear}_{ym} \cdot \text{Chinese}_e + \gamma\text{Chinese}_e + f_{e,s} + g_{e,m} + h_{e,y} + j_{sm} + k_{sy} + \epsilon_{e,sym}, \quad (2)$$

where DragonYear is a binary variable equal to one for months from February 1976 through January 1977 and for months from March 1988 through January 1989. In addition to ethnicity × state fixed effects ($f_{e,s}$), all specifications include ethnicity × month fixed effects ($g_{e,m}$) and state × month fixed effects (j_{sm}) to control for any region- or ethnicity-specific seasonality of birth. More importantly, we can now include ethnicity × year ($h_{e,y}$) and state × year fixed effects (k_{sy}). We also include state-ethnicity quadratic time trends in our base specification (omitted from eq. [2] for conciseness), and our most flexible specification includes ethnicity × state × year fixed effects.

V. Results

A. Estimation of Interethnic Fertility Spillovers

We estimate equation (1) to quantify the dragon year fertility response among both Chinese and Malay ethnic groups in columns 1–3 of table 3 using birth records from the *Vital Statistics*.[15] The results in column 1 suggest that Chinese birth rates rose by 12.9% (summing 0.139 and −0.010) in dragon years. The p-value of the F-test shows that the effect on Chinese fertility is statistically significant at the 1% level. The results are also robust to controlling for ethnicity-specific fertility trends (col. 2) and ethnicity × district-specific fertility trends (col. 3). In our most flexible specification (col. 3), we find that Chinese birth rates increased by 14.3% in dragon years. Based on the counterfactual birth rate predicted from 1970 to 1991 excluding dragon years, this implies that the two dragon years led to approximately 28,900 additional Chinese births.[16]

Table 3 also shows the effect of dragon years on Malay fertility. In contrast to the Chinese, Malays reduced their birth rates by 1.9% during dragon years (col. 3). This implies that there were around 8,500 fewer Malay newborns in the 1976 and 1988 dragon years combined, compared with the predicted

[15] Table A6 shows these results using birth rate in levels as the dependent variable instead of log birth rate.

[16] For comparison, Goodkind (1995) finds a 23% increase in births between 1987 and 1988. Our estimates are slightly lower because we pool the 1976 and 1988 dragon years, for which we find a 9.3% and a 19.0% increase among Chinese, respectively, and we control for district × ethnicity-specific time trends. In addition, we do not find evidence of gender differences in Chinese newborns in dragon years (see cols. 3 and 4 of table A3), which is not surprising given that dragon years are thought to be auspicious for both girls and boys (e.g., see Chia 1952).

TABLE 3
IMPACT OF CHINESE LUNAR CALENDAR ON BIRTH RATES

	Dependent Variable: Log(Birth Rate)				Dependent Variable: % Chinese Birth
	(1)	(2)	(3)	(4)	(5)
Dragon year	−.010**	−.019***	−.019***	.031***	.028***
	(.005)	(.005)	(.005)	(.007)	(.003)
Dragon year × Chinese	.139***	.162***	.162***		
	(.009)	(.009)	(.010)		
Level of observation	District-year-ethnicity	District-year-ethnicity	District-year-ethnicity	District-year	District-year
Controls:					
Region fixed effects, region trend	X	X	X	X	X
Ethnicity fixed effects	X	X	X		
Ethnicity trend		X	X		
Ethnicity × region fixed effects, ethnicity × region trend			X		
Observations	2,686	2,686	2,686	1,344	1,344
R^2	.741	.755	.972	.958	.998
Mean of dependent variable (in levels)	32.1	32.1	32.1	32.1	.31

Note. The sample includes 1970–90 Chinese and Malay births for 64 1970-adjusted districts. All fixed effects are interacted with quadratic time trends from 1970–81 and 1982–90, as well as a dummy for post-1981 births to account for a change in definition from place of occurrence to place of residence. All regressions are weighted by population. Means of the dependent variables are averaged nationally across time for the combined population of Malays and Chinese. Standard errors clustered at the district level are reported in parentheses.
** $p < .05$.
*** $p < .01$.

counterfactual Malay births, and this difference is statistically significant at the 1% level. In other words, for each additional Chinese newborn, Malays reduced their fertility by 0.30 births, suggesting the presence of large, negative, interethnic fertility spillovers in Malaysia.[17]

