

Superstition, Fertility, and Inter-ethnic Spillovers: Evidence from Peninsular Malaysia*

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Abstract

This paper documents a strong correlation between fertility and superstition among the Chinese ethnic diaspora in Malaysia and examines the effect of this Chinese adherence to their cultural norm on the fertility behavior and economic outcomes of ethnic Malays. We exploit a short-term change in fertility preferences induced by the Chinese zodiac calendar that leads to a 14.3 percent rise in birth rates during auspicious dragon years. In contrast, Malays—who do not adhere to this belief—reduce their fertility by 1.9 percent during dragon years. Declines in Malay births are larger in areas with relatively fewer public resources and investment, providing suggestive evidence that economic factors related to child well-being, such as demographic pressure on resources, drive Malay fertility responses. We also document worse health outcomes at birth for Malays born in dragon years and lower educational outcomes in later life. Lastly, we find spatial heterogeneity in health effects and an overall increase in student-teacher ratios that are consistent with an increased resource burden imposed by dragon cohorts.

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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 like 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 inter-ethnic spillovers? And (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 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 to 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

¹Family 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

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 inter-ethnic 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 like 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 inter-ethnic spillovers can therefore help to better understand the nature of the ethnic interactions in societies with diverse population 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 percent), while ethnic Chinese, who represent the largest minority, make up one quarter of the population. This ethnic heterogeneity in part comes from the legacy of British 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 disad-

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).

²If 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 public sector can reduce labor market competition between Chinese and Malays that can help to dampen the negative effects of larger Chinese cohort on the labor market returns to investments for Malays.

vantaged 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 et al., 2003).

Using newly digitized district-level data that span two decades (1970-1990) from the Malaysian Vital Statistics, we find that birth rates among ethnically Chinese Malaysians rose by 14.3 percent in dragon years (1976 and 1988). In contrast, ethnic Malays reduced their fertility by 1.9 percent in dragon years. This lunar-year shock led to a net 3.1-percent increase in size and a 9.0-percent 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 that favored Malays. These results suggest that economic factors like 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 an increase in infant mortality rates and 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 (Black et al., 2007; Behrman and Rosenzweig, 2004). Moreover, the spatial heterogeneity in health effects that shows larger negative effects in regions with low resources and higher Chinese concentrations are consistent with an increased strain on health resources due to 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 like 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 et al., 1999; Banerjee et al., 2005), higher levels of political corruption and conflict (Padró i Miquel, 2007; Esteban et al., 2012), and worse economic performance (Alesina and 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 inter-ethnic interaction.³ The impacts of segregation, however, have mostly been negative (Boeri et al., 2015; Douglas et al., forthcoming),⁴ and in particular, segregation has been shown to worsen ethnic inequality in education and healthcare (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, due to 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

³Baum-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 et al. (2008) find that white migration in most U.S. cities exhibits tipping-like behavior, with the distribution of tipping points ranging from a 5- to 20-percent 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 et al. (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.

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

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 (for example, Dickert-Conlin and Chandra (1999); Gans and Leigh (2009); LaLumia et al. (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 which larger cohort sizes and a different ethnic composition place an additional burden on resources.

Lastly, 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, Forthcoming), 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.

1 Background

1.1 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 percent of the population, and the remainder are Indian or members of other ethnic groups (Department of Statistics, 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 in order to ensure a continuous supply of labor to the booming tin mines that drove trade in the Straits Settlements (Purcell, 1948; Blythe, 1947). 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, 1958, 1959).

After independence, Malays were afforded explicit protections in the new constitution in exchange for citizenship for Chinese and Indian residents. The New Economic Policy (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 five-year Malaysia Plans from 1971 to 1990 (Faaland et al., 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

⁵We 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 percent of *bumiputera*.

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 socio-economic 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 percent of working-age Malays (ages 15-54) had completed secondary education, compared with 8.0 percent of Chinese. Similarly, 4.6 percent of working-age Malays were employed in high-skilled occupations,⁶ versus 8.7 percent of working-age Chinese.

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

1.2 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

⁶High-skill occupations are managers, professionals, technicians, and associate professionals, as defined by Major Groups 1 to 3 of the International Standard Classification of Occupations 1988.

⁷Prior to 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).

Figure 1 plots the annual birth rates in Malaysia between 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 percent, 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 prior to the 1988 dragon year that claimed that the 1976 boom led to higher maternal mortality due to increased pressure on health services and that the 1976 cohort faced overcrowded classrooms as a result of the boom.

2 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, still-births, and infant deaths by district, year, and ethnicity, as well as by state, month, and ethnicity from 1970-1990.⁸ We also add Vital Statistics records on the share of newborns with very low birth weights (less than 2.5 kg) by state, ethnicity, and year,

⁸We exclude the states of Sabah, 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 percent of the population of Malaysia. Moreover, East Malaysia is located more than 600km away from the Malay Peninsula on the island of Borneo, is sparsely populated, and has a very different demographic structure compared to the rest of Malaysia, as more than half of its residents are members of one of several small indigenous tribes (non-Malay *bumiputera*.)

although these are only available from 1983-1990.

