Fortunes of Dragons: Cohort Size Effects on Life Outcomes (Fortunes of Dragons)

Sumit Agarwal
Professor
BIZ1 7-66, 15 Kent Ridge Drive, Singapore 119245
National University of Singapore

Wenlan Qian
Associate Professor
BIZ1 7-66, 15 Kent Ridge Drive, Singapore 119245
National University of Singapore

Tien Foo Sing
Associate Professor
SDE1-05-17, 4 Architecture Drive, Singapore 117566
National University of Singapore

Poh Lin Tan (corresponding author)
Assistant Professor
LKS 02-13, 469B Bukit Timah Road, Singapore 259771
National University of Singapore
(65) 6601 5228
spptplj@nus.edu.sg

Acknowledgements We thank Hyun Soo Choi, James Choi, Nicolae Garleanu, Camelia Kuhnen, Alexander Ljungqvist, Randall Morck, Ivan Png, David Reeb, Jacob Sagi, Johan Sulaemon, Frank Yu, Washington University at Saint Louis, UNC Chapel Hill, University of Southern California, Georgetown University, George Mason University, HKUST, Hong Kong Baptist, National University of Singapore, Nanyang Technological University, PBC Tsinghua, Singapore Management University, and UNSW for valuable feedback. The authors thank the Provost's Office, National University of Singapore for providing administrative data. All errors are our responsibility.

Abstract

This paper examines the long-term effects of birth cohort size on life outcomes. Using administrative data from Singapore, we study the outcomes of large birth cohorts created by the Chinese superstitious practice of zodiac birth timing, where parents prefer to give birth in the year of the Dragon. This practice is followed exclusively by the Chinese majority, with no similar patterns detected among non-Chinese minorities, allowing us to differentiate cohort size effects from confounding year of birth effects. Despite the government's efforts to increase public educational resources for these cohorts, Chinese Dragons are less likely to gain admission to national universities and earn lower income. There is also evidence of negative externalities on non-practicing populations who happen to enter the labour market at the same time as Chinese Dragons. Our analysis suggests that the adverse life outcomes are not due to selection, but rather reflect the aggregate resource implications of birth cohort size.

Keywords Cohort Size, Cohort Effect, Fertility, Education, Income, Superstition

Conflict of Interest The authors declare that they have no conflict of interest.

Data availability The data that support the findings of this study are available from the corresponding author, PLT, upon reasonable request.

1. Introduction

A substantial literature suggests that birth cohort size generally has a negative impact on wages and employment (e.g., Welch 1979; Smith and Welch 1981; Berger 1985; Bloom, Freeman and Korenman 1988; Wright 1991; Korenman and Neumark 2000; Brunello 2010). Intuitively, individuals from a larger cohort face greater competition for limited resources, which hurts their economic well-being. Welch (1979)'s seminal work estimates that U.S. baby boom cohorts entering the labour market in 1970 had 10% lower lifetime earnings than cohorts entering in 1962. Beyond labour market outcomes, belonging to a large birth cohort also has implications for social behaviour and psychological well-being. Ahlburg and Schapiro (1984) find higher suicide rates among younger workers from larger cohorts in the U.S. Cohort size is also linked to higher probability of committing property crimes, possibly due to lower relative income and lower levels of adult supervision and care (O'Brien 1989; Savolainen 2000). Moreover, a recent body of research suggests that early life experiences can also significantly influence beliefs, perceptions of risk and future consumption and financial decisions (Malmendier and Nagel 2011; Malmendier and Nagel 2016).

While this question has motivated a large body of work, especially given the observed variation in birth cohort sizes in recent history and the associated macroeconomic and sociological implications, previous research has been hindered by various identification challenges. Most prominently, cohort effects are perfectly multicollinear with age and period effects, including a plethora of concurrent macroeconomic and sociological changes such as the rise in female labour participation, significant changes in population educational profiles and technological changes, and omitted variable bias, such as offsetting market and policy responses. In addition, birth cohort size is potentially endogenous to the relative income of preceding

generations (Easterlin 1961), resulting in the possibility of reverse causality bias. Moreover, cohort size influences a multitude of outcomes, but data limitations in existing studies restrict the scope for a comprehensive assessment.

This paper adds to the existing literature by employing an empirical strategy to clearly differentiate the cohort size effect from confounding year of birth effects. We exploit cohort size variation created by the superstitious practice of zodiac birth timing in the city-state of Singapore, which provides an ideal research setting due to its multi-racial composition with a Chinese majority and large Malay and Indian minorities. Chinese parents prefer to give birth in the year of the Dragon which occur once every 12 years, with the belief that children born under this sign are noble, long-lived and bound for success. Moreover, zodiac birth timing is practiced exclusively by the Chinese, with no evidence that parents from other races seek to either target or avoid the year. Using a difference-in-difference model which controls fully for year of birth fixed effects, we examine the impact of cohort size on a range of socio-economic variables, including individuals' family background, human capital acquisition, adult income and employment status, as well as consumption choices. We also look into whether the impact of zodiac birth timing spills over to other groups, including non-Chinese and other Chinese cohorts, who do not practice birth timing but are nevertheless exposed to the increased cohort size.

We estimate a significant spike in the number of Chinese births by 9.7% in the year of the Dragon, with no significant patterns detected among non-Chinese minorities. Consistent with previous literature, our difference-in-difference results show that socioeconomic selection into zodiac birth timing is generally weak. Nevertheless, the large birth cohorts are associated with statistically and economically significant negative effects on educational outcomes. Chinese Dragon babies are 2.3 percentage points less likely to be admitted to national universities,

especially for less competitive college majors, suggesting that cohort size disproportionately affects marginal students. These effects persist despite evidence that the government anticipated and consciously attempted to accommodate the large Dragon cohorts through the public educational system, suggesting limited capacity of such measures to accommodate the surge in demand for resources.

We also estimate that Chinese Dragon babies earn 6.3% lower incomes than other Chinese cohorts in the labour market, relative to the difference among the non-Chinese. The effects are largely due to a disproportionately high proportion of low-income earners, rather than a lower proportion of high-income earners. We find no significant effect on probability of unemployment, likely due to the loose labour regulatory regime in Singapore. Instead, Chinese Dragon babies are less likely to be hold higher-paid professional occupations in the formal sector, and more likely to be in the lower-paid self-employment sector.

Moreover, we find significant negative spillover effects on non-practicing groups who happen to enter the labour market at the same time as Chinese Dragons, which support the hypothesis that the adverse life outcomes are due to birth cohort size effects. First, non-Chinese individuals born in Dragon years also earn significantly lower incomes than other non-Chinese cohorts. The negative income effect is weaker, possibly due to the partially segmented labour market for different races in Singapore. Second, we exploit variation caused by the exogenous national service mandate, which strictly requires all Singaporean males to perform two and a half years of national service, commonly between the ages of 19 and 22. Hence, even though Singaporean men and women born in the same calendar year attend primary and secondary school together, the men enter the labour market with women who are two years younger (born in the year of the Horse). We find that this group also has significantly lower labour income,

whereas there are no effects for their male counterparts (who do not enter the labour market with the Dragon cohort).