In table A3, we find evidence that these changes in fertility in part reflect a shift in births. In the year before dragon years, Chinese births fall by 5.4%, and in the year following, Chinese births fall by 7.8%. On the other hand, Malay births remain low in the year following the dragon years, suggesting that the

[17] Table A4 incorporates the Indian ethnic group in the analysis. The Indian ethnic group, which also falls outside the category of bumiputera, is the second-largest minority group in Malaysia, but it makes up only about 7% of the population. We first estimate a separate Indian response and then pool Malay and Indian births to estimate the dragon year fertility responses among Chinese and non-Chinese (which includes Malays and Indians). The results in table A4 on non-Chinese fertility response in dragon years are similar to the results in table 3; we see no fertility response among the Indian population, and pooling this group with Malays does not affect the overall results.

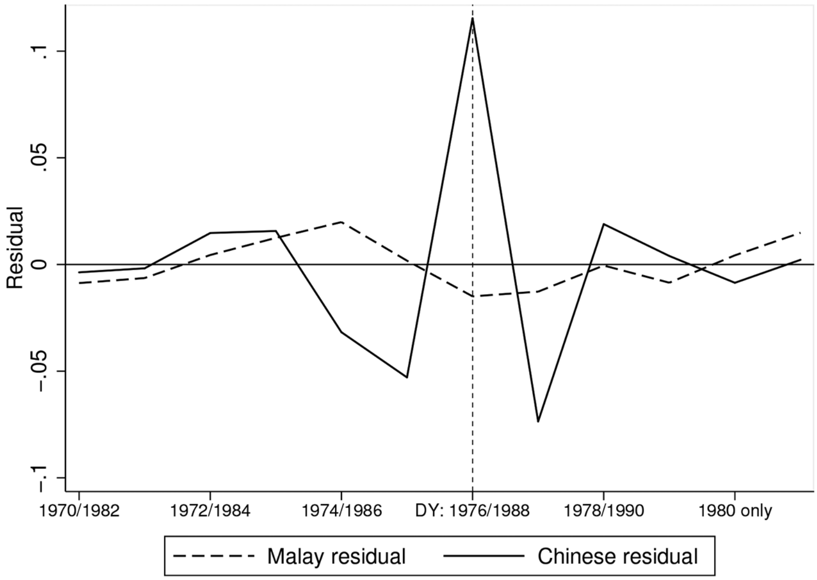

Figure 3. Averaged birth rate residuals by zodiac year, 1970–90. Each point represents population-weighted averages of district × ethnicity × zodiac year residuals calculated after predicting log birth rates using the region-ethnicity fixed effects and trends used in column 3 of table 3. The dragon years (1976 and 1988) are indicated by a dotted line.

dragon year effects on Malay fertility extend across multiple years. Figure 3 shows the estimated residualized birth rates by zodiac year for the Malay and Chinese populations. We calculate this by predicting log birth rates with the full set of fixed effects described in column 3 of table 3 and calculating the residuals. We plot the population-weighted average of these residuals separately by ethnicity across each zodiac year. We see sharp discontinuities in birth rates before and after the dragon years among the Chinese population. For the Malay population, the response is more spread out but centered around dragon years, reflecting that the perceived negative effects of a larger cohort can have spillovers into neighboring cohorts.

In table A3, we also quantify the dragon year fertility responses separately by male and female births in columns 3 and 4, respectively, and separately for 1976 and 1988 dragon years in column 5. For both Chinese and Malays, the fertility responses are almost identical across gender and not statistically significantly different between male and female births, suggesting no change in the gender composition of the dragon cohort. Additionally, the rise in Chinese fertility and the reduction in Malay births persist across both 1976 and 1988 dragon years, and differences in each individual year are statistically significant at the 10% and 1% levels, respectively.

These Chinese birth rate spikes and accompanying negative interethnic fertility spillovers onto Malays affect dragon cohorts in two ways: by changing the overall cohort size and by shifting the relative ethnic composition. Columns 4 and 5 of table 3 quantify these cohort size and composition effects, respectively. Overall, we find that there is around a 3.1% increase in birth rates, which implies a net increase of 20,100 newborns in dragon cohorts. The dragon cohort also has a Chinese concentration that is 2.8 percentage points higher, a 9.0% change in ethnic composition relative to the mean Chinese share (31%). Both estimates are statistically significant at the 1% level.

