2016

Three Essays on Health Economics

Cheng Wang
Lehigh University

Three Essays on Health Economics

by
Cheng Wang

Presented to the Graduate and Research Committee

of Lehigh University

in Candidacy for the Degree of

Doctor of Philosophy

In

Business and Economics

Lehigh University
September, 2016

Certificate of Approval

Approved and recommended for acceptance as a dissertation in partial fulfillment of the requirements of the degree of Doctor of Philosophy in Economics.

____

Accepted Date

Committee Member Signatures:

____

Shin-Yi Chou

____

Mary E. Deily

____

Chad D. Meyerhoefer

____

Jason Hockenberry

Acknowledgement

I would like to express my sincere appreciation to my advisor, Dr. Shin-Yi Chou. Without her guidance, understanding, patience and encouragement, I would not have been able to accomplish what I have in my time at Lehigh University. She is not only a good adviser, but also a great mentor and a close friend, who made my Ph.D. life much more enjoyable. I am equally grateful to my committee members: Dr. Mary E. Deily for her valuable suggestions on my research papers, advices on my future career, and great help during my job seeking process, Dr. Chad Meyerhoefer for his patient guidance and tremendous help throughout my Ph.D. study and Dr. Jason Hockenberry for his insightful comments on my job market paper. I also want to thank Dr. Steve Buell for his guidance on improving my teaching skills. Without their generous help, I would not be able to conquer one of the greatest obstacles in my life during my Ph.D. study.

I am also very thankful to all faculty members at the Department of Economics, Lehigh University, who have provided a steady source of inspiration and encouragement. I would like to extend my special thanks to Rene Hollinger, the administrative coordinator for the department, who is very helpful for all kinds of things. Additionally, I am very grateful for my friends and fellow graduate students for their warm support and encouragement. The thoughtfulness of Mary and Megan in the graduate program office is a gift that I will always treasure. I also highly appreciate health care providers' effort and help in various scenarios. Last but not least, I also want to thank my parents, who always support my decisions, and my ex-girlfriend for her love and support during my graduate student life.

Contents

List of Tables

List of Figures

Abstract

This dissertation consists of three essays. The first essay studies the quantity-quality tradeoff by studying China's one child policy. We utilize the community-level variations in China's One-Child Policy to isolate the actual effects of number of children on the quality of children. Based on the instrumental variable approach, we find that having a second child has significantly decreased the height of the first child, but had no impact on the weight status of the first child. And this quality quantity tradeoff only exists among girls, but not for boys, which indicates a son preference in China. By study the underlying mechanism, we find that it is the nutrition intake that may explain this quantity-quality tradeoff among children.

The second paper focuses on the financial impacts of ambulatory surgery centers on general surgical hospitals. Ambulatory surgery centers (ASCs), which treat surgical patients who do not need an overnight stay, are a health care service innovation that has proliferated in the United States (U.S.) in the past four decades. This paper examines the effect of ASCs on net patient revenues and total operating costs of hospitals. My major contribution is to use an exogenous instrumental variable which is the product of change in the over 65 years of age population at the county level over the years studied and change in the average Medicare payment rate for all ASCs' procedures over the same years. The results of two-stage least squares suggest that both hospital revenue and operating expenses will increase when ASCs enter the market, with operating expense increasing more, resulting in a decrease in profit

margin. I also find that this negative financial impact likely comes from the change in hospital inpatient-severity mix upon ASCs' entry.

The third paper is to assess the effectiveness of Hospital Readmissions Reduction Program (HRRP) program implemented in 2012 in the short run by focusing on the acute myocardial infarction (AMI) and heart failure (HF) patients. By using a difference in difference method, I find that HRRP is not effective in the short run in reducing the readmission in three quarters after the program was implemented.

Chapter 1: The More The Better? Evidence from China's One Child Policy

1. Introduction

From Jan. 1st 2016, China's OCP comes to the end, and all couples are allowed to have two children. There are many previous studies showing the negative relationship between the quantity and quality of children, and it is important to know what the expected effects of the policy change is. While it is too early to examine the effect of Two-child Policy, we are able to utilize the variation in the number of children due to different strictness of OCP in different areas to examine the effects of the second child on the first. In addition, lessons from China can be applied to other developing countries, especially those with limited child welfare resources. Our study also contributes to the mainstream of the Quantity-quality (QQ) tradeoff research.

The tradeoff between the quantity and quality of children has long been studied. Since families with limited resources tend to have more children and families that pay more attention to children's quality would choose to have fewer children, the direct relationship between quality and quantity of children does not indicate a causal relationship. Previous studies mainly use instrumental variable (IV) to isolate the true effects of the quantity of children on the quality. Multiple births or sex composition of the first two children are frequently used as an IV in previous studies (J. Angrist, Lavy, & Schlosser, 2010; Black, Devereux, & Salvanes, 2005;

Rosenzweig & Wolpin, 1980; Rosenzweig & Zhang, 2009). Multiple births are independent of family or individual characteristics and they assume that parents whose first two children are the same sex are more likely to have additional children. In a recent paper, Liu (2013) uses community-level one child policy dummy variable (0 indicates the policy exemption and 1 indicates the policy implementation) as IVs for quantity of children per household. In Liu's paper, couples are considered as eligible for having two children if any of the following condition are met: 1) couples lived in a community where all couples were allowed to have two children; 2) couple's first child was female and they lived in a community where couples were allowed to have two children if first born was a girl; 3) ethnic minority couples lived in a community where they were allowed to have two children. In our paper, we use a similar IV in which we identify the causal relationship between the quantity and the quality of children using China's OCP as a natural experiment. More specifically, we use a community variable based on the question "Is every couple in your village/neighborhood allowed to have two children?" as the IV.