We focus on the 1970-1990 period for two reasons. First, previous research finds no evidence of zodiac-based fertility decisions prior to 1970 in the Chinese diaspora, in part due to limited access to contraception (Sun et al., 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-by-year-by-ethnicity cell, calculated by linearly interpolating district populations using the 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 shows 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 percent higher than the average Chinese birth rate of 26.9. Malay newborns made up 62.0 percent of the birth cohort each year, on average, while 27.8 percent of newborns were Chinese. The stillbirth and infant-death rates were also higher for Malays compared to 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, 5.2 newborns were less than 2.5 kilograms at birth, and this rate is slightly higher for Malays than 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 1977-1996, which covers the period during which the 1970-1989

⁹The boundaries of some districts have changed over this period, mostly due to districts splitting into two or more districts. We merge districts that have split during the 1970-1990 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. See Appendix Table A.1 for a detailed description of which districts were merged.

birth cohorts were expected to enter primary school; as well as the pre-university national exam (*Sijil Tinggi Persekolahan Malaysia*) results for the 1974-1990 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 pre-university national exam who passed all five subjects was 18.4 percent, whereas, 52.8 percent of them passed at least four out of five subjects, and 72.2 percent passed at least 3 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 1976-1985, which includes all NEP-related education and health programs during this period, is obtained from the Mid-Term Reviews of the Third and Fourth Malaysia Plans (Government of Malaysia, 1979, 1984). Appendix Table A.2 contains the definition of each measure and its source. Figure 2 shows the regional distribution of these measures.

Figure 2a presents the spatial distribution of the Chinese population in Malaysia. The median district in Malaysia is 31 percent Chinese (restricting only to Chinese and Malays, ranging from 0.8 to 80 percent), and in 16 out of 64 districts, Chinese

¹⁰The *Sijil Tinggi Persekolahan Malaysia* (Malaysia 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 percent of matriculation slots are reserved for Malays), or students may proceed to vocational/technical education directly. We identify dragon cohorts based on the predicted year of school entry and exam-taking. Students start grade 1 when after turning 6 (Ministry of Education, 2018), and a typical student who completes two years of Form 6 would complete 13 years of schooling before taking the STPM. The missing data on examination results for earlier birth cohorts (1970-1973) is due to a different reporting scheme used in the Social Statistics Bulletin in earlier years.

residents outnumber Malay residents (we refer to these as “Chinese-majority” districts). Figure 2b 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).

Figures 2c and 2d show the state-level variation in social development expenditure and the district-level intensity of modern sector employment, respectively. In Figure 2d, 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 percent, respectively) and are therefore likely to benefit in later years from the NEP’s focus on modern-sector expansion.

3 Empirical Strategy

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

$$\begin{aligned} \ln(birthrate_{e,dy}) = & \alpha + \beta DragonYear_y + \delta DragonYear_y * Chinese_e \\ & + \gamma Chinese_e + \theta_1 Year7081_y + \theta_2 Year7081_y^2 \\ & + \theta_3 Year8290_y + \theta_4 Year8290_y^2 + f_d + \epsilon_{e,dy}, \end{aligned} \quad (1)$$

where the outcome variable is the log of birth rate measured at the ethnicity (e)-district (d)-year (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 1970-1981 and one for 1982-1990, to allow for

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

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 1970-1981, and a second set for 1982-1990, in order to allow additional flexibility.¹⁴ Secondly, we include ethnicity-by-district fixed effects and ethnicity-by-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 31 January, 1976, and ended on 17 February, 1977, while the 1988 dragon year spanned 17 February, 1988, to 5 February, 1989. We use the state-month-ethnicity level data and estimate the following equation:

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

where the *DragonYear* is a binary variable equal to one for months from February

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

¹³We 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.

¹⁴Appendix Table A.5 shows that our specifications are robust to using a single quadratic trend.

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

4 Results

4.1 Estimation of inter-ethnic fertility spillovers

We estimate equation 1 in order to quantify the dragon year fertility response among both Chinese and Malay ethnic groups in Columns 1 through 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 percent (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 one-percent level. The results are also robust to controlling for ethnicity-specific fertility trends (Column 2) and ethnicity-by-district-specific fertility trends (Column 3). In our most flexible specification (Column 3), we find that the Chinese birth rates increased by 14.3 percent in dragon years. Based on the counterfactual birth rate predicted from 1970-1991 excluding dragon years, this implies that the two dragon years led to approximately 28,900 additional Chinese births.¹⁶

¹⁵Appendix Table A.6 shows these results using birth rate in levels as the dependent variable instead of log birth rate.