B. Robustness Checks

Our main results show a positive fertility spike among Chinese and a negative response among Malays in dragon years. However, these estimates could be confounded by ethnicity-specific calendar year shocks that are spuriously correlated with the Chinese lunar calendar. We test the robustness of our results in three different ways.

First, we use state × month fertility data from the *Vital Statistics* to estimate equation (2). Since the Chinese lunar year is not perfectly aligned with the calendar year, it allows us to include calendar year fixed effects and estimate the dragon year effects by comparing dragon and nondragon months within the same calendar year. We report these results in columns 1 and 2 of table 4. The results in column 2, which include ethnicity × state × year fixed effects, confirm that there was a large, statistically significant fertility response among both the Chinese and the Malay populations. Chinese birth rates increased by 17.0% and Malay birth rates declined by 1.0% in dragon years. The two estimates are statistically significant at the 1% and 5% levels, respectively.[18]

Second, we estimate the fertility responses from Malay and Chinese ethnic groups in tiger years (1974 and 1986) alongside their responses in dragon years. According to the Chinese zodiac calendar, the tiger year is considered an inauspicious year for birth, particularly for girls (Goodkind 1991). Therefore, we hypothesize a reduction in Chinese births and a corresponding rise in Malay births. Column 3 of table 4 includes a tiger year and tiger year × ethnicity fixed effect. Indeed, we see a decrease in Chinese birth rates and an increase in Malay birth rates, although the total change in Chinese birth rates is

[18] Because we achieve identification based on the margins, timing makes it likely that we underestimate the magnitude of the negative Malay response. Indeed, we see that the coefficient in table 4 (−1.0%) is roughly half of the −1.9% estimate in table 3. This difference could also reflect heterogeneous responses across the lunar year. For example, if the Chinese response is bell shaped to minimize the chance of "missing" the dragon year, Malay responses may also be inversely bell shaped if families sought to avoid giving birth during peak times.

TABLE 4

IMPACT OF CHINESE LUNAR CALENDAR ON BIRTH RATES, ROBUSTNESS CHECKS

	(1)	(2)	(3)	(4)
Dragon year	−.010**	−.010**	−.014***	−.015**
	(.004)	(.004)	(.005)	(.006)
Dragon year × Chinese	.180***	.180***	.155***	.158***
	(.014)	(.013)	(.009)	(.009)
Tiger year			.022***	
			(.004)	
Tiger year × Chinese			−.032***	
			(.008)	
Dragon year × Chinese majority				−.016
				(.010)
Dragon year × Chinese × Chinese majority				.017
				(.019)
p-value of *F*-test:				
Dragon year + dragon year × Chinese	.000***	.000***	.000***	.000***
Tiger year + tiger year × Chinese			.123	
Dragon year + dragon year × Chinese majority				.000***
Level of observation	State-month-ethnicity	State-month-ethnicity	District-year-ethnicity	District-year-ethnicity
Controls:				
Ethnicity × region fixed effects, ethnicity × region trend	X	X	X	X
Ethnicity × month fixed effects, region × month fixed effects	X	X		
Ethnicity × year fixed effects, region × year fixed effects	X	X		
Ethnicity × region × year fixed effects		X		
Observations	5,126	5,126	2,686	2,686
R^2	.921	.923	.972	.972
Mean of dependent variable (in levels)	2.67	2.67	32.1	32.1

Note. The dependent variable is log (birth rate). State-month-ethnicity observations start from August 1970, the 1970 census enumeration month. For cols. 1 and 2, the dragon year dummy is assigned to months that are completely within the dragon year, which are February 1976–January 1977 and March 1988–January 1989. All specifications include fully interacted region-ethnicity fixed effects and trends, as used in col. 3 of table 3. All regressions are weighted by population. Means of the dependent variables are averaged nationally across time for the combined Malay and Chinese population. Standard errors are clustered at the district level in cols. 3 and 4 and at the state level in cols. 1 and 2, and they are reported in parentheses. Given a small number of states, we also calculate the *p*-values using the *t*-asymptotic wild cluster bootstrap at the state level for dragon year and dragon year × Chinese variables in cols. 1 and 2, respectively, and the results are robust to the statistical inference procedure.

** $p < .05$.

*** $p < .01$.

statistically significant only at the 15% level. The change in Malay birth rates is statistically significant at the 1% level.