In order to avoid contaminated effects from birth order and birth spacing, this paper focuses on the first-born single birth only. In addition, we exclude those families with more than 2 children. We focus on the first born and exclude families with more than 2 children because the current literature identifies birth order and spacing as the two most influential cofactors.[1]

[1] Taubman (1986) finds empirical evidence for birth order effects on (age-adjusted) schooling and on earnings of young adults in the USA, though the latter is not robust across different specifications. Zajonc and Markus (1975) develops a confluence model to predict positive as well as negative effects of birth order based on data

Our main variable of interest in measuring the quality is the standard height and weight from the U.K. growth chart[2]. Researchers predominantly tend to use intelligence related measures including educational attainment and IQ scores to indicate the quality of children (J. Angrist et al., 2010; J. D. Angrist & Evans, 1998; Black et al., 2005; Blake, 1981; Conley & Glauber, 2006; Goux & Maurin, 2005; Guo & VanWey, 1999; Hanushek, 1992; J. Lee, 2008; Li, Zhang, & Zhu, 2008; Qian, 2009; Rosenzweig & Schultz, 1987; Rosenzweig & Wolpin, 1980; Rosenzweig & Zhang, 2009; Taubman, 1986; Zajonc & Markus, 1975). Some use labor market, marriage, and fertility outcomes to measure the quality (J. Angrist et al., 2010). A few study the birth weight related measures (Liu, 2013; Rosenzweig & Zhang, 2009). Because intelligence related measures have been widely used, we are going to focus on a less explored area—children's weight and height measurements. Moreover, past studies heavily focus on the effect of increases in the number of children from two to three or even more. In contrast, our paper focuses on the effect of an additional child on the first one.

---

collected from individuals who had been born during the Dutch famine of 1944. Scientifically, both short (<18 months) and long (>60 months) birth spacing interval are associated with low birth weight (LBW) and preterm birth. Short inter-pregnancy intervals may result in inadequate replenishment of maternal nutrient stores and reduced fetal growth (Zhu, Haines, Le, McGrath-Miller, & Boulton, 2001). A mother's ability to facilitate growth to the fetus declines gradually over the year after the first pregnancy. This may lead to preterm birth/LBW in mothers with long inter pregnancy intervals(Sharma & Mishra, 2013).

[2] Liu (2014) uses the standardizing function based on the U.S. growth chart which only looks at children or youth who are 2 years of age or older. The U.K. version of the standardizing function, on the other hand, covers 0-23 years of age. We think it is important to the U.K. version of standardizing function to include 0-2 infant groups because those stages measurements are critical to predict children's future growth (Alderman, Hoddinott, & Kinsey, 2006). In addition, Mozumder, KHUDA, KANE, Levin, and Ahmed (2000) indicate that children are at a higher risk of malnutrition if either previous or subsequent siblings were born within 24 months. Combining the evidence above, an infant who is younger than 2 years old and has an older brother or sister is facing a huge disadvantage, but that sample is dropped when using the U.S. standardizing function.

Our paper differs from the previous studies in the following ways: First, besides the main measures of children's quality, we also attempt to investigate the underlying mechanism. We confirm that nutrition intake explains the relationship between the QQ tradeoff of children in China. Second, we use data from 1989 to 2009 to look at the long term trend. Third, we investigate the QQ tradeoff within different subsamples. In this paper, we introduce the background information about OCP in section 2; describe our sample in section 3; specify our empirical strategy in section 4; present the empirical results in section 5; provide extended robustness checks in section 6; discuss extensively based on the sub-sample analysis in section 7 and finally offer our conclusions based on the analysis in section 8.

2. Background of China's One Child Policy

The QQ tradeoff we mentioned previously is an important incentive for the Chinese government to conduct a birth control plan.[3] In fact, besides the fearful environmental consequences and possible economic development drawbacks from the enormous growth in population, one of the prime goals of controlling the population in China is to improve the population quality in the Communist Party of China's (CPC) agenda (Greenhalgh & Winckler, 2005). The key draftsmen of the OCP in the early Deng era were all scientists and they treated OCP in a scientific way. After studies and researches, they believed continued rapid human number growth will hold back human capital development in China during their time

[3] There are many slogan variants of quantity-quality trade-off to promote China's OCP among local residents. Classic ones include "One child only is the best" "Human beings only have one earth and hence we must control population growth","Fewer and healthier (baby), Happy life forever" , "Low fertility, good quality, both boys and girls are treasurers".

(Greenhalgh, 2008). Although there are people who believe birth control is not necessary,[4] the QQ tradeoff provides theoretical support for the government.

Most literature to date has regarded the 1980s as the period in which the OCP was formed; however, the idea of the OCP actually can be traced to as early as 1950. Based on Greenhalgh and Winckler (2005), the OCP policy can be divided into four periods: Mao's era, Deng's era, Jiang's era, and Hu's era. Mao's era is composed of a lot of turbulence: both the Great Leap Forward and the Cultural Revolution had added great noise to the formation and implementation of the OCP. Therefore, even though the concept and practice of state planning of births was invented during Mao's era, there were next to none specific practical instructions to guide the implementation. More specifically, Mao Zedong strategically advocated family planning and birth control but he was not sure how to implement it among farmers which comprised the majority of the Chinese population then and sometimes that uncertainty led to self-contradictory stands. The big changes happened in Deng's era (late 1970s to late 1980s).

[4] There are people who argue that population control is unnecessary. Hartmann (1995) charges that the philosophy underlying population control measures assumes that "1) rapid population growth is a primary cause of development problems, 2) people must be persuaded or forced to have fewer children even before their standard of living is improved, 3) birth control services can be delivered in a top-down fashion in the absence of basic health care systems, and 4) contraceptive efficacy is more important than safety." His book rejects these assumptions by explaining that "1) rapid population growth is a symptom, not a cause, of development problems; 2) the best way to motivate people to have fewer children is by improving living standards and women's status; and 3) health, safety, and individual control over a method should be the primary concerns in the development and promotion of contraceptive technology that should be offered through a popularly based health care system." While a lot of his charges and suggestions are practical, constructive and intriguing, his first charge is controversial and questionable. If abundant population quantity causes the low quality, then rapid growth is indeed a primary cause of the development problems because human capital is the essential part of any development plan. Therefore, it is imperative to verify the validity of quantity-quality tradeoff, not only in the case of China, but also for international population policies at large.