Finally, we document that while Chinese Dragons spend a higher fraction of their incomes on necessities (and hence have relatively low savings rates), they do not cut down on status-seeking consumption on luxurious items such as jewellery and beauty salons, consistent with literature on the effects of cohort size on conspicuous consumption. Hence, belonging to a large birth cohort may also has implications for consumption and financial decisions.

The structure of the rest of the paper is as follows. Section 2 provides a historical overview of zodiac birth timing in Singapore and other Confucian-influenced societies, and discusses relevant background information on Singapore's demographic, educational and civil institutions. Section 3 presents the data sources and empirical methodology. Section 4 presents evidence on the impact of birth cohort size on life outcomes of Chinese Dragons and negative externalities on other groups. Section 5 presents robustness tests and looks at the consumption behavior of Dragon babies. Section 6 summarizes and concludes.

2. Background

2.1 Zodiac birth timing in East and Southeast Asia

The superstitious belief that an individual's personality, abilities and luck depend to some extent on the positioning of the constellations and astrological phenomena at the time of birth is rooted in multiple cultures around the world. In the U.S. and European countries, astrological readings and predictions are primarily based on the Greek zodiac, which has twelve signs based approximately on month of birth. The Chinese zodiac (*sheng xiao*) also has twelve signs, but signs are based on year rather than month of birth. Each twelve-year cycle is assigned one of five

elements (wood, water, fire, earth or metal), so that the full zodiac cycle takes 60 years to complete.

Among the twelve animal signs in the Chinese zodiac, the Dragon commands a special allure as the only mythical creature. Unlike the Western notion of the Dragon, which is typically associated with the serpent from the Garden of Eden and portrayed as man-eating and destructive, the Chinese conception is overwhelmingly positive and associated with benevolence, intelligence, might and potency (Goodkind 1991; Yip, Lee and Cheung 2002). Traditionally, the Dragon is used as a symbol for the Chinese emperor (usually depicted in imperial yellow, the color of royalty), while ordinary Chinese may sometimes refer to themselves as "descendants of the Dragon". Accordingly, children born under this sign are believed to be blessed with good fortune, longevity and nobility, and the men, in particular, are seen as bound for great things.

In the wake of the profound cultural and social changes in the past century and importance of science as a mainstay of public education curricula in East and Southeast Asia, it may seem surprising that modern Chinese populations pay credence to an unfounded traditional superstition. In fact, zodiac birth timing is a modern day phenomenon as cultural prescriptions surrounding fertility shifted from having as many sons as possible (*duo zi duo fu* or "the more sons, the more fortunate"), to viewing childbearing as a conscious choice where child quality, including ensuring that the child is born under the most auspicious zodiac sign, became increasingly important (Goodkind 1996). The shift was heavily pushed by local governments through national family planning programs which provided family counselling and access to contraceptives, sterilization and legal abortion, and generally embraced by people as a way to secure a better life for their families.

While the practice of zodiac birth timing has been documented among Chinese populations across East and Southeast Asia, including Hong Kong, Malaysia, the Philippines, Singapore, Taiwan and Thailand, it did not make an appearance in mainland China until recently, due to state-led condemnation of traditional superstitious beliefs during the 1966-76 Cultural Revolution. With the opening up of China, there is some evidence that zodiac birth timing is beginning to catch on among younger cohorts, especially in higher income areas (Nye and Xue 2014; Mocan and Yu 2017), although the superstitions take on a differing form in some respects, including a view of the year of the Sheep as an unlucky year for childbearing (Lee and Park 2006; Lu et al. 2020). Although the Japanese and South Koreans follow very similar zodiacs, birth timing mainly takes the form of avoiding the year of the Horse for having daughters (Kaku and Matmoto 1975; Lee and Park 2006). However, there is no marked preference or aversion towards children born in the year of the Dragon. Hence, the Dragon seems to be a uniquely Chinese obsession.

Several papers have examined motivations and forces of selection underlying zodiac birth timing (Goodkind 1991; Goodkind 1996; Yip, Lee and Cheung 2002). In Singapore, the biodemographic proximate determinants explaining the rise in births during Dragon years include timing of marriage and increased coital frequency. There is evidence that selection into zodiac birth timing is generally weak or positive: the phenomenon was observed across all family sizes smaller than five in Singapore, and across all age, education and urbanization categories in Malaysia, with larger effects in low-fertility districts (Goodkind 1995; Goodkind 1996). Analyses using individual-level data suggest that parents who engage in zodiac birth timing have similar or higher socioeconomic profiles, compared to parents who give birth in other years (Johnson and Nye 2011; Mocan and Yu 2017). Other unobserved attributes may also

favour children born in Dragon years, since more conscientious parents may be more willing to "play safe" by adhering to the dictates of superstitious lore with regard to childbearing.

Only a handful of studies have examined the long-term consequences of belonging to a large Dragon cohort. The most closely related study is Sim (2015), which uses the nationally representative National Youth Survey to study the impact on probability of university admission among Singaporean men. He finds that men born in the year of the Dragon are less likely to enter university, and that the effects persist after controlling for parental income. This paper's research question and methodology differ from Sim (2015) by modelling cohort size as a determinant of labour market outcomes, rather than as an instrument for educational attainment, using a difference-in-differences approach which controls fully for cohort fixed effects. In addition, we present evidence of negative externalities on other races and zodiac groups. Both papers find similar negative consequences of being born in a Dragon cohort on educational outcomes. On the other hand, Mocan and Yu (2017) provide evidence from Chinese microdata that Dragons have higher university entrance scores and are more likely to attend university; similarly, Lau (2019) and Wong and Yung (2005) estimate that Dragons have better school performance, completed slightly more schooling and received slightly higher wages after controlling for education and work experience in Hong Kong. Taken together, the literature suggests that competition arising from increased cohort size leads to competing influences on students' performance: it may boost individuals' motivation and effort, while simultaneously diluting communal resources available to each individual. Under non-identical institutional contexts, the former effect may dominate the latter in some cases, while the latter may outweigh the former in other cases.

A couple of studies have also studied the impact of astrological beliefs in non-Chinese societies: Johnson and Nye (2011) show that Asian children in the United States (excluding

immigrants from mainland China or India) completed more education if they were born in the 1976 year of the Dragon, and attribute their finding to positive selection into zodiac birth timing. Finally, Do and Phung (2010) document that Vietnamese children born under auspicious signs according to the Vietnamese horoscope (which include non-Dragon years) complete slightly more schooling, likely due to higher probability of birth intendedness. This paper adds to this body of research by using a multi-racial setting to examine a more comprehensive range of cohort outcomes, including human capital acquisition, income and employment status, and consumption choices.