Last, we allow the fertility response to vary between Chinese-majority and nonmajority districts. Given that an increase in Chinese birth rates leads to relatively larger Chinese cohorts in areas with high Chinese concentration, we should therefore expect that these areas would have more negative Malay fertility responses. In line with our prior, Malay fertility declined by 3.1% in

Chinese-majority districts and by 1.5% in nonmajority districts (col. 4). This regional difference in Malay response is large (more than double in magnitude), though it is not statistically significant at conventional levels.

C. Differential Fertility Responses by Resources

Although we see robust evidence of Malay fertility responses, the previous analysis does not rule out the possibility that we are observing a spurious correlation that happens to align with the Year of the Dragon. As an additional set of tests, we interact our dragon year and ethnicity indicators with spatial economic factors that we expect to influence fertility spillovers, creating groups that we hypothesize to be relatively more or less treated in dragon years.

In particular, demographic pressure on resources such as health and education facilities can affect the immediate and later-life economic costs and outcomes of children born in a dragon year and hence induce Malay parents to decrease fertility in dragon years. Specifically, we hypothesize greater Malay fertility responses in areas with fewer public resources and fewer public expenditures. Although potential measurement error in these resource and investment proxies may bias our results toward zero, we find that our results are consistent with differential responses across administrative districts in our hypothesized directions. These results increase our confidence in our overall results and, more importantly, suggest that economic resource constraints induced by Chinese birth shocks may be an important driver of Malay fertility response in dragon years.

1. Differential Fertility Responses by Relative Resources

We estimate the Malay fertility response separately by districts with different levels of resources. We anticipate that the economic returns to childbearing will be most adversely affected in areas with relatively lower resource levels ex ante. In table 5, we use four district-level measures to proxy for the availability of resources, all measured as of 1970: an average household wealth index, the share of households using modern cooking fuels for heating and cooking, the number of teachers per capita, and the number of health workers per capita.[19]

The results in columns 1–4 of table 5 show that increased district-level resources indeed mitigate the negative Malay fertility response to increased Chinese births in dragon years. In districts with below-median resources, there is

[19] Since availability of resources in a particular year can be directly affected by the fertility rates in that year (including in dragon years), we use initial level of resources in 1970 instead of annual district resources.

TABLE 5

DIFFERENTIAL RESPONSE TO CHINESE LUNAR CALENDAR, BY CHINESE CONCENTRATION AND RESOURCES

	District-Level Resource Measure				
	Household Wealth Index (1)	% Using Modern Fuels (2)	Teachers Per Capita (3)	Health Workers Per Capita (4)	Resource Index (5)
Dragon year	−.020**	−.026***	−.020**	−.022***	−.028***
	(.009)	(.008)	(.008)	(.008)	(.009)
Dragon year × Chinese	.156***	.163***	.162***	.175***	.171***
	(.014)	(.011)	(.018)	(.010)	(.016)
Dragon year × Chinese majority	−.023**	−.026**	−.019*	−.020**	−.023**
	(.010)	(.010)	(.010)	(.010)	(.010)
Dragon year × Chinese × Chinese majority	.020	.023	.020	.028	.024
	(.019)	(.020)	(.018)	(.018)	(.018)
Dragon year × high resource	.013	.023**	.009	.013	.023**
	(.010)	(.010)	(.010)	(.010)	(.010)
Dragon year × Chinese × high resource	−.002	−.012	−.008	−.033**	−.023
	(.017)	(.016)	(.019)	(.015)	(.017)
p-value of *F*-test:					
Dragon year + dragon year × Chinese	.000***	.000***	.000***	.000***	.000***
Dragon year + dragon year × Chinese majority	.002***	.000***	.002***	.001***	.000***
Dragon year + dragon year × high resource	.207	.555	.130	.228	.395
Observations	2,686	2,686	2,686	2,686	2,686
R^2	.958	.958	.958	.958	.958
Mean of dependent variable (in levels)	32.1	32.1	32.1	32.1	32.1
Resource measure, median	.135	.149	5.908	.850	−.031

Note. The dependent variable is log(birth rate). All specifications include fully interacted district-ethnicity fixed effects and trends, as used in col. 3 of table 3. All regressions are weighted by population. Means of the dependent variables are averaged nationally across time for the combined Malay and Chinese population. "Resource Index" is an equally weighted sum of standardized measures of the resource variables in cols. 1–4 and then standardized with mean zero and standard deviation one. "High resource" is a district-level indicator variable, which equals one if the district is above the median in the respective district resource measure and zero otherwise. Standard errors clustered at the district level are reported in parentheses.