¹⁶For comparison, Goodkind (1995) finds a 23-percent 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 an 9.3 and a 19.0 percent increase among Chinese, respectively, and we control for district-by-ethnicity-specific time trends. In addition, we do not find evidence of gender differences in Chinese newborns in dragon years (see Columns 3 and 4 of Appendix Table A.3), which is not surprising given that dragon

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 percent during dragon years (Column 3). This implies that there were around 8,500 fewer Malay newborns in the 1976 and 1988 dragon years combined, compared to the predicted counterfactual Malay births, and this difference is statistically significant at the one-percent level. In other words, for each additional Chinese newborn, Malays reduced their fertility by 0.30 births, suggesting the presence of large, negative, inter-ethnic fertility spillovers in Malaysia.¹⁷

In Appendix Table A.3, 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 percent, and in the year following, Chinese births fall by 7.8 percent. On the other hand, Malay births remain low in the year following the dragon years, suggesting that the 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 birthrates 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 year, reflecting that the perceived negative effects of a larger cohort can have spillovers into neighboring cohorts.

In Appendix Table A.3, 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

years are thought to be auspicious for both girls and boys (for example, see Chia (1952)).

¹⁷Appendix Table A.4 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 they make up only about 7 percent 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 Appendix Table A.4 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.

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 persists across both 1976 and 1988 dragon years, and differences in each individual year are statistically significant at the ten- and one-percent levels, respectively.

These Chinese birth-rate spikes and accompanying negative inter-ethnic 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. We find that, overall, there is around a 3.1-percent 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, an 9.0 percent change in ethnic composition relative to the mean Chinese share (31 percent). Both estimates are statistically significant at the one-percent level.

4.2 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-by-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 non-dragon 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-by-state-by-year fixed effects, confirm that there was a large, statistically

significant fertility response among both the Chinese and Malay populations. Chinese birth rates increased by 17.0 percent, and Malay birth rates declined by 1.0 percent in dragon years. The two estimates are statistically significant at the one-percent and five-percent levels, respectively.¹⁸

Second, we estimate the fertility responses from Malay and Chinese ethnic groups in tiger years (1974 and 1986) alongside with 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-by-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 only statistically significant at the 15-percent level. The change in Malay birth rates is statistically significant at the one-percent level.

Lastly, we allow the fertility response to vary between Chinese-majority and non-majority districts. Given that an increase in Chinese birth rates leads to relatively larger Chinese cohorts in high-Chinese concentration areas, 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 percent in Chinese-majority districts and by 1.5 percent in non-majority districts (Column 4). This regional difference in Malay response is large (more than double in magnitude), though it is not statistically significant at conventional levels.

¹⁸Because 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 percent) is roughly half of the -1.9-percent 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.

4.3 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 like 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.

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

¹⁹Since 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.

The results in Columns 1 through 4 of Table 5 show that, indeed, increased district-level resources mitigate the negative Malay fertility response to increased Chinese births in dragon years. In districts with below-median resources, there is 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 percent, while in high-resource districts it is only -0.5 percent (and not statistically significant). The former is statistically significant at the one-percent level. The Malay fertility response to Chinese births in a low-resource district, therefore, is more than five-fold larger in magnitude relative to the response in a high-resource district, and this difference is also statistically significant at the five-percent level.

Differential fertility responses by public expenditures: The state also may affect the net returns to childbearing by its investment in public resources or through ethnicity-specific policies, especially if fertility decisions are influenced by inter-ethnic 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 percent 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-by-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-by-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-by-social expenditure) is positive and statistically significant at the 10-percent 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.

4.4 Health and education outcomes of the dragon cohort

Lastly, we provide direct evidence of worse infant health and education outcomes among 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 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 (Duffield et al., 2011; Rafferty et al., 2007; Lang et al., 2004). 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 individual's educational and labor market trajectories (Maccini and Yang, 2009; Black et al., 2007; Behrman and Rosenzweig, 2004; Almond, 2006), 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 et al., 2011), we consider whether dragon years bring an increased risk of under-1 mortality (stillbirth or death before age one) 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 2.5 kilograms) respectively, using the most flexible specification from Column 3 of Table 3. Because we observe zero infant deaths in five percent of districts-ethnicity-year cells, we aggregate the mortality data to the state level. For birthweights, data is only available 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 5.1 percent, and the share of newborns with very low birth weights increased by 15.6 percent. Both are statistically significant at the five-percent 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

²⁰We also note that, despite not seeing a change in fertility among Indians in Appendix Table A.4, that the under-1 mortality rate also does rise among Indians, and it is statistically significant at the ten-percent level.

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 who have children in non-dragon years.²¹ We consider household characteristics such as family composition and household wealth, as well as parents' characteristics such as education and employment. We find no evidence that Malay families who 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 Appendix Table A.10).

Secondly, Columns 2 and 4 of Table 7 estimates the dragon-year health effects differentially by regions with varying Chinese concentration, and by areas with different levels of resources. If the negative health impacts on Malay newborns are, in part, caused by increased pressure on resources imposed by larger Chinese cohorts in dragon years, then these effects are likely to be more severe in high-Chinese concentration areas and in regions with low levels of resources.