The OCP was officially announced in 1979. Local cadres were given economic incentives to suppress fertility rates. “Document 7” , issued on April 13, 1984, was a landmark in the sense that it allowed for regional variation in family planning policies to curb female infanticide. It allowed rural couples to have a second child if the first one was a girl (so called “1.5 child” rule). It also forbade forced abortion and forced sterilization. Local governments were officially granted the right to issue permits for a second child. Another landmark was accession of Peng Peiyun as the new birth program leader in early 1988 to correct the soft implementation of the OCP which was reflected by a reversed downward trend in fertility in 1986-1987. Peng greatly reinforced the OCP in the following 5 years from 1989-1993. Fast forward to Jiang’s era (roughly 1989-2003) which was a period of deep reform for hard birth planning. According to Greenhalgh and Winckler (2005), Jiang’s era began with “a phase of controlled consolidation: state-centric reforms to correct program maladministration, to professionalize birth work and to improve positive incentives for citizen to compliance”. However, unlike the middle of the Deng period, that quasi-consolidation did not involve inadvertent relaxation of enforcement. Basically, Jiang was a hardliner. Hu Jintao came on to the stage at the right time to use the right approach to ease the tension between the government and public which formed due to Jiang’s hard approach so that he could continue to successfully implement the OCP. Hu’s era (2003-2012) began with his new ideology--a “scientific concept of development”. Hu’s reforms had two major perspectives: a scientific perspective and a democratic perspective. The scientific perspective is not new--Deng’s administration had already treated the population problem as a scientific problem rather than social problem. In fact, the person in charge during

Deng's time was Song Jian, who was a scientist trained in Moscow before he assumed office. Hu's administration deepened the role of science by strategically planning and optimizing government's structure to further smooth the implementation of the OCP. Democratic perspective can be seen by deviating away from punishment approach by including more economic incentives for compliance. Additionally, Hu Jintao fully promoted "human-centered, comprehensive, coordinated and sustainable" development during the March 2004 National People's Congress. Unlike during previous eras when the public had to gain permits, citizens now could decide the timing of their childbearing as long as they were within the legal limits on the number of children they could have.

The OCP is a long term scientific national birth planning policy which is well implemented during the late Deng era, Jiang era and Hu era and it is extremely effective and strictly implemented since Jiang Zemin. The majority of data was collected in Jiang's era so it is a great indication that our IV is valid since Jiang implemented OCP strictly. We want to emphasize that OCP is a dynamic process. The OCP was constantly evolving in the time window of 1978-1988. The OCP became relatively stable after the Document 7. Even one year before Document 7, there was a disturbing incident: the director of the State Family Planning Commission, Qian Zhongxin, forged very strict and sometimes inhuman family planning policies. In the year of 1983, the frequency of intra-uterine device, sterilization, and abortion were as high as ever. Since then, he was laid off and never appointed again. That incident strongly suggests that we should focus on children born in or after 1985, which is the stage that OCP becomes fairly stable.

3. Data

According to the official website (http://www.cpc.unc.edu/projects/china), the China Health and Nutrition Survey (CHNS) is a collaborative project between the Carolina Population Center at the University of North Carolina at Chapel Hill and the National Institute of Nutrition and Food Safety at the Chinese Center for Disease Control and Prevention. Its main goal is to study the effects of the health, nutrition, and family planning policies and programs implemented by national and local governments and examine the dynamic impact of the economic transformation of Chinese society on the health and nutritional status of its population. The survey is collected over a 3-day period with a sample of about 4,400 households, including 26,000 individuals in nine provinces. In addition, detailed community data were collected.

In this paper, data from 1989--2009 are used. Firstly we exclude people who have appeared in the same wave more than once, and then merged all the data based on individual unique ID and wave. We use the community-level one child policy as an IV, which is based on whether all couples are allowed to have two children in the neighborhood. Next, we use a relationship data file to match each child to their parents. We are interested in the standardized height and weight. The sample is further restricted to those who were born after or in 1985 as mentioned above. Document 7 in 1984 opened a new chapter and introduced the basic model of the modern OCP. We regard 1985 as the starting point of a relatively stable and consistent OCP period. We dropped observations with missing dependent variables (such as height and weight) and independent variables (such as household income and age).

Summary statistics are shown in Table 1.1. Statistics for the whole sample differ from our selected sample which is restricted to families whose first born was after or in 1985. More importantly, families under a restricted OCP (treatment group) have a lot of similar characteristics compared to those which are allowed to have two children (control group). Both groups' parents have similar education levels up to upper middle school and give birth at similar ages. It is expected that the treatment group has fewer kids than the control group. The only significant difference in the comparison is that the treatment group tends to be richer than the control group. We think it is fair to say that the treatment and control groups have similar observable characteristics. This similarity demonstrates that our IV is not likely to be correlated with household characteristics. As far as dependent variables, our selected sample tends to be taller and heavier than the whole sample. However, the whole sample tends to have higher intake of calories, protein and carbohydrate and less fat intake. This could be due to the fact that the average age of the whole sample is 2 years older than our sample. Treatment and control groups in our sample have less than a one year age difference, and treat group tends to be significantly taller and heavier.

Numerous medical journals have contributed the height growth to nutrition intake and based on current medical literature, balanced nutrition is the key for height growth (Adamson, Rugg-Gunn, Butler, Appleton, & Hackett, 1992; Cadogan, Eastell, Jones, & Barker, 1997; Gary M. Chan, Karen Hoffman, & Martha McMurry, 1994; Gibson et al., 1989; Johnston Jr et al., 1992; W. T. Lee et al., 1995; Pluske, Williams, & Aherne, 1996; Prynne et al., 2006). Some authors even use height and weight data to compare the nutritional status of groups of children (Waterlow et al., 1977). We think that looking at a single nutrition component separately is insufficient for identifying the mechanism. So, we created a nutrition index based on multiple nutrition intakes which is explained in the next section. As a side note, standard heights and weights have negative values because Chinese children are shorter and lighter relative to the median of U.S. children in the same age cohort.

4. Identification strategy

First of all, we want to emphasize that the OCP is a national policy, although it was implemented at local cadres starting in the mid-1980s. There are two penitential problems with the validity of the IV: first, the local cadres do not implement the OCP regardless of the order from the central government; second, different neighborhoods with different endogenous factors face different OCP policies. The first violation is easy to dispute since only 4.06% of the local cadres did not implement family planning over all waves based on the community survey data. We next prove that the IV is uncorrelated with neighborhood/community characteristics.

There are 234 communities over all waves. Figure 1.1 shows the variable average which is whether all couples are allowed to have two children in the village/neighborhood at province level (0 means two children per couple is forbidden and 1 otherwise). Except for Guangxi and Guizhou (based on the fifth population census, those two provinces are among the four highest minority concentrated provinces which have more than 10 million minority population), all other provinces have a relatively strict OCP that does not allow for two children for the most parts (Heilongjiang only entered the survey in 1997 to make up for Laoning's absence and remains in the survey since then). There is a consistent huge drop among all provinces in 1991 (except for Heilongjiang which is not surveyed in 1991). It implies that although local cadres had their own implementation leeway, the central government has great power over local cadres to make a national move. What happened in 1991 is that there was a much stronger enforcement of a stricter version of the OCP in 1991. One representative event is that the CPC Central Committee and the State Council issued Document 9 in May: “Decision on Strengthening Family Planning Work to Control Population Growth”. In that document, it states: "Party committees and governments should assume responsibility for the completion of the region’s population plan. They should also implement and improve the population control and family planning responsibility system. The assessment of the population control should be an important indicator of party committees’ achievement of leading cadres at all levels of government and … Higher Party committees and governments should strengthen the supervision of implementation of population control at subordinate committees and ensure the accuracy of the statistics of family planning results. Concealed and/or false report should be strictly forbidden … Any negligence of duty which causes loss of control of the population should be investigated and relevant leaders should be held accountable." The earliest survey date in 1991 was August 10th and the latest one was December 24th. It is obvious that the national policy announced in May greatly impacted local cadres only several months later. Therefore, this is our first evidence that the OCP should be an exogenous IV because it is very nationally controlled in nature based on our data sample. Moreover, since the empty dots indicate that the number of observations is relatively stable, this big drop is unlikely to be caused by some accidental number of observation movements.