* $p < .10$.

** $p < .05$.

*** $p < .01$.

a consistently more negative fertility response among Malays across all four resource measures. Because there is a relatively high, positive correlation between these four measures, in column 5 we use a district-level resource index constructed by normalizing an equally weighted mean of the standardized distributions of four resource measures. The Malay fertility response in low-resource districts is −2.8%, while in high-resource districts it is only −0.5% (and not statistically significant). The former is statistically significant at the 1% level. The Malay fertility response to Chinese births in a low-resource district, therefore, is more than fivefold larger in magnitude relative to the response in a high-resource district, and this difference is also statistically significant at the 5% level.

2. Differential Fertility Responses by Public Expenditures

The state may also affect the net returns to childbearing by its investment in public resources or through ethnicity-specific policies, especially if fertility decisions are influenced by interethnic competition for resources. This issue is particularly relevant in Malaysia because the government implemented a series of economic policies under the NEP to protect its Malay population and reduce competition with other ethnic groups, particularly the Chinese. For this purpose, we estimate the Malay fertility response to additional Chinese births in dragon years differentially by regions with different degrees of separation.

We consider one indirect and one direct measure of state investments during the NEP period: (1) the 1970 share of the employment in "modern sectors," as described explicitly in the Third Malaysia Plan, and (2) the log of per capita total spending in social development programs, which include education and training, health and family planning, and social and community services (Government of Malaysia 1976). This spending makes up approximately 31% of federal development expenditures across each Malaysia Plan. Because funding decisions for development programs and NEP activity were made jointly by the federal government, we cannot isolate development programs from NEP activity, but we can examine their impact together as part of the state's attempts to address resource competition.

Table 6 reports the results of interacting these two measures separately with dragon year and dragon year × Chinese indicators. For reference, column 1 repeats column 5 of table 5. Column 2 shows that as the share of employment in the modern sector increases, the Malay response in dragon years is mitigated. This differential response partly, though not entirely, captures some of the relationship between fertility decisions and access to resources, as the coefficient on the dragon year × resource index interaction term falls and is no longer statistically significant. In column 3, using the direct measure of state investment, we find that greater social development expenditures also lessen the negative Malay fertility response above and beyond the effect of resources on Malay fertility. The coefficient on the interaction term (dragon year × social expenditure) is positive and statistically significant at the 10% level. Taken together, these results emphasize the role of state policies in mitigating Malay responses to Chinese fertility decisions by improving resources in general or for Malays.

TABLE 6
DIFFERENTIAL RESPONSE TO CHINESE LUNAR CALENDAR BY PUBLIC INVESTMENTS

	(1)	(2)	(3)
Dragon year	−.028***	−.032***	−.022**
	(.009)	(.010)	(.011)
Dragon year × Chinese	.171***	.168***	.161***
	(.016)	(.018)	(.021)
Dragon year × Chinese majority	−.023**	−.028*	−.028**
	(.010)	(.015)	(.011)
Dragon year × Chinese × Chinese majority	.024	.018	.030
	(.018)	(.016)	(.023)
Dragon year × high resource	.023**	.020	.024**
	(.010)	(.012)	(.009)
Dragon year × Chinese × high resource	−.023	−.026	−.024
	(.017)	(.018)	(.016)
Dragon year × modern sector intensity		.031	
		(.054)	
Dragon year × Chinese × modern sector intensity		.027	
		(.080)	
Dragon year × social expenditure			.016
			(.012)
Dragon year × Chinese × social expenditure			−.023
			(.027)
p-value of *F*-test:			
Dragon year + dragon year × Chinese	.000***	.000***	.000***
Dragon year + dragon year × Chinese majority	.000***	.006***	.000***
Dragon year + dragon year × high resource	.395	.364	.806
Dragon year + dragon year × modern sector intensity		.987	
Dragon year + dragon year × social expenditure			.795
Observations	2,686	2,686	2,686
R^2	.972	.972	.972
Mean of dependent variable (in levels)	32.1	32.1	32.1

Note. The dependent variable is log(birth rate). All specifications include fully interacted district-ethnicity fixed effects and trends, as used in col. 3 of table 3. All regressions are weighted by population. Means of the dependent variable are means across time for the combined population of Malays and Chinese at the level of Peninsular Malaysia. "Modern sector intensity" is the share of employed workers in manufacturing, mining, commerce, or construction out of all employed workers in the district. "Social expenditure" is the log of revised amount of federal public expenditures allocated for education, health, and social and community services from 1976 to 1985 in the state. See table A2 for more details on the state-level variables. Standard errors clustered at the district level are reported in parentheses.
* $p < .10$.
** $p < .05$.
*** $p < .01$.