2.2 Background on Singapore

Singapore is a multi-racial island nation with a land area of 719 square kilometres, approximately the same size as New York City, with a population size of 5.54 million in 2015, of which 3.90 million are citizens or permanent residents. The bulk of the population comprises of three main ethnic groups: 74.3% Chinese, 13.3% Malay and 9.1% Indian (Ministry of Health 2016). Although Singapore is a highly westernized society, with English as the medium of primary instruction from primary school to university, the public school curriculum also includes mother tongue classes (Standard Mandarin, Malay or Tamil) under the Bilingual Policy, in order to preserve the identities and values of the three main ethnic groups. While the government provides public fair employment practice guidelines, historically there were no legal penalties against employers who expressed race- or language-based preferences in hiring – instead, ethnic communities were encouraged to provide in-group assistance and support, including training for job seekers, through the establishment and funding of race-based self-help groups (Moore 2000; Adzahar 2014). A recent survey found that around half of minorities (51.6% of Malays and

4.7.0% of Indians) report facing racial discrimination when applying for a job, compared to only 12.2% of Chinese (Mathews, Lim and Selvarajan 2019). Currently, it is still not unusual to see job advertisements citing racial or language needs or preferences (Supplementary Appendix IA.1).

The formal education system in Singapore consists of two years of kindergarten at ages 5-6, six years of primary school at ages 7-12 and four years of secondary school at ages 13-16. By far the three most common routes to post-secondary education are: a) two-year junior college programs, considered the elite track for university aspirants, b) three-year polytechnic courses, which award diplomas, and c) Institute of Technical Education (ITEs), which award vocational certificates. These three routes account for 27%, 45% and 26% of all final year secondary school students in 2013 (Ministry of Education 2015). Historically, the two national universities in Singapore are the National University of Singapore (NUS) and Nanyang Technological University (NTU), which were established in 1980 and 1981 respectively. Although most men apply for university in the same year as female members of their birth cohort, they are usually two years older than the women when they enter university and their first job, due to a strict mandate that all Singaporean males must perform two and a half years of national service, commonly between the ages of 19 and 22.

Singapore has undergone drastic demographic change in the past five decades since independence. Immediately after independence in 1965, the government established a Family Planning and Population Board Act to reduce the national fertility rate. As baby boom cohorts reached childbearing ages in the early 1970s, the birth rate spiked, leading to re-doubled efforts to control population growth. Abortion and sterilization was legalized in 1970, and the government launched one of the most comprehensive anti-natalist programs in the world, under

the “Stop at Two” campaign from 1969 to 1972. By the mid-1970s, the fertility rate had fallen from above four in 1965 to below replacement levels, and by the late 1980s, the low rates became a matter of national concern, causing the government to reverse its policies under the slogan “Have Three or More (If You Can Afford It)”. Currently, with high levels of urbanization, economic development and education, the fertility rate in Singapore is one of the lowest in the world, and families are now offered a package of pro-natalist incentives, including paid parental leave, tax reliefs and childcare subsidies.

3. Data and Descriptive Statistics

3.1 Data

Our analysis employs three sources of administrative data. First, we use monthly birth data from Singapore Statistics for four Chinese zodiac cycles (48 years) between Jan 1960 and December 2007, for both sexes and four races (Chinese, Malay, Indian and Other). We exclude birth data from the current zodiac cycle to obtain a balanced dataset. The sample size is 4,608. Most of the results are presented following the western or Julian calendar, which is used by Singaporean educational institutions, since the school entry cutoff birthdate is January 1. We compare these results using the lunar calendar beginning in February and ending in January of the following year, as the Chinese New Year usually falls between late January and mid-February (Goodkind 1996).

There are relatively few sources of individual-level survey data on income in Singapore. Our second dataset is a large and rich administrative dataset of a random and representative sample of all customers at a leading bank in Singapore. All data were collected between April 2010 and March 2012. The dataset contains information on customer income, occupation,

monthly financial transactions, and background demographic information such as age, race, gender and type of residence. We exclude accounts which have been transferred, closed or active for fewer than three months, and limit our sample to Singaporean citizens born between 1960 and 1990, where 1960 is the first year for which we have birth data and 1990 is the last birth cohort for customers aged 20 and above. The sample size is 102,472. We compute average monthly income reported over the sample period of April 2010 to March 2012, winsorised for the top and bottom 1% to remove outliers and adjusted to January 2014 Singapore dollars. We do the same for individuals' total monthly credit card and debit card spending, measured as a ratio of spending to monthly income to reflect personal financial budgeting. Finally, we use data on self-reported employment status and type of occupation, excluding individuals who are currently students, national servicemen or retired, and type of residence (whether public or private) for customers with valid local addresses, as a proxy for wealth.

One important issue associated with using administrative bank data is that even though card spending constitutes an important medium of consumption and checks and direct deposit are widely used for recurring mortgage, rent, and auto loans payments (Agarwal and Qian 2014), lower-income groups may be less likely to use formal banking services. Hence, the dataset may not be nationally representative. The underrepresentation of lower-income groups is unlikely to produce negative income effects unless low-income Dragons are more likely to use more banking services compared to low-income non-Dragons. We find no indication that banking use is correlated with being born in the year of the Dragon: on average, Chinese Dragons open their bank accounts at age 21.4, very similar to 21.5 for non-Dragons. Instead, to the extent that birth cohort size has a negative impact on earnings in Dragon cohorts and produce a higher proportion of low-income individuals who are not captured by the dataset, the results in this paper may

understate the true effects of cohort sizes. Nevertheless, the estimates are still valuable, since lower bounds of the effects can be used to provide evidence of long-term consequences of zodiac birth timing. An important advantage of the dataset is that unlike most survey datasets, individual monthly income and employment status information are measured with high accuracy, since all personal information submitted to banks is by request accompanied by copies of identification cards/passports and proof of income, e.g., employer pay stubs or tax returns.

Third and finally, we use individual-level university admissions data for the two main national universities, National University of Singapore (NUS) and Nanyang Technological University (NTU), between 1981 and 2015. Before 2000, these are effectively the only universities, which enrol over 98% of all university students in the country. Between 1989 and 2003, NUS and NTU conducted joint admissions; in all other years, the dataset contains applications to NUS only. Our sample consists of 466,173 Singaporean applicants born between 1960 and 1996. We consider applicant scores and admission outcomes. Applicant scores are computed by the university admissions offices based on classified metrics, and are not generally comparable across different years or academic tracks. To allow for comparability across time, we generate each applicant's Z-score within the same application year and academic track. We consider applicants from two major academic tracks: junior college and polytechnic, which account for 85.44% and 14.56% of applicants respectively, and measure applicant scores in terms of standard deviations within the same admission year and academic track. Applicants apply for admission to specific university departments, where the minimum admission criteria for each department are usually announced prior to application deadlines. Departments are classified into three tiers based on mean applicant score of admitted students: the top third (mean score is above 0.7 of a standard deviation), middle third (mean score is between 0.3 and 0.7 of a

standard deviation), and bottom third (mean score is below 0.3 of a standard deviation), which account for 32.84%, 30.55% and 36.61% of admitted students respectively. Finally, the dataset contains information on whether applicants applied for need-based financial aid (based on household income).