The Malay under-1 mortality rate and rate of very low birth weights in dragon years increased by 2.0 and 21.5 percent, respectively, in regions with low Chinese concentration and low resources. The second estimate is statistically significant at the five-percent 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 five-percent 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. Considering birthweights, the differential effects of dragon

²¹Appendix Table A.8 demonstrates that we also detect large and statistically significant dragon-year fertility responses among both Chinese and Malays in the 1991 Census.

years on Malays across high and low resource areas are statistically significant at the ten-percent level.

Lastly, 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 pre-university test scores of children born in dragon years, which are consistent with the health results.

To measure of education infrastructure quality, we assume that children enter primary school at the age of seven following Ministry of Education guidelines (Ministry of Education, 2018) 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 one-percent level. Assuming that states do not reallocate teachers across grades within primary-level, this implies a 6.3 percent decline in the quality of primary education infrastructure due to increased births during dragon years (compared to the mean student-all teacher ratio of 4.1).

Columns 2-4 of Table 8 present the impact on later life education outcomes measured by the results from the Malaysia Higher School Certificate examination. Overall, dragon cohort members have worse exam results. In years that dragon cohorts were expected to take the national pre-university exam (1995 and 2007), the share of students who passed all five subjects in this exam decreased by 3.59 percentage points, those who passed at least four out of five subjects declined by 2.67 percentage points, and those who passed at least three subjects declined by 1.67 percentage points. All three estimates are statistically significant at the one-percent level, and signify a 19.5 percent, 5.1 percent, and 2.3 percent decrease over their means respectively.

We note three limitations to our education outcomes analysis. First, because our education data pools 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 secondary because of larger cohorts, could have chosen alternative post-secondary pathways like Matriculation (a one-year program open to Malay students that is accepted as an alternative to the HSC by local public universities). However, if it is lower-achieving students that do not progress with their cohort or that opt out of the HSC, 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 high-Chinese concentration areas, and in regions with low levels of resources. Interestingly, the health results are inline 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 larger Chinese dragon cohort that, in turn, influences Malay fertility decisions.

5 Conclusion

In this paper, we exploit variation in the Chinese lunar calendar to document inter-ethnicity fertility spillovers in Peninsular Malaysia. We find that in auspicious dragon years, Chinese births rise by 14.3 percent (28,900 additional births across both cycles), and Malays respond by reducing their births by 1.9 percent (8,500 fewer births across both cycles), which reduces the overall gain in cohort size by 30 percent. 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 inter-ethnic spillovers through several mechanisms associated with economic as well as non-economic factors. We provide evidence that the inter-ethnic 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 can not be explained solely through non-economic 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, 2016) and fertility timing decisions (Dickert-Conlin and Chandra, 1999; Gans and Leigh, 2009; LaLumia et al., 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 dragon cohort. We also find suggestive evidence of a decline in educational infrastructure quality and on pre-university test scores of 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.

Lastly, these results also highlight the role of individual behavior in mitigating inter-

ethnic tensions, in so far as, increased competition for economic resources has been shown to exacerbate conflicts along ethnic lines (Bai and Kung, 2011; Miguel et al., 2004; Mitra and Ray, 2014). In developing countries, state policies—that are seen as the primary instruments to address ethnic tensions—are often lacking possibly due to weak state institutions. In such contexts like 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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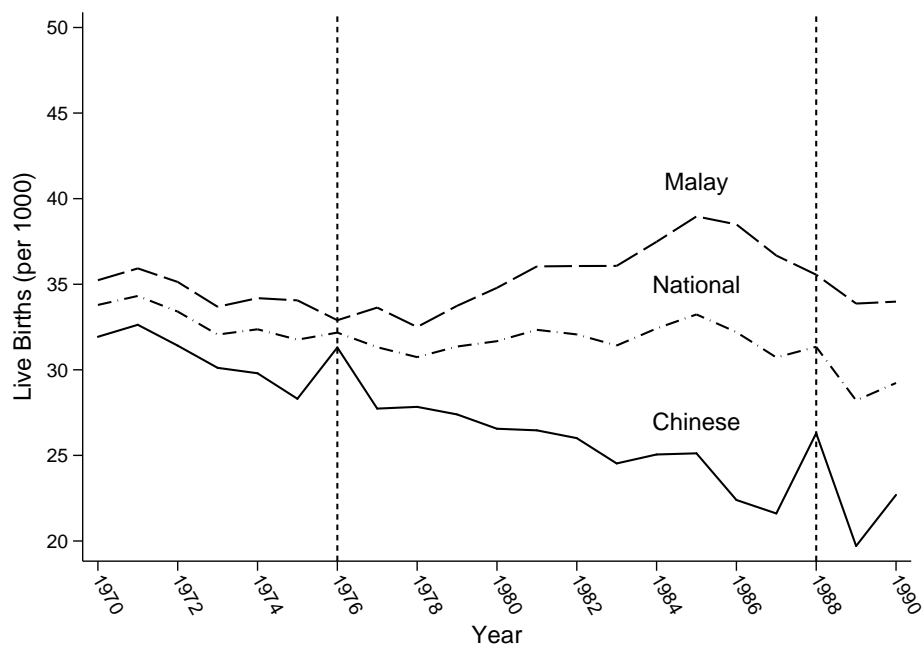
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Figures and Tables

Figure 1: Annual Birth Rates by Ethnicity, 1970-1990



Notes: Birth rates are calculated by dividing the total number of live births by the estimated year-by-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 using a dotted line.