D. Health and Education Outcomes of the Dragon Cohort

Last, we provide direct evidence of worse infant health and education outcomes among the dragon cohort. First, we estimate the health effects at and around the time of birth using the census records from the *Vital Statistics*. We then examine the later-life educational outcomes of the dragon cohort using administrative data from the *Social Statistics Bulletin*.

Examining the health impact of dragon years can be informative for two main reasons. Medical literature on health infrastructure typically identifies the quality of medical care based on nurse-patient ratio, and this is shown to affect health outcomes of patients (Lang et al. 2004; Rafferty et al. 2007; Duffield et al. 2011). Hence, a negative health impact on Malay children suggests that increased Chinese births may indeed have put pressure on hospital resources and made access to quality medical care more difficult for Malays. Second, to the extent that early health shocks persist throughout individuals' educational and labor market trajectories (Behrman and Rosenzweig 2004; Almond 2006; Black, Devereux, and Salvanes 2007; Maccini and Yang 2009), the infant health results underscore the negative effect of Chinese superstitious belief and their adherence to this belief on the economic outcomes of Malays.

In line with the existing literature that documents an adverse effect of negative income shocks on infant health (Bhalotra 2010; Baird, Friedman, and Schady 2011), we consider whether dragon years bring an increased risk of under-1 mortality (stillbirth or death before age 1) and low birth weights for children born at that time. Columns 1 and 3 of table 7 report the results on the log under-1 mortality rate and the log number of newborns with very low birth weights (under 1.5 kg), respectively, using the most flexible specification from column 3 of table 3. Because we observe zero infant deaths in 5% of district-ethnicity-year cells, we aggregate the mortality data to the state level. For birth weights, data are available only at the state level for children born between 1983 and 1990. Overall, Malay dragon year births are associated with worse health outcomes. In dragon years, the Malay under-1 mortality rate increased by 1.3%, and the share of newborns with very low birth weights increased by 15.6%. The latter estimate is statistically significant at the 5% level.[20]

These results can be confounded by selection into childbearing. Recent empirical evidence suggests that Chinese children born in auspicious years may benefit relative to Chinese children born in other years because they are better planned by their parents (Do and Phung 2010) or because their families, who respond to the lunar calendar, are positively selected (Johnson and Nye 2011). Similarly, the differential cost of having children in dragon years may vary based on individual and household characteristics within the Malay population, as well as based on their ability to respond to these perceived changes.

We seek to address the selection problem in the above health analysis in two ways. First, we use 1991 census data to predict the characteristics of families that have children during dragon years relative to those that have children in nondragon years.[21] We consider household characteristics, such as family

[20] We also note that, despite not seeing a change in fertility among Indians in table A4, the under-1 mortality rate does also rise among Indians, and it is statistically significant at the 10% level.

[21] Table A8 demonstrates that we also detect large and statistically significant dragon year fertility responses among both Chinese and Malays in the 1991 census.

TABLE 7
IMPACT OF CHINESE LUNAR CALENDAR ON INFANT MORTALITY AND BIRTH WEIGHT

	Dependent Variable: Log of Under-1 Mortality Rate		Dependent Variable: Log of Very Low Birth Weight Rate	
	(1)	(2)	(3)	(4)
Dragon year	.013	−.014	.156**	.215**
	(.020)	(.018)	(.065)	(.073)
Dragon year × Chinese	−.072***	−.085***	−.089	−.168
	(.014)	(.022)	(.131)	(.217)
Dragon year × Chinese majority		.036*		.136
		(.018)		(.109)
Dragon year × Chinese × Chinese majority		−.001		−.429***
		(.024)		(.113)
Dragon year × high resource		.052*		−.240*
		(.025)		(.124)
Dragon year × Chinese × high resource		−.011		.465*
		(.033)		(.224)
p-value of *F*-test:				
Dragon year + dragon year × Chinese	.004***	.000***	.388	.755
Dragon year + dragon year × Chinese majority		.408		.024**
Dragon year + dragon year × high resource		.046**		.810
Observations	462	462	172	172
R^2	.981	.982	.583	.591
Mean of dependent variable (in levels)	35.6	35.6	4.7	4.7