Panel A of Table 1 shows that even though the Chinese make up almost three-quarters of the population in Singapore, the number of Chinese annual births is only around twice that of the non-Chinese (slightly over 32,000 compared to around 14,000), pointing to their lower fertility rates. On average, the number of annual births rises by around 4,000 or 12% in Dragon years relative to other years for the Chinese, while the corresponding figures are around 450 or 3% for the non-Chinese, with large spikes observable in 1976, 1988 and 2000 (Supplementary Appendix Figure IA.1 Panel A). Panel B shows Chinese individuals are also more likely to gain admission to one of the two local national universities (around 60% compared to slightly over 40%). The admission outcomes correspond to their higher applicant Z-scores. Both Chinese and non-Chinese individuals born in the year of the Dragon have lower admission chances, with differences generally larger for the Chinese themselves (a decline in probability of admission by around 5 percentage points compared to around 2.5 percentage points), and non-Chinese individuals born in the year of the Dragon tend to have higher Z-scores, an artifact of the larger relative decline in admission scores among the Chinese. Consistent with their stronger educational backgrounds, Chinese individuals tend to have higher monthly incomes than their non-Chinese counterparts (around S$5,500 compared to around S$4,000), with similar levels of unemployment (around 5.5%) (Panel C). Both Chinese and non-Chinese individuals born in the year of the Dragon have significantly lower average monthly incomes, although unlike birth cohort sizes in Panel A where age is not a factor, income effects are more difficult to distinguish

visually due to the collinearity between age, period and cohort effects (Supplementary Appendix Figure IA.1 Panel B). The raw differences are even larger for the non-Chinese (around S$400 compared to around $150), suggesting significant spillover effects on other races. Below, we discuss how our difference-in-differences model allows us to differentiate the impact of cohort size from confounding year of birth effects.

[INSERT TABLE 1 ABOUT HERE]

3.2 Empirical Specification

While the Chinese may favour giving birth in Dragon years, especially for sons, there are no such views in the Malay and Indian cultures. This institutional setting allows us to use a difference-in-differences model for distinguishing birth timing effects from the effects of business cycles, social or technological changes, by fully controlling for race, month and year of birth fixed effects.

$$B_{g,j,t} = \beta_0 + \beta_1 * Dragon_t + \beta_2 * ChineseDragon_{j,t} + \beta_3 * X_{g,j,t} + \theta_j + \varepsilon_{g,j,t} \quad (1)$$

where $B_{g,j,t}$ is the dependent variable representing the log of number of births born in a given month-year t to race j and gender g. $Dragon_t$ is a dichotomous variable for whether the month-year t is in a Dragon year. $ChineseDragon_{j,t}$ is a dichotomous variable for whether the race j is Chinese and the month-year t is in a Dragon year. Hence, β_2 is a difference-in-differences estimator for the percentage change in number of Chinese births born in the year of the Dragon. $X_{g,j,t}$ denotes a vector of controls for gender, race, year of birth and month of birth fixed effects,

θ_j captures race-specific quadratic trends in the number of births, and $\varepsilon_{g,j,t}$ represents robust standard errors.

To examine the effects of being born in a Dragon year on life outcomes, we use individual-level data and a difference-in-difference model which fully controls for cohort fixed effects:

$$L_i = \beta_0 + \beta_1 * Dragon_i + \beta_2 * ChineseDragon_i + \beta_3 * X_i + \theta_i + \varepsilon_i \quad (2)$$

where $ChineseDragon_i$ is a binary variable equal to one if the individual is Chinese and born in a Dragon year. X_i denotes a vector of controls for race, gender, year of birth and month of birth fixed effects. In addition to fixed effects by year of birth, which follow a similar general trend (Supplementary Appendix Figure IA.1 Panel B), θ_i allows for race-specific quadratic age trends in the case of labour market outcomes and consumption behavior, and race-specific quadratic time trends in the case of university admissions since most Singaporeans apply for university admissions within a narrow range of ages from 19 to 21. Our results are qualitatively similar whether we include or exclude race-specific age and time trends, and are statistically significant at the same levels. All errors are clustered by residential location, measured using the postal sector.

While the difference-in-difference specification fully controls for time trends, the estimates are lower bounds due to potential spillover effects on non-Chinese races who may also be affected by changes in cohort size. To check for spillover effects on other races, we conduct the analysis for the Chinese and non-Chinese separately using the following model:

$$L_i = \beta_0 + \beta_1 * Dragon_i + \beta_3 * X_i + \theta_i + \varepsilon_i \quad (3)$$

where L_i is the dependent variable representing labour market outcomes. $Dragon_i$ is a binary variable equal to one if the individual was born in a Dragon year. X_i denotes a vector of controls for gender, and month of birth fixed effects, and θ_i captures quadratic age trends. All errors are clustered by postal code.

4. Main Results

4.1 Impact on Average Cohort Size

Using the difference-in-differences model, we estimate that the number of monthly births spikes by 9.7% in Dragon years (exp(0.093)-1 = 0.097) (Panel A of Table 2). The effect is statistically significant at the 1% level. By contrast, the coefficient of the non-Chinese Dragon variable is insignificant when we do not fully control for year and month fixed effects (which absorb this coefficient due to perfect multicollinearity), suggesting that there is no effect on non-Chinese births. Figure 1 plots the difference-in-difference estimate for each zodiac sign, and shows that the upward spike in birth is unique to the year of the Dragon. (On other hand, there is a significant dip in births during Tiger years, which we discuss in detail below.)

[INSERT FIGURE 1 ABOUT HERE]

[INSERT TABLE 2 ABOUT HERE]

Panel B provides further evidence that the spike in births follows the Chinese zodiac, which is based on the lunar rather than the Julian calendar. The January of Dragon years tends to fall under the preceding Rabbit zodiac sign, and our estimates indicate that the number of births during this month is not especially high or low (0.103-0.106 = -0.003); on the other hand, there is

a significant and large impact on births in February (0.103-0.008 = 0.095). Similarly, we find that there are more births in the January of Snake years, which fall under the Dragon sign (-0.006+0.090 = 0.084), but not in February (-0.006+0.031 = 0.025). Hence, there is strong evidence that parents deliberately practice zodiac birth timing, and that the behavior is unique to Singaporean Chinese.

4.2 Selection Effect

Next, we examine whether parents who engage in zodiac birth timing differ in terms of socioeconomic characteristics from parents who give birth in other years. One potential hypothesis is that couples who have lower levels of formal education may be more likely to adhere to traditional non-scientific superstitious beliefs; on the other hand, those with more education or resources may be more motivated or have higher ability to control timing of childbearing. As noted in the literature review, previous studies suggest that selection effects are generally either weak or positive (Goodkind 1996; Johnson and Nye 2011; Mocan and Yu 2017).

To look empirically into this issue, we use two sources of administrative data. First, we use indicators of parental background available from the university admissions dataset, namely whether applicants requested for need-based financial aid, and type of residence (whether public or private) at the time of university application. Second, we obtain another random sample of accounts from the same bank, restricted to customers aged 25-54 who report having at least one child, and the child's year of birth. The additional dataset was collected in December 2017. Similar to our main dataset, we use income data, winsorised for the top and bottom 1% to remove outliers and adjusted to January 2014 Singapore dollars, employment status, occupation and residence type. The sample size is 37,561.