Next, we will prove empirically that the IV is unrelated with most community characteristics. Here we use the twelve neighborhood variables developed by Jones-Smith and Popkin (2010)[5]. All variables were surveyed each year from 1991 to 2006 with a few exceptions. Smith and Popkin use those characteristics to study urbanity and those 12 measurements are a comprehensive summary of the community characteristics. We have to prove that policy is exogenous to those measurements. Our regression is listed as follows:

$$\mathrm{Policy_i} = \beta_0 + \mathrm{Char_{it}}\beta_1 + \mathrm{X_{it}}\beta_2 + \mathrm{Z_{it}}\beta_3 + \tau_t + \zeta_p + \tau_t \times \zeta_p + \varepsilon_{ipt}, \quad (1)$$

where $\mathrm{Policy_i}$ is the OCP household i faced, and $\mathrm{Char_{it}}$ are the 11 characteristics of the neighborhood proposed by Smith and Popkin (2010) . Notice that the neighborhood education level is excluded because we measured the educational environment at a finer level by including mother's educational attainment as controls. X_{it} is a vector of the child's characteristics including gender, age, age squared, and Z_{it} represents a set of parental attributes including maternal educational attainments and age at children's birth, as well as the log of household income. We have also controlled for province fixed effects and wave fixed effects, as well as a province-specific time trend which is the product of the province dummies and wave dummies. Only the educational outcomes of mothers are controlled for (there are more missing values for father's educational outcomes). Controlling for mother's education is critical because numerous studies have proven that mother's education level affects a child's height (Duncan, 1994; Duncan Thomas, 1991). Also, Savage et al. (2013) find that mother's age at

[5] See appendix Table A1 for detail.

birth is positively correlated with child height. Hence, we include mother's age at birth as one of the controls as well. If we include father's educational attainment and age at birth as a robustness check, the results are similar and shown in Table 1.5 Panel B. All standard errors are clustered at the province_rural level which is created by the product of province dummies and rural dummies to account for rural and urban difference. All community characteristics are lagged by one period. Data are collapsed at the community level.

Results are presented in Table 1.2. We see that four of the neighborhood characteristics have influence on the OCP policy. As a robustness check, we add in all the four significant community characteristics into our main regression which is shown below. And the results are shown in Table 1.5 Panel D. The finding is that after adding those significant community characteristics, the conclusion is not altered and results are still significant.

Our main empirical model is described as follows:

$$\text{quality}_{it} = \beta_0 + \text{quantity}_{it}\beta_1 + X_{it}\beta_2 + Z_{it}\beta_3 + \tau_t + \zeta_p + \tau_t \times \zeta_p + \varepsilon_{ipt}, \qquad (2)$$

where quality_{it} is measured by the standardized weight and height, and quantity_{it} is the number of children in the household. The coefficient of interest is β_1, which measures impacts of number of children on the quality of children. For example, a negative sign of β_1 indicates a tradeoff between quantity and quality of children. X_{it} and Z_{it} are the same as above and regression is also clustered at province_rural level. In a 2SLS setting, the above equation is the second stage, and the first stage is specified as

$$\text{quantity}_{it} = \alpha_0 + \text{policy}_i\alpha_1 + X_{it}\alpha_2 + Z_{it}\alpha_3 + \tau_t + \zeta_p + \tau_t \times \zeta_p + \varepsilon_{ipt}, \quad (3)$$

where policy_i is the OCP household i faced. X_{it} and Z_{it} are the same as above and regression is clustered at province_rural level.

We want to explain more about $Policy_i$. The main IV, $Policy_i$, is the status of the OCP at the community level. Family planning constraint is unbounded if the couple decides only to have one kid. Thus, the OCP only matters for couples who would like to have more than one child. Therefore, we use the policy variable followed by the first born as our IV. For example, we impose the 2009 policy for families with first born's birth year between 2006 and 2009. Another approach would be using the policy variable in one year prior to the second born. This approach might be more accurate given the fact that one year or probably two years before the second born is the time period that the couples decide to have a second child. However, we would not be able to assign IV to those families with only one child, which are essentially the control group in our sample. Therefore, we use the first method.

5. Empirical Results

5.1 Weight and Height Outcomes

The main results about the impact of the number of children on the weight and height outcomes of children are shown in Table 1.3. We present the Ordinary Least Squares (OLS) results in columns 1 and 3. The estimates of -0.169 and -0.234 indicate that an additional child reduces the standard height and weight of the first child by 0.169 and 0.234 standard deviations, respectively. The IV results are presented in columns 2 and 4. First of all, the first stage is statistically significant at the 1% level which implies that the local one child policy has a significant impact on the number of children. The first stage result has its own merit: if couples are allowed to have two children in their community, the average number of children increases by 0.17. The estimate of -0.681 (Column 2 of Table 1.3) indicates that an additional child would decrease the height of the first-born child by 0.681 standard deviations. Compared with the OLS results, the 2SLS yields much larger estimates, which implies a downward bias caused by the endogeneity. [6] In contrast, a second child will not affect the weight of the first-born child. There are numerous medical journal articles that have indicated that height growth is highly dependent on nutrition intake (Adamson, Rugg-Gunn, Butler, Appleton, & Hackett, 1992; Cadogan, Eastell, Jones, & Barker, 1997; Gary M. Chan, Karen Hoffman, & Martha McMurry, 1994; Gibson et al., 1989; Johnston Jr et al., 1992; W. T. Lee et al., 1995; Pluske, Williams, & Aherne, 1996; Prynne et al., 2006). In the economic literature, Thomas (1994) argues that height reflects children's long-run nutritional status and is closely related to their mental development, mortality and income in adulthood. Liu (2013) finds that the number of siblings increases children's cereal consumptions but decreases their meat consumption. However, such a finding hardly reflects overall nutrition intake. In the next section, we define a nutrition index and prove that the nutrition intake is the invisible hand behind height growth.