Note. Regressions use ethnicity-state-year observations and include fully interacted state-ethnicity fixed effects and trends. Regressions in cols. 1 and 2 include 1970–90, and regressions in cols. 3 and 4 use data from 1983 to 1990. All regressions are weighted by population. Means of the dependent variables are averaged across Peninsular Malaysia across time for the combined Malay and Chinese population. Standard errors clustered at the district level are reported in parentheses. "Under-1 Mortality Rate" is the sum of stillbirths and infant deaths divided by 1,000 live births. "Very Low Birth Weight" is the number of children born weighing less than 2.5 kg divided by 1,000 live births.
* $p < .10$.
** $p < .05$.
*** $p < .01$.

composition and household wealth, as well as parents' characteristics, such as education and employment. We find no evidence that Malay families that have children in dragon years are negatively selected, and therefore the negative health outcomes we observe in table 7 are unlikely to be driven by selection (see table A10).

Second, columns 2 and 4 of table 7 estimate the dragon year health effects differentially by regions with varying Chinese concentration and with different levels of resources. If the negative health impacts on Malay newborns are caused in part by greater pressure on resources because of larger Chinese cohorts in dragon years, then these effects are likely to be more severe in areas with a high concentration of Chinese and in regions with low levels of resources.

The Malay rate of very low birth weights rose by 21.5% during dragon years in regions with low Chinese concentration and low resources, which is statistically significant at the 5% level. In comparison, the negative dragon year effects on under-1 mortality rates and very low birth weights for Malays are larger in Chinese-majority regions. This difference in under-1 mortality rates between the two types of regions is statistically significant at the 10% level in the case of infant mortality. Similarly, the negative birth weight effects observed in low-resource regions disappear in areas with high resources (and net effects are no longer statistically significant), although this is not the case for the under-1 mortality rate. The differential effects of dragon years on Malays across high- and low-resource areas are statistically significant at the 10% level.

Last, we examine the effects on the education attainment of dragon cohorts, and we find suggestive evidence of worsening education quality (measured by the student–all teacher ratio) associated with dragon cohorts, along with worse long-term educational outcomes based on the preuniversity test scores of children born in dragon years, which are consistent with the health results.

To measure education infrastructure quality, we assume that children have turned 6 by the first day of the calendar year in which they enroll, following Ministry of Education guidelines (Ministry of Education Malaysia 2020) and construct the ratio of the number of students enrolled in grade 1 over the total number of primary school teachers. Column 1 of table 8 reports the results on this student–all teacher ratio, and we find that in years that children born in a dragon year were expected to enter primary school (1977 and 1995), the student–all teacher ratio in grade 1 increased by 0.259. The estimate is statistically significant at the 1% level. Assuming that states do not reallocate teachers across grades within primary level, this implies a 6.3% decline in the quality of primary education infrastructure due to increased births during dragon years (compared with the mean student–all teacher ratio of 4:1).

Columns 2–4 of table 8 present impacts on later-life education outcomes measured by the results from the STPM examination. Overall, dragon cohort members have worse exam results. In years that dragon cohorts were expected to take the national preuniversity exam (1995 and 2007), the share of students who passed all five subjects in this exam decreased by 3.6 percentage points, those who passed at least four out of five subjects decreased by 2.7 percentage points, and those who passed at least three subjects decreased by 1.7 percentage points. All three estimates are statistically significant at the 1% level and signify a 19.5%, 5.1%, and 2.3% decrease over their means, respectively.