Using the same difference-in-differences framework employed for the above birth analysis, we find no significant differences in parental income levels, employment status or occupation (Table 3). While the coefficient for parental income levels is small and negative, differences are not consistent (Supplementary Appendix Figure IA.1 Panel C) and the coefficient for parental professional occupation is small and positive, suggesting an overall mixed picture. Chinese Dragons are no more or less likely to apply for need-based financial aid than non-Dragons, and evidence from both data sources indicates that their families have similar probabilities of residing in public housing. Consistent with past literature, the results suggest that selection effects are weak and unlikely to explain cohort differences in life outcomes.

Although the indicators of parental background available in the administrative datasets are not significant, we acknowledge that this balancing test is not sufficient in itself to prove that there are no unobserved differences in background characteristics between Chinese Dragons and non-Dragons. Reassuringly, our study conclusions remain the same when we control for residential location, the only individual-level proxy for socioeconomic and demographic characteristics available in the administrative data. Moreover, in the rest of the paper, we provide other pieces of evidence that strongly suggest that birth cohort size do indeed have long-term effects on life outcomes.

[INSERT TABLE 3 ABOUT HERE]

4.3 Educational Outcomes

Despite the lack of significant differences in family backgrounds, does belonging to a larger birth cohort hurt Dragons' prospects of gaining admission to national universities? Consistent with Sim (2015), we estimate that, on average, Chinese Dragons are 2.3 percentage

points less likely to be admitted than other Chinese, relative to the difference between their non-Chinese counterparts (Table 4). The effect is significant at the 5% level. When we consider the results separately for Chinese and non-Chinese, we find lower probability of university admission among Chinese Dragons but not non-Chinese Dragons, although the results are not statistically significant for these smaller samples (Supplementary Appendix Table IA.1). The difference-in-difference effect of 2.3 percentage points is not large, representing a decline of 4.0% in the baseline admission rate for the Chinese and appears to be driven by lower probabilities of admission to the middle and bottom third of departments, especially the latter, suggesting that cohort size affects marginal applicants more.

[INSERT TABLE 4 ABOUT HERE]

We consider two possible explanations for the result: first, the larger cohort size may increase the applicant pool, making it more difficult to get in; and second, cohort size effects may also affect Chinese Dragons' ability to prepare for tertiary education, resulting in their significantly lower applicant scores by around 0.06 of a standard deviation. To look into the first explanation, we compute ratios of applicants to birth cohort size by race for each year. On average, applicant ratios are marginally higher in Dragon years by 6 and 4 per 1,000 among the Chinese and non-Chinese respectively. The differences are statistically insignificant, suggesting that Dragons have similar probabilities of graduating from secondary school, though with lower school performance. Hence, each Dragon applicant faces more competition simply due to the larger base population. Second, we check whether the lower probability of admission can be explained by differences in pre-tertiary preparation, and find that coefficient sizes decline substantially and are no longer statistically significant once applicant scores are controlled for

(Supplementary Appendix Table IA.2). Hence, the results appear to be primarily driven by the second explanation.

Our findings are consistent with administrative evidence and anecdotal observations that the local educational system anticipates and prepares for the fluctuations in cohort sizes, including opening nine new primary schools in preparation for the 1988 Dragon year cohort. More recently, the Minister for Education announced that an additional 2,600 places have been prepared for the incoming 2012 Dragon primary school cohort, noting that "[t]he planning of school places are also considered both at the national and local levels to ensure there are sufficient vacancies" (Channel NewsAsia 2018). Indeed, there is little evidence that Dragon cohorts were disadvantaged by higher student-teacher ratios in primary or secondary schools, based on annual aggregate statistics on teacher and student populations between 1985 and 2015 (Supplementary Appendix Table IA.3). Similarly, the national universities appear to adjust the number of available places in response to the larger Dragon cohorts: on average, universities admit 7.2% more Chinese applicants in Dragon years than in non-Dragon years. Taken together, the evidence suggests that Chinese Dragons are less likely to gain admission to a national university, largely due to lower pre-tertiary preparation, rather than a lack of educational facilities.

4.4 Labour Market Outcomes

The impact of cohort size on labour market outcomes tends to be contextualized by regulatory regimes (Korenman and Neumark 2000; Brunello 2010). In markets with more protections for labour, including a number of European economies and Japan, increases in cohort size led to stable youth wages but higher unemployment. By contrast, in the U.S. where markets

are more flexible with fewer employment protection rights for older workers, youth wages declined while the impact on unemployment was mitigated by movement to a wider set of non-youth intensive industries (Bloom, Freeman and Korenman 1988).

Panel B of Table 4 shows that on average, the incomes of Chinese Dragon cohorts are lower by around 6.3%, statistically significant at the 1% level. The effect is driven by a disproportionately high proportion of low-earning individuals making less than SGD2,000 a month, rather than a lower proportion of high-income earners (those earning SGD6,000 a month or more) (Supplementary Appendix Figure IA.2). Given our estimate of a 9.7% surge in Chinese birth numbers in Dragon years, the elasticity of income with respect to cohort size is fairly large, on the order of -0.65.

Consistent with the literature, the impact on probability of unemployment is statistically small at 0.1% and insignificant, reflecting Singapore's relatively low levels of labour regulation. While Chinese Dragons are not less likely to be working, they are 3.4 percentage points less likely to be employed in the formal sector, and 1.1 percentage points more likely to be engaged in self-employment or other types of income generating activities (Supplementary Appendix Table IA.4). The effects are statistically significant at the 5% level. Since self-employment tends to be lower paying than professional occupations (Supplementary Appendix Figure IA.3), our evidence is consistent with previous literature suggesting that cohort size increases the probability of underemployment (Slack and Jensen 2008). Hence, competition for scarce formal work is likely to be an important mechanism behind the lower incomes of Chinese Dragons.

4.5 Externalities on non-Chinese Dragons

We also examine whether spillover effects exist for other groups who do not engage in zodiac birth timing. First, we consider the labour market performance of non-Chinese born in Dragon years, relative to other non-Chinese. After controlling for gender fixed effects, month of birth fixed effects, as well as quadratic age trends, we find that these cohorts earn incomes that are 3.6% lower on average (Table 5), largely due to a disproportionately high proportion of low-income earners (Figure 2, Panel B). Similar to the difference-in-difference analysis, we do not find a significant impact on unemployment status. Our estimates suggest that the impact of birth cohort size is greater for the Chinese themselves than for the non-Chinese, and that the difference-in-differences estimate is a lower bound. One plausible explanation is that in Singapore, demand for labour is not perfectly substitutable across races since workers from different races tend to have different language skills and thus face partially segmented labour markets (Supplementary Appendix IA.1).