We also witness a positive relationship between the mother's education level and children's height. In particular, starting from lower middle school, more educated mothers tend

[6] Liu (2013) also finds much smaller OLS results and a much larger 2SLS results for the standardized height in his paper.

to have taller and heavier children. This fact reflects that the way the children are raised has a profound impact. It appears that a mother with higher educational attainment put more effort and have the correct knowledge to raise their child well. Additionally, the older a child becomes, the smaller the difference is.

The positive coefficient of log household income indicates that households with higher income tend to have bigger children. Household income should have a direct impact on the nutrition quality and quantity that the children are endowed within China. Results imply that poorer families might not be able to supply all of the nutrition that their children need.

5.2 Underlying Reason

In this section, we study the possible underlying mechanism. More specifically, we investigate the impact of number of children on the parents' children care time, smoking and drinking behaviors of children, and nutrition intake. Except for the nutrition intake, none of the factors has an impact. Therefore, we use the nutrition intake as an example to explain the regression specification.

$$zh_{it} = \beta_0 + age_{it}\beta_1 + age_{it}^2\beta_2 + gender_i\beta_3 + Cereal_{it-1}\beta_4 + Protein_{it-1}\beta_5 + Carbo_{it-1}\beta_6 + fat_{it-1}\beta_7 + \tau_t + \zeta_p + \tau_t \times \zeta_p + \varepsilon_{ipt}, \quad (4)$$

and use the predicted value of zh_{it} as $Index_{it}$. I purposely use the previous period nutrient and cereal intake to predict the standard height in the current period. The nutrition intake survey only started in 1991, because we are using a lagged nutrient intake, effectively we are dropping observations from year 1989 and 1991. We include age, gender, year and province fixed effects and year and province interaction dummies in the regression. However, when we predict the standard height zh_{it}, we run a partial prediction based on cereal, protein, carbohydrates and fat intake from the previous period only. Before we go deeper, we want to verify this index does predict standard height very well in our main regression. So we run the following regression:

$$zh_{it} = \alpha_0 + Index_{it}\alpha_1 + X_{it}\alpha_2 + Z_{it}\alpha_3 + \tau_t + \zeta_p + \tau_t \times \zeta_p + \varepsilon_{ipt}, \quad (5)$$

The coefficient of index is 0.425 with a standard error of 0.17, indicating that the coefficient is statistically significant at 5% level. It proves that the nutrition index does explain the standard height very well.

Next, we run 2SLS again. Second stage is:

$$Index_{it} = \beta_0 + quantity_{it}\beta_1 + X_{it}\beta_2 + Z_{it}\beta_3 + \tau_t + \zeta_p + \tau_t \times \zeta_p + \varepsilon_{ipt,} \quad (6)$$

And first stage is:

$$quantity_{it} = \alpha_0 + policy_i\alpha_1 + X_{it}\alpha_2 + Z_{it}\alpha_3 + \tau_t + \zeta_p + \tau_t \times \zeta_p + \varepsilon_{ipt}, \quad (7)$$

Results are shown in Table 1.4. The first stage is statistically significant at 5%. Based on the second stage results, we know that one additional child reduces the nutrition index of the first born by 0.259. So, the mechanism channel has been established: more children lower the nutritional intake of the first born and a lower nutrition intake further decreases the height of the first born.[7] We believe that we are the first to establish such a mechanism by using the CHNS dataset.

We also find that the total time parents spend on their children is not affected by the number of kids in the family and the probability of drinking or smoking is not related to the number of children in the family. Results are shown in columns 1 through 4 of Table 1.4.

6. Robustness Check

6.1 Insurance Status

Since children's access to health care should affect their health situation and subsequently body shape significantly, we further control for insurance status in this subsection. The results are shown in Panel A of Table 1.5, and the results are nearly identical to our main results.

6.2 Father's Education and Age at Child's Birth

In the main results, we only include the mother's educational information in order to preserve the size of the dataset. This is due to the fact that variables relating to fathers have more missing values than mothers. However, father's education level and age at children's birth should have an important impact on children's stature too. Duncan Thomas (1991) finds that in the U.S.,

[7] In the mechanism study above, the variables of fat, protein and carbohydrate are only available after 1991. Hence, we want to make sure 1991-2009 samples produces similar results. In order to exactly replicate the sample which is used to create the index above, we dropped observations with missing values on cereal, protein, carbohydrate or fat intake. And then we run our 2sls regressions again on this modified sample. The results are presented in Panel A of Table 10. The results are very identical to our main results in Table 5. Subsequently, we can extrapolate the results to our whole sample which is from 1989-2009 and deduct that the nutrition intake must also be the underlying mechanism of decreased height.

Brazil, and Ghana, the education of the mother has a bigger effect on her daughter's height; paternal education, in contrast, has a bigger impact on his son's height. As a result, we include father’s educational attainment and age at children's birth as a robustness check. As shown in Panel B of Table 1.5, the sample size is reduced from 4,333 to 4,172 but the QQ tradeoff is still statistically significant and results remain almost unchanged.[8]

6.3 Parent’s Height

Genetic endowment is one of the biggest concerns of the QQ tradeoff study. Previous studies already confirm that the influence of parental height on children's height is evident (Kagan & Moss, 1959; Leger, Limoni, Collin, & Czernichow, 1998). We want to include maternal and/or paternal height to control genetic endowment. In our sample, the minimum for a mother is 19 with a mean value of 33.5 and fathers have a minimum age of 21 with a mean value of 35.1. There are slight variations of the height for the same individual over different waves. We attribute this variation to the random measurement error since both mothers and fathers in our sample are adults and their heights should not change significantly over the years. To control for such measurement error, we use the average height across all waves to represent parents' height. We first include mother's height and then include both parents' heights as controls. Results are shown in Panel C of Table 1.5. Maternal and paternal heights are highly significant (results not shown) with a *p* value less than 1%. However, the coefficient of standard first born child height remains significant even with the inclusion of maternal and paternal heights. This

[8] We also run a regression only controlling for the mother’s information, but use the same sample size as the father’s sample, and the results are robust.

is a strong signal that aside from genetic endowments, the number of children in the family does have an impact on the quality of the first born.