We note three limitations to our education outcomes analysis. First, because our education data pool ethnic groups, we can only speak to worse performance across the entire cohort. Second, data limitations mean that we cannot account for potential cohort-specific differences in grade retention and promotion. Third, some Malays, anticipating increased competition in upper

TABLE 8

IMPACT OF CHINESE LUNAR CALENDAR ON EDUCATION OUTCOMES

	Dependent Variable: Number of Students in Grade 1/Number of Primary School Teachers	Dependent Variable: Share of Students Who Passed:		
		All Five Subjects	At Least Four Subjects	At Least Three Subjects
	(1)	(2)	(3)	(4)
Dragon year	.259***	−3.59***	−2.67***	−1.67***
	(.0547)	(.417)	(.539)	(.528)
Observations	209	187	187	187
R^2	.931	.857	.824	.805
Mean of dependent variable	4.093	18.37	52.84	72.22

Note. Regressions use state-year observations and include state trends. The regression in col. 1 uses data from 1977 to 1996, which covers the period in which individuals born in 1970–89 would have entered first grade in primary school. Regressions in cols. 2–4 use data from the Sijil Tinggi Persekolahan Malaysia (Malaysia Higher School Certificate) examination for the 1974–90 birth cohorts. All regressions are weighted by population. Standard errors clustered at the state level are reported in parentheses.
*** $p < .01$.

secondary because of larger cohorts, could have chosen alternative postsecondary pathways, such as matriculation (a 1-year program open to Malay students that is accepted as an alternative to the STPM by local public universities). However, if it is lower-achieving students that do not progress with their cohort or that opt out of the STPM, our results would be biased closer to zero, making it more notable that we do find effects.

To summarize, we find negative impacts on the health and education outcomes of Malay newborns in dragon years, and more importantly, both effects are not likely to be explained by selection alone. The size of the negative effects on both types of health outcomes are also larger in areas with high Chinese concentration and in regions with low levels of resources. Interestingly, the health results are in line with the differential spatial patterns that we observed on Malay fertility response in dragon years, providing strong evidence for an increased burden on resources put by a larger Chinese dragon cohort that in turn influences Malay fertility decisions.

VI. Conclusion

In this paper, we exploit variation in the Chinese lunar calendar to document interethnicity fertility spillovers in Peninsular Malaysia. We find that in auspicious dragon years, Chinese births rise by 14.3% (28,900 additional births across both cycles) and Malays respond by reducing their births by 1.9% (8,500 fewer births across both cycles), which reduces the overall gain in cohort size by 30%. Our results are highly robust to alternative specifications, and we document a similar but reverse phenomenon in inauspicious tiger years.

The change in cohort size and ethnic composition induced by dragon years may drive interethnic spillovers through several mechanisms associated with economic as well as noneconomic factors. We provide evidence that the interethnic fertility spillovers that we observe are spatially correlated with economic factors, and as long as such regional variations are not correlated with social preferences, our results cannot be explained solely through noneconomic factors. Specifically, we observe fertility spillovers among Malays that are particularly negative in areas with scarcer public resources, where the strain of cohort size is greatest. This pattern is particularly notable because we might initially expect a more muted response if families in these poorer areas are less sophisticated or have limited ability to control their fertility timing. Additionally, government investment also affects the intensity of the spillover. Areas with increased government investment experience smaller negative fertility spillovers among Malays. These results indicate that Malays adjust their fertility in response to Chinese fertility behavior, complementing work on the impact of changes in the net returns to childbearing on overall fertility (Lovenheim and Mumford 2013; Apostolova-Mihaylova and Yelowitz 2017) and fertility timing decisions (Dickert-Conlin and Chandra 1999; Gans and Leigh 2009; LaLumia, Sallee, and Turner 2015).

Despite this Malay fertility response, we still observe higher rates of infant mortality and low birth weights among Malays in dragon years, especially in areas with low resources and higher Chinese concentration. These health results are consistent with increased pressure on medical resources put by the dragon cohort. We also find suggestive evidence of a decline in educational infrastructure quality and on preuniversity test scores of the dragon cohort in later life. We do not find that these negative effects can be explained by parental selection into childbearing. More importantly, these results show that cultural norms of one group can have spillover effects on the well-being of another group, when the two groups share common economic resources that are closely tied with health and education investments.

Last, these results also highlight the role of individual behavior in mitigating interethnic tensions insofar as increased competition for economic resources has been shown to exacerbate conflicts along ethnic lines (Miguel, Satyanath, and Sergenti 2004; Bai and Kung 2011; Mitra and Ray 2014). In developing countries, state policies—which are seen as the primary instruments to address ethnic tensions—are often lacking, possibly because of weak state institutions. In such contexts as in Malaysia, our results show that individual-level responses in the form of change in Malay fertility during dragon years might have played an important role in easing the demographic pressure put on resources due to

Chinese adherence to their cultural norms and helped to mitigate ethnic tensions between the two groups.

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