[INSERT TABLE 5 ABOUT HERE]

Next, we examine another group subjected to spillover effects due to a unique institutional feature: the National Service mandate required of all Singaporean males, so that men are usually two years older than female members of their birth cohort when they start their first job. Hence, even though Dragon men and women share similar early life experiences (and apply for university admission in the same year), the men enter the labour market with women who are two years younger, who were born in the year of the Horse. (Similarly, Dragon women enter the labour market with men who are two years older, born in the year of the Tiger. However, as discussed later, Tiger birth cohorts tend to be smaller. Hence, we focus on the subgroup of Horse birth cohorts for greater clarity of interpretation.) We hypothesize that women born in Horse years earn lower income due to their exposure to the Dragon cohort, whereas the men, who are

not exposed, do not. The difference-in-differences results support our hypothesis: while Chinese Horse women have incomes that are 3.2% lower on average, statistically significant at the 1% level, Horse men do not have significantly different income levels (-0.033+0.052 = 0.02 which is statistically insignificant) (Panel B of Table 5). The results for Horse cohorts cannot be explained by differences in human capital outcomes, which are not statistically different from those of other birth cohorts (Supplementary Appendix Table IA.5).

The presence of negative externalities on other groups suggest that birth cohort size has a long-lasting, large impact on the economic well-being of a significant portion of the population, including those who do not practice this superstition. Furthermore, it provides additional evidence that the poor labour outcomes of Chinese Dragons are caused at least in part by differential economic conditions arising from cohort size, rather than purely due to differences in background socioeconomic characteristics.

5. Extension and Robustness

5.1 Credit Access, Consumption and Private Residence

Unsurprisingly given their lower income levels, Chinese Dragons are 2.6 percentage points less likely to hold a credit account. Moreover, among those who do hold at least one credit account, the total credit limit across all accounts is on average lower by 10.4% (Supplementary Appendix Table IA.6). The effects are statistically significant at the 1% level. We also find that they spend a higher fraction (and thus save a lower fraction) of their incomes, particularly on necessities such as groceries and utilities.

Perhaps surprisingly, we do not find that Dragons spend a lower proportion of income on conspicuous consumption on luxurious items such as jewellery and beauty salons.[5] They are also

no less likely to reside in private housing, an important status symbol in Singapore. To interpret these results, we note that conspicuous consumption may be viewed as a form of social status signalling (Ireland 1994; Corneo and Jeanne 1997). Hence, our results suggest that the larger cohort size of Dragons may also influence their consumption choices and propensity to engage in status signalling behaviour.

5.2 Robustness Tests

5.2.1 Lunar Calendar Year

Although zodiac birth timing closely follows the lunar calendar (Panel B of Table 1), we expect the effects on human capital and income to be slightly weaker under this cohort definition, since the Singaporean educational system follows the Julian calendar. The data analysis supports our expectations: under the lunar calendar, the estimated impact on monthly births in Dragon years is larger at 10.6% (compared to 9.7% under the Julian calendar), but the effects on probability of admission to a national university and average monthly income are slightly weaker (-2.1 percentage points and -5.9% respectively, compared to -2.3 percentage points and -6.3% under the Julian calendar) (Supplementary Appendix Table IA.7). The effects are significant at the 5% level.

5.2.2 Restricting the Sample to Surrounding Cohorts

Our difference-in-differences research design fully controls for year of birth fixed effects in addition to race-specific quadratic time trends. To further check that our results are not driven by these effects, we repeat our analysis with the sample restricted to birth cohorts born within three years of the Dragon cohorts, i.e. Singaporeans born in 1973-79 and 1985-91. When we use

this restricted sample, we continue to find a 6.3% decline in average incomes in Dragon years, significant at the 5% level (Supplementary Appendix Table IA.8), identical to when we include the full sample.

5.2.3 Evidence from Malaysian Chinese Dragons

We also consider the case of Malaysian Chinese as an interesting comparison group. While the two countries share strong cultural affinities, there is a large difference in the proportion of Chinese residents. In Malaysia, Chinese are the minority group, accounting for 23% of the total population (while Malays make up close to 52% of the population). As previously noted, the Chinese population in Malaysia also engages in zodiac birth timing – in fact, Chinese racial identity and cultural influences may be even stronger in Malaysia, due to ongoing state-sponsored discriminatory educational and taxation laws against the relatively wealthy Chinese minority (Goodkind 1995). Nevertheless, the practice has a smaller impact on aggregate birth cohort size due to their minority status.

We repeat our difference-in-differences analysis, using data on Malaysians who hold Singaporean bank accounts from our administrative dataset. We note that this is a selected sample, since most Malaysians do not use Singaporean banking services; nevertheless, we note that the ratio of Dragons is 9.53% among the Malaysian Chinese and 9.74% among the Malaysian non-Chinese, a difference which is not statistically significant. For this sub-sample, being born in a Dragon year is not associated with lower income; if anything, Malaysian Chinese Dragons have higher incomes on average, although again the difference is not significant (Supplementary Appendix Table IA.9). The results suggest that selection is likely to be weak and possibly even positive, consistent with our discussion above.

5.2.4 The Case of Tiger Women

At the opposite spectrum from Dragons, Tiger babies are less desired by Chinese parents, due to the association of Tigers with rebelliousness and ferocity (Goodkind 1996). In particular, daughters are thought to be unsuitable for marriage or even for attending others' weddings, as they may "eat up the good luck at weddings if invited" (Goodkind 1991). We estimate that monthly births are on average 7.8% lower in Tiger years than in other years among Singaporean Chinese, significant at the 1% level (Supplementary Appendix Table IA.10).

We find statistically significant positive effects on probability of university admission for both Chinese and non-Chinese Tigers (Supplementary Appendix Table IA.11). The effects are larger for the non-Chinese than for the Chinese, and we discuss potential explanations for these results in conjunction with the results for Dragon cohorts in the discussion section below. However, we do not find that women born in the year of the Tiger have significantly higher income levels, possibly due to asymmetric effects of cohort size effects on income (Supplementary Appendix Table IA.10). (While the results are insignificant for both women and men, we focus on the outcomes of the former, since the latter enter the labour market with Dragon women, and are hence less likely to benefit from belonging to a smaller cohort.) For example, employers may be less willing to increase wages with a temporary decline in cohort size than workers are to accept lower wages with a discontinuous jump in number of job seekers. We leave this interesting question for future research.

6. Discussion and Conclusion

Chinese parents prefer to give birth in the year of the Dragon, under the belief that children born under this sign are noble, long-lived and bound for success. Using data from the multi-racial setting of Singapore, and a difference-in-differences model which controls fully for year of birth effects, we estimate that monthly births increase by around 9.7% in Dragon years among the Chinese majority, with no similar patterns detected among non-Chinese minorities. Contrary to (and ironically, because of) superstitious lore, Chinese Dragons face daunting future economic prospects, including lower probability of admission to a national university, especially among marginal applicants, and lower average incomes and probability of holding a higher-paid professional occupation in the formal sector.

Moreover, there is evidence that impact of zodiac birth timing spills over to non-practicing populations. We find a significant negative impact on non-Chinese Dragons, although the effect appears to be smaller, possibly due to the partially segmented labour market for different races in Singapore. In addition, using variation caused by the exogenous national service mandate, which strictly requires all Singaporean males to perform two and a half years of national service, we show that women born in the year of the Horse, who enter the labour market at the same time as Dragon males, also have significantly lower earnings, whereas there are no effects for their male counterparts. The significant spillover effects suggest that Chinese Dragons' ill economic fates are caused at least in part by cohort size, rather than to differences in background socioeconomic characteristics.