7. Discussion

7.1 Social-economics Status

In this subsection, we want to examine whether better social-economic status can help to buffer the negative impact on the first child from an additional child. We first look at the impact from income. Gilbert (2002) defines families with household income in the top 45% as the middle class or above. We adopt this cutoff and divide the population into two groups: those who are middle class or above and those who are below the middle class. The first stage result suggests that the OCP has more power on the working class or poor people. It is understandable given the fact that richer families are in a much better position to face fines or other government punishment for a violation of the rules. Moreover, the QQ tradeoff is only reflected in families who are below the middle class and the scale is very similar to our main results (col. 2 of Table 1-6). It supports our hypothesis that resource constraints that cause the shorter height of the first born in the family with more than one child.

We next examine the impact of mother's education. From Panel B of Table 1.6, we find that children will suffer from QQ tradeoff only if mothers have low educational attainment (below high school).

In order to provide further evidence about the effects of social economic status, we look at the QQ tradeoff in relatively poor areas of China, which are generally the western parts. We restrict our sample to only include Guizhou, Guangxi, Henan, Hubei, and Hunan provinces. The QQ tradeoff is much larger in the poorer areas of China, implying that nutrition intake might be the key reason for the QQ tradeoff because household in poorer area cannot afford nutritious food.[9]

7.2 Son Preference

Parents in China face income or resource constraints when raising more children, and having more children increases the possibility of heavy fines and loss of jobs. "At least a boy" is an important reason for parents to have additional children, especially in the rural areas of China. In fact, the first born being a girl is an incentive for a lot of parents to have a second child and later versions of the OCP incorporated this reality in order to make it more practical. This "more boys" fetish can be partly explained by the culture and economic background where parents believe more kids, especially boys, imply higher labor productivity and better protection in their older age. Therefore, a first born girl is likely to sacrifice for creating more growth space for her younger brothers or sisters. Whether first born girls sacrifice for brothers only or for both brothers and sisters is left for future researchers.

We divide the sample by gender to explore the potential gender differences in the QQ tradeoff. As demonstrated in panel A of Table 1.7, the tradeoff between quantity and quality is significant only among girls, and the effects turn out to be large (close to 1 standard deviation). This is consistent with the preference for sons in China, where sons tend to be given better care

[9] Results are not shown, but available upon request.

and resources, which can help to buffer the negative impact from the increase in the number of children.

In addition, we want to explore differences among households with different income levels. Families with high household income (which can be used to represent social-economic status) tend to negate the negative quantity effect on the quality of a first born girl. Household income does not play a critical role in the case of male first born children (results are not shown). This confirms again that there is a boy fetish: girls in the wealthier families are better off, while boys' quality is not affected by income. The results above imply that when the resources are limited, boys are given more resources.

The preference for sons is greatly affected by the parents' education level because less educated parents tend to believe in certain social doctrine without any second thought. To test this hypothesis, we group the sample based on whether the mother has a high school diploma. Because we want to see the difference at a broader category level, mother's educational controls are dropped from the original regression. Panel C of Table 1.7 shows that if the mother has a high school diploma, the disadvantage for a first born girl vanishes but if the mother does not have a high school diploma, the first girl faces significant disadvantages. Therefore, a mother's education significantly affects children's quantity and quality tradeoff for first born girls.

7.3 Children’s Age

Based on Table 1.8, we can see that a child younger than 14 is affected negatively by having more children in the family and the scale is bigger than the original result which is 0.804 for children who are younger than 7 years old. The first stage is not statistically significant for children aged 14 or above. We find that children aged 14 or above are born between 1985 and 1995 with a mean birth year 1988.13 and a standard deviation of 2.6. Figure1.2 shows the histogram of the birth year distribution. Most children over the age of it were born between 1985 and 1990. This is a period when the OCP was loosened to limit the backlash created by the director of the State Family Planning Commission, Qian Xinzhong, in 1983 by his very strict and sometimes inhuman approach to birth control. However, this period was ended by Jiang Zemin in 1991 due to his document to strengthen OCP implementation. Therefore, it is not surprising to see that first stage is not significant for children aged 14 because most of them were born during the time when the OCP was loosely implemented.[10]

8. Conclusion and Implication

This paper estimates the effect of family size on the stature of children in China. It overcomes the obstacles of joint determination by exploiting the exogenous variation in the number of children allowed by China's One Child Policy. The results show that parents with bigger family sizes breed shorter children. Our findings provide empirical evidence for a novel insight into

[10] Reader might question the 14 age cutoff. We meant to distinguish children from teenager. A teenager, or teen, is a young person whose age falls within the range from 13–19. They are called teenagers because their age number ends in "teen". Someone aged 18 or 19 is also considered a young adult. The UN, for statistical consistency across regions, defines 'youth', as those persons between the ages of 15 and 24 years, without prejudice to other definitions by Member States. In any case, we want to show that our results are robustness to different cutoff standards. In the following panels of Table 6, we show the results for cutoff at age 12, 13 and 15 and our main conclusion is not changed. Additionally, for children older than 13 and 15, the first stage is barely significant which supports our conjecture about the insignificant first stage above. Also, the smaller the cutoff, the more significant the effect is. It implies that the trade off normally happens at young children group instead of the youth group.

the quantity-quality tradeoff in China's context and confirm the existence of such a trade-off. Empirical evidence also suggests that resource constraints cause the quantity-quality tradeoff. More specifically, first born children in bigger families take less nutrition. Becker and Lewis (1974) demonstrate that the observed income elasticity of demand with respect to the quality of children exceeds income elasticity with respect to quantity, while at the same time the observed price elasticity with respect to quantity is greater than price elasticity with respect to quality. Their analysis explains the empirical QQ tradeoff identified in our paper from the income and cost perspective. Income and cost actually boil down to the resource constraints. Blake (1981) uses U.S. data with whites primarily and finds evidence of the "dilution model"—on average, the more children in a family, the lower quality of each child due to diluted resources on each child. Again, his paper supports our empirical finding and the constrained nutrition intake mechanism. A similar QQ tradeoff in human capital has been identified in India (Rosenzweig & Wolpin, 1980), France (Goux & Maurin, 2005), U.S.A (Conley & Glauber, 2006) and China (Rosenzweig & Zhang, 2009). We also find that young first born girls in poor families are most negatively affected by additional siblings because they tend to be disadvantaged when resources are constrained.

Liu (2013) concludes that the number of children has a significant negative effect on both boy's and girl's height. The trade-off is stronger for boys at the lower half of the height distribution, but it does not vary systematically across the height distribution for girls. The IV estimates for boys suggest that the impact could vary from 0.453 (SE = 0.232) to 0.511 (SE = 0.183) standard deviations and his IV estimates for girls are almost identical to that for boys.