Figure 2: Regional Distribution of Chinese Ethnicity, Resources, and Public Expenditures

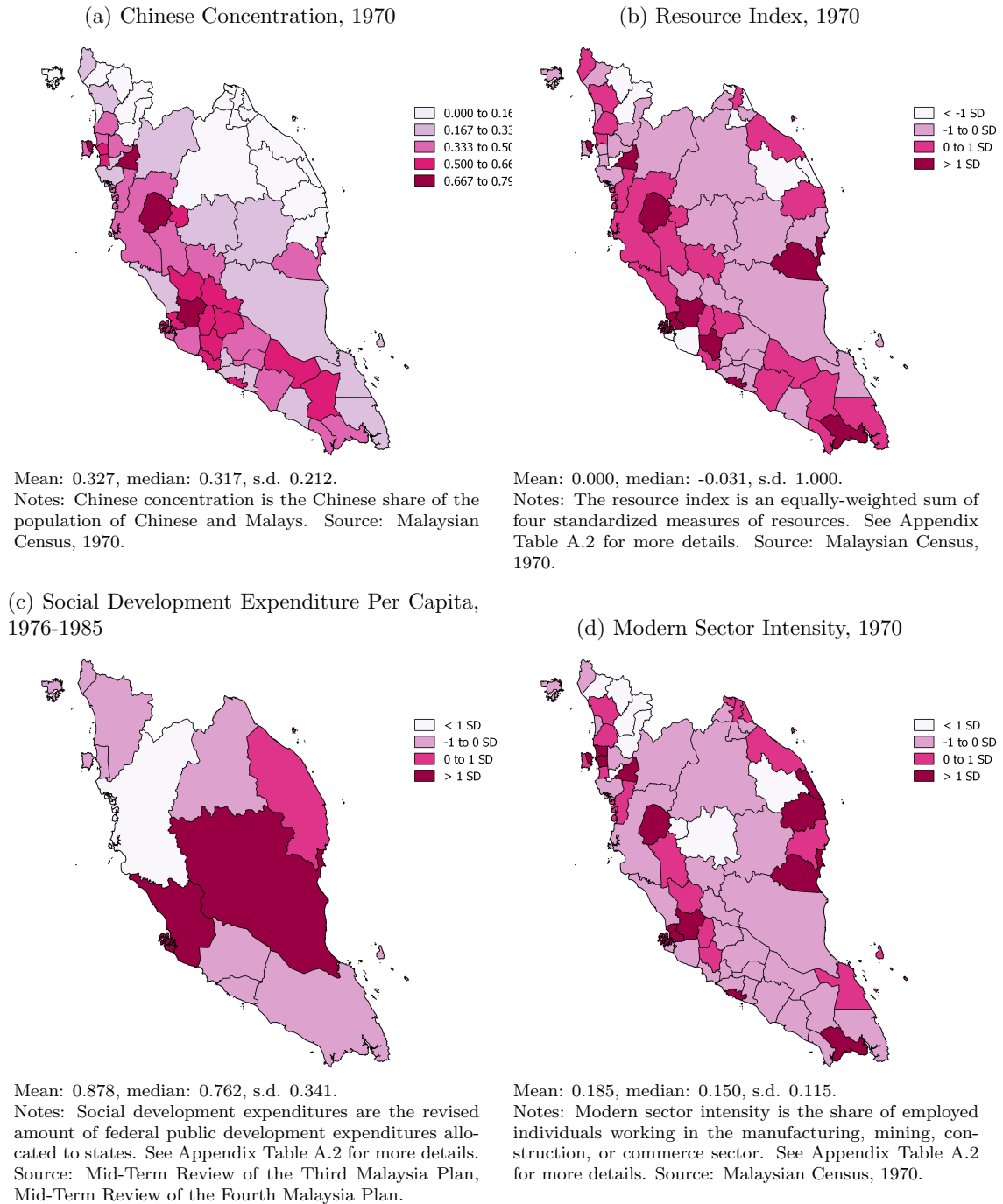
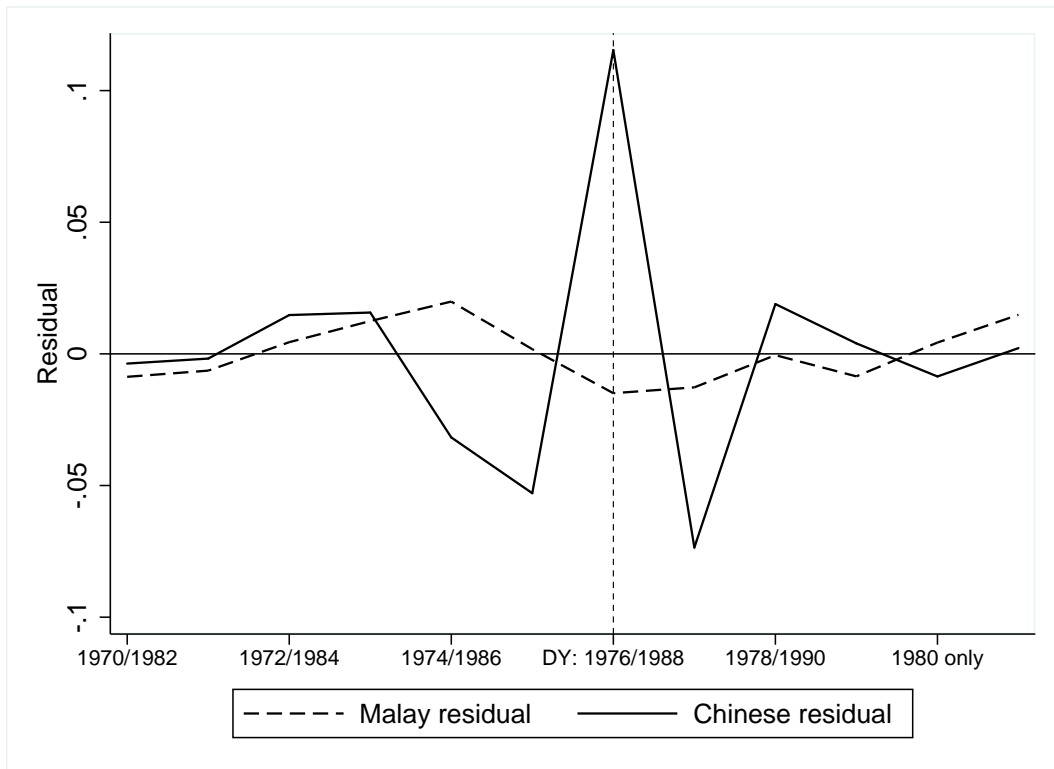