The long-lasting negative life outcomes of being born in larger cohorts persist even though the Singaporean government anticipated and consciously attempted to accommodate larger cohorts through the public educational system, pointing to limited capacity of policy measures to accommodate sudden surges in demand for resources, such as finding experienced

teachers for larger classes. Moreover, the effects tend to be larger for Chinese Dragons than for non-Chinese Dragons. We consider two alternative explanations. One, there may be increased race-specific competition for schools specializing in certain mother tongues as well as limited educational resources in the private educational market, i.e. shadow education, so that a spike in Chinese cohort size has a disproportionate impact on the educational outcomes of the Chinese. Two, although local universities do not have official affirmative action policies, similar quality applicants from an ethnic minority background may offer more attractive admission applications, by bringing with them different experiences which bring cultural and intellectual diversity to campus. As a result, these applicants may be relatively shielded from increased competition. Our results for the smaller Tiger cohorts, where the positive effects on admission chances tend to be larger for the non-Chinese, are consistent with the second explanation which predicts that minorities would disproportionately benefit from increased educational opportunities, while the first explanation would predict the opposite: that the Chinese would benefit more from a race-specific decline in cohort size. In either case, to ameliorate the negative impacts of zodiac birth timing, one possible response is to reduce the level of common exposure (and competition for resources), such as adjusting school entry laws to reduce the overlap between school (and labour market) cohorts and zodiac cycles.

There are several limitations of this paper. First, our administrative bank dataset may not be nationally representative if lower-income groups are less likely to use formal banking services, since the evidence strongly suggests that being born in the year of the Dragon has a negative impact on income. Hence, the estimates in this paper provide evidence of long-term consequences of zodiac birth timing, but may understate the true magnitude of these effects. Second, although we test for and do not detect significant differences in parental background

characteristics, it is nevertheless possible that parents treat Dragon children differently, by reinforcing their perceived natural advantages through increased resource allocation and/or higher parental expectations (see, e.g., Do and Phung 2010; Mocan and Yu 2017). The implications of positive selection in unobserved parental characteristics and preferential parental treatment again suggest that our results, if anything, understate the impacts of being born to a large cohort. Third, we are unable to account for the impact of zodiac birth timing on number of siblings, which has implications for dilution of parental resources and may help to explain effects such as lower educational achievement. We note, however, that the evidence of negative externalities on non-practicing populations strongly suggests that birth cohort size plays a causal role in determining economic well-being. Finally, while we interpret Dragons' equal propensity to engage in conspicuous consumption despite substantially lower incomes as status signalling behavior, we cannot rule out alternative explanations, including the impact of internalized stereotypes on self-esteem and consumption preferences, or poorer financial knowledge and management skills resulting from lower acquisition of human capital.

References

Agarwal, Sumit, and Wenlan Qian. 2014. Consumption and debt response to unanticipated income shocks: evidence from a natural experiment in Singapore, *American Economic Review* 104(12): 4205-4230.

Agarwal, Sumit, Wenlan Qian, and Xin Zou. 2017. Thy neighbor's misfortune: peer effects on consumption. SSRN Working Paper.

Ahlburg, Dennis A., and Morton Owen Schapiro. 1984. Socioeconomic ramifications of changing cohort size: an analysis of U.S. postwar suicide rates by age and sex, *Demography* 21(1): 97-108.

Adzahar, Fadzli Baharom. 2014. Weak ties in the Singapore Labour Market. *Asian Journal of Social Science* 42(3/4): 203-232.

Berger, Mark C. 1985. The effect of cohort size on earnings growth: a reexamination of the evidence, *Journal of Political Economy* 93(3): 561-573.

Bertrand, Marianne, Esther Duflo, and Sendhil Mullainathan. 2004. How much should we trust differences-in-differences estimates? *Quarterly Journal of Economics* 119(1): 249-275.

Bloom, David E., Richard B. Freeman, and Sanders D. Korenman. 1988. The labour-market consequences of generational crowding, *European Journal of Population* 3(2): 131-176.

Brunello, Giorgio. 2010. The effects of cohort size on European earnings, *Journal of Population Economics*, 23: 273-290.

Cameron, A. Colin, and Douglas L. Miller. 2015. A practitioner's guide to cluster-robust inference. *Journal of Human Resources* 50: 317-372.

Channel NewsAsia. 2,600 more places available for Dragon year primary 1 cohort: Ong Ye Kung, 27 June 2018. https://www.channelnewsasia.com/news/singapore/dragon-year-primary-1-cohort-more-placed-ong-ye-kung-10475384

Charles, Kerwin Kofi, Erik Hurst, and Nikolai Roussanov. 2009. Conspicuous consumption and race, *Quarterly Journal of Economics* 124: 425-467.

Corneo, Giacomo and Olivier Jeanne. 1997. Conspicuous consumption, snobbism and conformism, *Journal of Public Economics*: 66, 55-71.

Do, Quy-Toan and Tung D. Phung. 2010. The importance of being wanted, *American Economic Journal: Applied Economics* 2(4): 236-253.

Easterlin, Richard A. 1961. The American baby boom in historical perspective, *American Economic Review* 51(5): 869-911.

Goodkind, Daniel M. 1996. Chinese lunar birth timing in Singapore: new concerns for child

quality amidst cultural modernity, *Journal of Marriage and Family* 58(3): 784-795.

Goodkind, Daniel M. 1995. The significance of demographic triviality: minority status and zodiacal fertility timing among Chinese Malaysians, *Population Studies* 49(1): 45-55.

Goodkind, Daniel M. 1991. Creating new traditions in modern Chinese populations: aiming for birth in the year of the Dragon, *Population and Development Review* 17(4): 663-686.

Heffetz, Ori. 2011. A test of conspicuous consumption: visibility and income elasticities, *Review of Economics and Statistics* 93(4): 1101-1117.

Ireland, Norman J. 1994. On limiting the market for status signals. *Journal of Public Economics* 53: 91-110.

Johnson, Noel D. and John V. C. Nye. 2011. Does fortune favor Dragons? *Journal of Economic Behavior and Organization* 78: 85-97.

Kaku Kanae, and Y. Scott Matsumoto. 1975. Influence of a folk superstition on fertility of Japanese in California and Hawaii, 1966, *American Journal of Public Health* 65(2): 170-174.

Korenman, S, and D. Neumark. 2000. Cohort crowding and youth labor markets, in D. G., Blanchflower and R. B. Freeman (eds), Youth Employment and Joblessness in Advanced Countries. University of Chicago Press, pp. 57-106.

Lau, Yan. 2019. The dragon cohort of Hong Kong: traditional beliefs, demographics, and education. *Journal of Population Economics* 32(1): 219-246.

Lee, Jungmin, and Myungho Paik. 2006. Sex preferences and fertility in South Korea during the year of the Horse, *Demography* 43(2): 269-292.