In contrast, by using a much larger sample, better data cleaning approaches, and updated data with more accurate matching between parents and children, we find that the QQ tradeoff is concentrated on the first born girl while the first born boy is largely unaffected, which is consistent with the preference for boys in a lot of areas of China. Our IV estimates for girls are much larger at 0.921. Given so much research on traditional Patriarchal China and its derived boy fetish (e.g. (Coser, 1986)), we strongly believe that it is unlikely that there is no significant difference between girls and boys. Plenty of news reports alert us that in rural China, girls not only are given less food, but some of them are also denied their educational rights because the boys in the family are the priority given limited resources. We believe that our results are much more realistic and convincing. Liu also uses meat and cereal consumption as the only indicators of nutrition intake. Instead, we develop a nutrition index based on some of the actual nutrient measures and cereal intake and find evidence to support the hypothesis that nutrition intake is the key for stunted growth.

Our paper has great policy implications: the government should start to pay attention to first born girls in poor families with multiple children. Since their reduced quality is caused by resource constraints, the government should find a way to provide subsidies to help those girls to grow bigger and healthier. Also, it is time to build up a comprehensive child welfare system so that children's health or growth is not constrained by family social economic status.

However, there are several caveats that we need to pay attention to when explaining our results. First of all, our study is based on a Chinese sample, and the results may not be able to generalize to other areas due to some unique characteristics of China: 1) China has a large proportion of rural population; 2) Chinese people have a strong preference for sons; and 3) the child care system is not well built in China. Second, due to the limitations/ variations in the number of children, we mainly focus on the impact of a second child on the first one, and the relationship may change as the number of children continues to increase. Last but not least, the number of children may be underreported since unstipulated children cannot get *Hukou*, a record in the system of household registration required by law in mainland China.

The Quantity-Quality tradeoff should also be reflected in other characteristics of children. Future research could add in population census data in China to discover additional quantity-quality tradeoff phenomena. We also believe there is more than one possible causal mechanism, such as parents' behaviors, but we are not able to identify this due data limitations. Future researchers can explore this in more detail with additional data.

References

Adamson, A., Rugg-Gunn, A., Butler, T., Appleton, D., & Hackett, A. (1992). Nutritional intake, height and weight of 11–12-year-old Northumbrian children in 1990 compared with information obtained in 1980. *British Journal of Nutrition, 68*(03), 543-563.

Agarwala, S. N. (1960). Population Control in India- Progress and Prospects. *Law and Contemporary Problems,* 577-592.

Alderman, H., Hoddinott, J., & Kinsey, B. (2006). Long term consequences of early childhood malnutrition. *Oxford Economic Papers, 58*(3), 450-474. doi: 10.1093/oep/gpl008

Angrist, J., Lavy, V., & Schlosser, A. (2010). Multiple Experiments for the Causal Link between the Quantity and Quality of Children. *Journal of Labor Economics, 28*(4), 773-824. doi: 10.1086/653830

Angrist, J. D., & Evans, W. N. (1998). Children and Their Parents' Labor Supply: Evidence from Exogenous Variation in Family Size. *The American Economic Review, Vol. 88, No. 3*, 450-477.

Angrist, J. D., Lavy, V., & Schlosser, A. (2005). New Evidence on the Causal Link between the Quantity and Quality of Children. *NBER Working Paper No. 11835*.

Becker, G. S., & Lewis, H. G. (1974). Interaction between Quantity and Quality of Children. *Economics of the Family: Marriage, Children, and Human Capital*.

Berbaum, M. L., & Moreland, R. L. (1980). Intellectual development within the family: A new application of the confluence model. *Developmental Psychology, Vol 16(5)*.

Black, S. E., Devereux, P. J., & Salvanes, K. G. (2005). The More The Merrier? The Effect of Family Size and Birth Order on Children's Education. *The Quarterly Journal of Economics*.

Blake, J. (1981). Family Size and the Quality of Children. *Demography,, Vol. 18, No. 4*, 421-442.

Blake, J. (1987). *Differential Parental Investment: Its Effects on Child Quality and Status Attainment*. New York.

Cadogan, J., Eastell, R., Jones, N., & Barker, M. E. (1997). Milk intake and bone mineral acquisition in adolescent girls: randomised, controlled intervention trial. *Bmj, 315*(7118), 1255-1260.

Conley, D., & Glauber, R. (2006). Parental Educational Investment and Children's Academic Risk: Estimates of the Impact of Sibship Size and Birth Order from Exogenous Variation in Fertility. *Journal of Human Resources*, 722-737.

Coser, R. L. (1986). *American Journal of Sociology, 91*(4), 990-992. doi: 10.2307/2779972

Duncan, T. (1994). Like Father, like Son; Like Mother, like Daughter: Parental Resources and Child Height. *Journal of Human Resources, 29*(4), 950-988.

Duncan Thomas, J. S. a. M.-H. H. (1991). How Does Mother's Education Affect Child Height? *The Journal of Human Resources, Vol. 26, No. 2*, 183-211.

Galbraith, R. C. (1982). Just one look was all it took: Reply to Berbaum, Markus, and Zajonc. *Developmental Psychology, Vol 18(2)*, 181-191.

Gary M. Chan, M., Karen Hoffman, & Martha McMurry, M. (1994). Effects of dairy products on bone and body composition in pubertal girls. *The Journal of Pediatrics, 126*(4), 551-556. doi: 10.1016/S0022-3476(95)70348-9

Gibson, R., Vanderkooy, P., MacDonald, A., Goldman, A., Ryan, B., & Berry, M. (1989). A growth-limiting, mild zinc-deficiency syndrome in some southern Ontario boys with low height percentiles. *The American journal of clinical nutrition, 49*(6), 1266-1273.

Gilbert, D. (2002). *The American Class Structure in an Age of Growing Inequality*: Wadsworth Publishing.

Goux, D., & Maurin, E. (2005). The effect of overcrowded housing on children's performance at school. *Journal of Public Economics, 89*(5-6), 797-819. doi: 10.1016/j.jpubeco.2004.06.005

Greenhalgh, S. (2008). *Just One Child: Science and Policy in Deng's China* (1st ed.): University of California Press.

Greenhalgh, S. (2010). *Cultivating Global Citizens: Population in the Rise of China*: Harvard University Press.

Greenhalgh, S., & Winckler, E. (2005). *Governing China's Population: From Leninist to Neoliberal Biopolitics* (1st ed.): Stanford University Press.