Figure 3: Averaged Birth Rate Residuals by Zodiac Year, 1970-1990



Notes: Each point represents population-weighted averages of district-by-ethnicity-by-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 using a dotted line.

Table 1: Characteristics of Malay and Chinese Ethnic Groups, 1970 and 1991 Censuses

	Malay		Chinese	
	1970 (1)	1991 (2)	1970 (3)	1991 (4)
Panel A: Characteristics of population				
Total population ('000)	4,681	8,119	3,126	3,962
Share of population (in %)	53.2	58.9	35.5	28.7
Panel B: Characteristics of working-age group (in %), 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	0.5	7.0	1.2	6.5
Employment rate	56.4	57.8	57.2	61.2
Employed in high-skill occupation ^a	4.6	11.9	8.7	15.7
Employed in modern sector ^b	12.6	41.8	45.3	67.6
Panel C: Household characteristics				
Urban residence (in %)	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 ^c	0.3	0.5	0.4	0.7
Modern cooking fuel ^d (in %)	21.1	-	27.6	-

Notes: Sample includes Peninsular Malaysia, and it also includes non-citizens in 1970 but not in 1991. ^a*High-skill occupations* are managers, professionals, technicians, and associate professionals, as defined by Major Groups 1 to 3 of the International Standard Classification of Occupations 1988. ^b*Modern sectors* are manufacturing, mining, commerce, and construction, which were explicitly targeted by the NEP to increase Malay participation. ^c*Household wealth index* is the equally-weighted mean of five indicator variables for whether the household owns any refrigerators, automobiles, phones, televisions, and radios. ^d*Modern cooking fuels* are electricity, gas, or kerosene, as opposed to wood or charcoal.

Table 2: Summary Statistics of Vital Statistics and Social Statistics Bulletin, 1970-1990

	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	5.2	5.5	3.8
Mean no. of students enrolled in first grade	30,262	-	-
Mean no. of primary school teachers	7,475	-	-
Mean student-teacher ratio	4.1	-	-
Mean share of students who passed ^a :			
All 5 subjects (%)	18.4	-	-
At least 4 subjects (%)	52.8	-	-
At least 3 subjects (%)	72.2	-	-

Notes: Sample includes Peninsular Malaysia only. National statistics in Column 1 include all Malaysian nationals including those belonging 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 number of children born less than 2.5 kilograms divided by 1,000 live births. ^aSijil Tinggi Persekolahan Malaysia (or Malaysian Higher School Certificate) is a pre-university national examination taken by students in Malaysia, which is equivalent to completing a high-school degree.