Lu, Jackson G., Xin Lucy Liu, Hui Liao, and Lei Wang. 2020. Disentangling stereotypes from social reality: Astrological stereotypes and discrimination in China. Journal of Personality and Social Psychology. Advance online publication.

Malmendier, Ulrike, and Stefan Nagel. 2016. Learning from inflation experiences. *Quarterly Journal of Economics* 131(1): 53-87.

Malmendier, Ulrike, and Stefan Nagel. 2011. Depression babies: do macroeconomic experiences affect risk taking? *Quarterly Journal of Economics* 126(1): 373-416.

Mathews, Mathew, Leonard Lim, and Shanthini Selvarajan. 2019. IPS-Onepeople.sg indicators of racial and religious harmony: Comparing results from 2018 and 2013. IPS Working Paper No. 35.

Ministry of Education. 2015. Education statistics digest 2015. https://www.moe.gov.sg/docs/default-source/document/publications/education-statistics-

digest/esd-2015.pdf. Accessed 17 November 2016.

Ministry of Health. 2016. Population and vital statistics. https://www.moh.gov.sg/content/moh_web/home/statistics/Health_Facts_Singapore/Population_And_Vital_Statistics.html. Accessed on 17 November 2016.

Mocan, Naci H. and Han Yu. 2017. Can superstition create a self-fulfilling prophecy? School outcomes of Dragon children of China. NBER Working Paper No. 23709.

Moore, R. Quinn. 2000. Multiracialism and meritocracy: Singapore's approach to race and inequality, *Review of Social Economy* 58(3): 339-360.

Nye, John N., and Melanie Meng Xue. 2014. Raising Dragons. George Mason University Working Paper in Economics No. 15-18.

O'Brien, Robert M. 1989. Relative cohort size and age-specific crime rates: an age-period-relative-cohort-size model, *Criminology* 27(1): 57-78.

Savolainen, Jukka. 2000. Relative cohort size and age-specific arrest rates: a conditional interpretation of the Easterlin effect, *Criminology* 38(1): 117-136.

Sim, Nicholas. 2015. Astronomics in action: the graduate earnings premium and the Dragon effect in Singapore, *Economic Inquiry* 53(2): 922-939.

Slack, Tim, and Leif Jensen. 2008. Birth and fortune revisited: a cohort analysis of underemployment, 1974-2004, *Population Research and Policy Review* 27: 729-749.

Smith, James P., and Finis Welch. 1981. No time to be young: the economic prospects for large cohorts in the United States, *Population and Development Review* 7(1): 71-83.

Welch, Finis. 1979. Effects of cohort size on earnings: the baby boom babies' financial bust, *Journal of Political Economy* 87(5): S65-S97.

Wong Ka Fu, and Linda Yung. 2005. Do Dragons have better fate? *Economic Inquiry* 43(3): 689-697.

Wright, Robert E. 1991. Cohort size and earnings in Great Britain, *Journal of Population Economics* 4(4): 295-305.

Yip, Paul S. F., Joseph Lee, and Y. B. Cheung. 2002. The influence of the Chinese zodiac on fertility in Hong Kong SAR, *Social Science and Medicine* 55: 1803-1812.

Table 1: Summary statistics, by race and year of the Dragon

Notes: Birth statistics are computed using mid-year population estimates for 1960 to 2007 from Singapore Statistics. ***, **, and * correspond to statistical significance at 1%, 5% and 10% level respectively.

Table 2: Differences in birth patterns in the year of the Dragon

Notes: The dependent variable is the natural logarithm of monthly births between 1960 and 2007. All estimates control for gender and race fixed effects, year and month of birth fixed effects, and race-specific quadratic time trends, unless otherwise specified. All specifications use robust standard errors. ***, **, and * correspond to statistical significance at 1%, 5% and 10% level respectively.

Table 3: Differences in parental characteristics in the year of the Dragon

Notes: Panels A and B control for parental race and gender fixed effects, year and month of birth fixed effects and race-specific quadratic age trends. Panel C controls for child race and gender fixed effects, race-specific quadratic time trends, repeat applications and the 1989-2003 university joint admission exercise. All estimates control for child year of birth fixed effects. Standard errors are clustered by residential sector. ***, **, and * correspond to statistical significance at 1%, 5% and 10% level respectively.

Table 4: Educational and labour market outcomes of Singaporeans born in the year of the Dragon

Notes: Panel A controls for race-specific quadratic time trends, repeat applications and the 1989-2003 university joint admission exercise. Panel B controls for race-specific quadratic age trends. All estimates control for race and gender fixed effects, and year and month of birth fixed effects. Standard errors are clustered by residential sector. ***, **, and * correspond to statistical significance at 1%, 5% and 10% level respectively.

Table 5: Externalities on other Singaporeans' labour market outcomes

Notes: All estimates control for gender fixed effects, month of birth fixed effects and race-specific quadratic age trends. Standard errors are clustered by residential sector. ***, **, and * correspond to statistical significance at 1%, 5% and 10% level respectively.

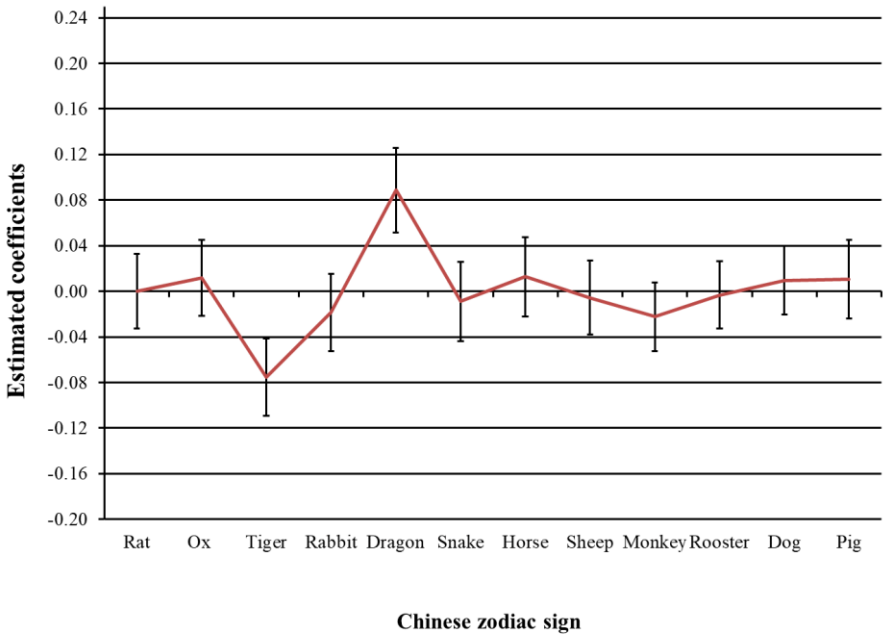

Figure 1: Difference-in-difference estimates by zodiac sign

Notes: All estimates control for gender and race fixed effects, year and month of birth fixed effects, and race-specific quadratic time trends. 95% confidence intervals are represented by error bars. Birth data from 1960 to 2007 are obtained from Singapore Statistics.