Table 3: Impact of Chinese Lunar Calendar on Birth Rates

Dependent variable:	log(birth rate)			% Chinese birth	
	(1)	(2)	(3)	(4)	(5)
Dragon year	-0.010** (0.005)	-0.019*** (0.005)	-0.019*** (0.005)	0.031*** (0.007)	0.028*** (0.003)
Dragon year X Chinese	0.139*** (0.009)	0.162*** (0.009)	0.162*** (0.010)		
Level of observation		District-year-ethnicity		District-year	District-year
Controls:					
Region FE, region trend	X	X	X	X	X
Ethnicity FE	X	X	X		
Ethnicity trend		X	X		
Ethnicity X reg. FE, ethnicity X reg. trend			X		
Observations	2,686	2,686	2,686	1,344	1,344
R-squared	0.741	0.755	0.972	0.958	0.998
Mean of dependent variable (in levels)	32.2	32.2	32.2	32.2	0.31

Notes: Sample includes 1970-1990 Chinese and Malay births for 64 1970-adjusted districts. All fixed effects are interacted with quadratic time trends from 1970-1981 and 1982-1990, 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<0.10, ** p<0.05, *** p<0.01.

Table 4: Impact of Chinese Lunar Calendar on Birth Rates, Robustness Checks

	(1)	(2)	(3)	(4)
DragonYear	-0.010** (0.004)	-0.010** (0.004)	-0.014*** (0.005)	-0.015** (0.006)
DragonYear X Chinese	0.180*** (0.014)	0.180*** (0.013)	0.155*** (0.009)	0.158*** (0.009)
TigerYear			0.022*** (0.004)	
TigerYear X Chinese			-0.032*** (0.008)	
DragonYear X Chinese majority (ChMaj)				-0.016 (0.010)
DragonYear X Chinese X ChMaj				0.017 (0.019)
P-value of F-test:				
DragonYear + DragonYear X Chinese	0.000***	0.000***	0.000***	0.000***
TigerYear + TigerYear X Chinese			0.123	
DragonYear + DragonYear X ChMaj				0.000***
Level of observation	State-month-ethnicity		District-year-ethnicity	
Controls:				
Ethn. X Reg. FE, Ethn. X Reg. Trend	X	X	X	X
Ethn. X Month FE, Reg. X Month FE	X	X		
Ethn. X Year FE, Reg. X Year FE	X	X		
Ethn. X Region X Year FE		X		
Observations	5,126	5,126	2,686	2,686
R-squared	0.921	0.923	0.972	0.972
Mean of dependent variable (in levels)	2.68	2.68	32.2	0.31

Notes: Dependent variable is log (birth rate). State-month-ethnicity observations start from August 1970, the 1970 Census enumeration month. For Columns 1 and 2, the dragon year dummy is assigned to months that are completely within the dragon year, which are February 1976 to January 1977 and March 1988 to January 1989. All specifications include fully interacted region-ethnicity fixed effects and trends, as used in Column 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 Columns 3-4 and at the state level in Columns 1-2, 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 *DragonYear* and *DragonYear X Chinese* variables in Columns 1-2, and the results are robust to the statistical inference procedure. * p<0.10, ** p<0.05, *** p<0.01.

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)
DragonYear	-0.020** (0.009)	-0.026*** (0.008)	-0.020** (0.008)	-0.022*** (0.008)	-0.028*** (0.009)
DragonYear X Chinese	0.156*** (0.014)	0.163*** (0.011)	0.162*** (0.018)	0.175*** (0.010)	0.171*** (0.016)
DragonYear X ChMaj	-0.023** (0.010)	-0.026** (0.010)	-0.019* (0.010)	-0.020** (0.010)	-0.023** (0.010)
DragonYear X Chinese X ChMaj	0.020 (0.019)	0.023 (0.020)	0.020 (0.018)	0.028 (0.018)	0.024 (0.018)
DragonYear X Hi-Res	0.013 (0.010)	0.023** (0.010)	0.009 (0.010)	0.013 (0.010)	0.023** (0.010)
DragonYear X Chinese X Hi-Res	-0.002 (0.017)	-0.012 (0.016)	-0.008 (0.019)	-0.033** (0.015)	-0.023 (0.017)
P-value of F-test					
DragonYear + DragonYear X Chinese	0.000***	0.000***	0.000***	0.000***	0.000***
DragonYear + DragonYear X ChMaj	0.002***	0.000***	0.002***	0.001***	0.000***
DragonYear + DragonYear X Hi-Res	0.207	0.555	0.130	0.228	0.395
Observations	2,686	2,686	2,686	2,686	2,686
R-squared	0.958	0.958	0.958	0.958	0.958
Mean of dependent variable (in levels)	32.2	32.2	32.2	32.2	32.2
Resource measure, median	0.135	0.149	5.908	0.850	-0.031

Notes: Dependent variable is log(birth rate). All specifications include fully interacted district-ethnicity fixed effects and trends, as used in Column 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. ^aResource index is an equally-weighted sum of standardized measures of the resource variables in columns 1-4, and then standardized with mean zero and standard deviation one. ^bHi-Res is a district-level indicator variable, which equals one if the district is above median in the respective district resource measure, and zero otherwise. Standard errors clustered at the district level are reported in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

Table 6: Differential Response to Chinese Lunar Calendar, by Public Investments

	(1)	(2)	(3)
DragonYear	-0.028*** (0.009)	-0.032*** (0.010)	-0.022** (0.011)
DragonYear X Chinese	0.171*** (0.016)	0.168*** (0.018)	0.161*** (0.021)
DragonYear X ChMaj	-0.023** (0.010)	-0.028* (0.015)	-0.028** (0.011)
DragonYear X Chinese X ChMaj	0.024 (0.018)	0.018 (0.016)	0.030 (0.023)
DragonYear X Hi-Res	0.023** (0.010)	0.020 (0.012)	0.024** (0.009)
DragonYear X Chinese X Hi-Res	-0.023 (0.017)	-0.026 (0.018)	-0.024 (0.016)
DragonYear X Modern sector intensity (ModSec)		0.031 (0.054)	
DragonYear X Chinese X ModSec		0.027 (0.080)	
DragonYear X Social expenditure (SocExp)			0.016 (0.012)
DragonYear X Chinese X SocExp			-0.023 (0.027)
P-value of F-test			
DragonYear + DragonYear X Chinese	0.000***	0.000***	0.000***
DragonYear + DragonYear X ChMaj	0.000***	0.006***	0.000***
DragonYear + DragonYear X Hi-Res	0.395	0.364	0.806
DragonYear + DragonYear X ModSec		0.987	
DragonYear + DragonYear X SocExp			0.795
Observations	2,686	2,686	2,686
R-squared	0.972	0.972	0.972
Mean of dependent variable (in levels)	32.2	32.2	32.2

Notes: Dependent variable is log(birth rate). All specifications include fully interacted district-ethnicity fixed effects and trends, as used in Column 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. ^a *Modern sector intensity* is the share of employed workers in manufacturing, mining, and commerce, or construction out of all employed workers in the district. ^b *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 Appendix Table A.2 for more details on the state-level variables. Standard errors clustered at the district level are reported in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

Table 7: Impact of Chinese Lunar Calendar on Infant Mortality and Birth Weight

Dependent variable:	Log of:			
	Under-1 mortality rate		Very low birth weight rate	
	(1)	(2)	(3)	(4)
DragonYear (DY)	0.051** (0.022)	0.020 (0.017)	0.156** (0.065)	0.215** (0.073)
DragonYear X Chinese (Ch)	-0.056*** (0.013)	-0.073*** (0.020)	-0.089 (0.131)	-0.168 (0.217)
DragonYear X ChMaj (ChMaj)		0.068** (0.023)		0.136 (0.109)
DragonYear X Chinese X ChMaj		-0.012 (0.018)		-0.429*** (0.113)
DragonYear X Hi-Res		0.045 (0.025)		-0.240* (0.124)
DragonYear X Chinese X Hi-Res		-0.007 (0.027)		0.465* (0.224)
P-value of F-test				
DragonYear + DragonYear X Ch	0.827	0.018**	0.388	0.755
DragonYear + DragonYear X ChMaj		0.012**		0.024**
DragonYear + DragonYear X Hi-Res		0.006***		0.810
Level of observation	District-year-ethnicity		State-year-ethnicity	
Observations	462	462	172	172
R-squared	0.897	0.898	0.583	0.591
Mean of dependent variable (in levels)	35.6	35.6	4.7	4.7

Notes: Regressions use ethnicity-state-year observations and include fully interacted state-ethnicity fixed effects and trends. Regressions in columns (1) and (2) includes 1970 to 1990, and regressions in columns (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 number of children born less than 2.5 kilograms divided by 1,000 live births. * p<0.10, ** p<0.05, *** p<0.01.

Table 8: Impact of Chinese Lunar Calendar on Education Outcomes

Dependent variable:	No. of students in grade 1/ No. of primary school teachers (1)	Share of students who passed:		
		All 5 subjects (2)	At least 4 subjects (3)	At least 3 subjects (4)
DragonYear	0.259*** (0.0547)	-3.59*** (0.417)	-2.67*** (0.539)	-1.67*** (0.528)
Observations	209	187	187	187
R-squared	0.931	0.857	0.824	0.805
Mean of dependent variable	4.093	18.37	52.84	72.22

Notes: Regressions use state-year observations and include state trends. Regression in column (1) uses data from 1977 to 1996, which covers the period in which individuals born in 1970 to 1989 would have entered first grade in primary school. Regressions in columns (2), (3), and (4) use data from the *Sijil Tinggi Persekolahan Malaysia* (Malaysia Higher School Certificate) examination for the 1974-1990 birth cohorts. All regressions are weighted by population. Standard errors clustered at the state level are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.