Guo, G., & VanWey, L. K. (1999). Sibship Size and Intellectual Development: Is the Relationship Causal? *American Sociological Review, Vol. 64, No. 2*, 169-187.

Haberkorn, G. (2008). Pacific Islands' Population and Development: Facts, Fictions and Follies. *New Zealand Population Review*(33/34), 95-127.

Hanushek, E. A. (1992). The Trade-off between Child Quantity and Quality. *Journal of Political Economy, Vol. 100, No. 1*, 84-117.

Hartmann, B. (1995). *Reproductive rights and wrongs: the global politics of population control* (Revised edition ed.). Boston, Massachusetts: South End Press.

House, W. J. (1999). What should be the nature of population policies in the Pacific Island countries? *UNFPA COUNTRY SUPPORT TEAM Office for the South Pacific Discussion Paper No. 18*.

Isaacs, S., Cairns, G. and Heckel, N. (1991). *Population Policy 2nd Edition*.

Johnston Jr, C. C., Miller, J. Z., Slemenda, C. W., Reister, T. K., Hui, S., Christian, J. C., & Peacock, M. (1992). Calcium supplementation and increases in bone mineral density in children. *New England journal of medicine, 327*(2), 82-87.

Jones-Smith, J. C., & Popkin, B. M. (2010). Understanding community context and adult health changes in China: development of an urbanicity scale. *Social Science & Medicine, 71*(8), 1436-1446.

Kagan, J., & Moss, H. A. (1959). Parental correlates of child's IQ and height: a cross-validation of the Berkeley growth study results. *Child Development*, 325-332.

Lee, J. (2008). Sibling Size and Investment in Children's Education: An Asian Instrument. *Journal of Population Economics, 21 (4)*, 855-875.

Lee, W. T., Leung, S. S., Leung, D. Y., Tsang, H. S., Lau, J., & Cheng, J. C. (1995). A randomized double-blind controlled calcium supplementation trial, and bone height acquisition in children. *British Journal of Nutrition, 74*(01), 125-139.

Leger, J., Limoni, C., Collin, D., & Czernichow, P. (1998). Prediction factors in the determination of final height in subjects born small for gestational age. *Pediatric research, 43*(6), 808-812.

Li, H., Zhang, J., & Zhu, Y. (2008). The Quantity-Quality Trade-off of Children in a Developing Country: Identification using Chinese Twins. *Demography, Volume 45-Number 1*, 223–243.

Liu, H. (2013). The quality–quantity trade-off: evidence from the relaxation of China's one-child policy. *Journal of Population Economics, 27*(2), 565-602. doi: 10.1007/s00148-013-0478-4

Magnusson, P. K., Rasmussen, F., & Gyllensten, U. B. (2006). Height at age 18 years is a strong predictor of attained education later in life: cohort study of over 950 000 Swedish men. *International Journal of Epidemiology, 35*(3), 658-663.

Moreland, M. L. B. a. R. L. (1985). Child Development Intellectual Development within Transracial Adoptive Families: Retesting the Confluence Model. *Child Development, Vol. 56, No. 1*, 207-216.

Mozumder, A. K. A., Khuda, B.-E., Kane, T. T., Levin, A., & Ahmed, S. (2000). The effect of birth interval on malnutrition in Bangladeshi infants and young children. *Journal of biosocial science, 32*(03), 289-300.

Pluske, J., Williams, I., & Aherne, F. (1996). Maintenance of villous height and crypt depth in piglets by providing continuous nutrition after weaning. *Animal Science, 62*(01), 131-144.

Prynne, C. J., Mishra, G. D., O'Connell, M. A., Muniz, G., Laskey, M. A., Yan, L., . . . Ginty, F. (2006). Fruit and vegetable intakes and bone mineral status: a cross-sectional study in 5 age and sex cohorts. *The American journal of clinical nutrition, 83*(6), 1420-1428.

Qian, N. (2009). Quantity-Quality and the One Child Policy:The Only-Child Disadvantage in School Enrollment in Rural China. *NBER Working Paper No. 14973*.

Rodgers, J. L. (1988). Birth order, SAT, and confluence: Spurious correlations and no causality. *American Psychologist, Vol 43(6)*.

Rosenzweig, M. R., & Schultz, T. P. (1987). Fertility and Investments in Human Capital: Estimates of the Consequences of Imperfect Fertility Control in Malaysia, *Bulletin Number 87-1*.

Rosenzweig, M. R., & Wolpin, K. I. (1980). Testing the Quantity-Quality Fertility Model: The Use of Twins as a Natural Experiment. *Econometrica, Vol. 48, No. 1*, 227-240.

Rosenzweig, M. R., & Zhang, J. (2009). Do Population Control Policies Induce More Human Capital Investment? Twins, Birth Weight and China's “One-Child” Policy. *Review of Economic Studies, 76*(3), 1149-1174. doi: 10.1111/j.1467-937X.2009.00563.x

Savage, T., Derraik, J. G. B., Miles, H. L., Mouat, F., Hofman, P. L., & Cutfield, W. S. (2013). Increasing Maternal Age Is Associated with Taller Stature and Reduced Abdominal Fat in Their Children. *PLoS One, 8*(3), e58869. doi: 10.1371/journal.pone.0058869

Schultz, T. P. (2002). Wage gains associated with height as a form of health human capital. *Yale Economic Growth Center Discussion Paper*(841).

Sewell, R. D. R. a. W. H. (1991). Birth Order and Intelligence: Further Tests of the Confluence Model. *American Sociological Review, Vol. 56, No. 2*, pp. 141-158.

Sharma, M., & Mishra, S. (2013). Maternal risk factors and consequences of low birth weightin Infants. *IOSR Journal Of Humanities And Social Science, 13*(4), 39-45.

Shea, J. (2000). Does parents' money matter? *Journal of Public Economics, 77*, 155-184.

Siddiqui, F. A. (2001). Importance of a population policy in Pakistan. *The Pakistan Development Review*, 345-369.

Stookey, J. D., Wang, Y., Ge, K., Lin, H., & Popkin, B. M. (2000). Measuring diet quality in China: the INFH-UNC-CH diet quality index. *European Journal of Clinical Nutrition, 54*, 811-821. doi: 10.1038/sj.ejcn.1601098

Stulp, G., Buunk, A. P., Verhulst, S., & Pollet, T. V. (2013). Tall claims? Sense and nonsense about the importance of height of US presidents. *The Leadership Quarterly, 24*(1), 159-171.

Taubman, J. R. B. a. P. (1986). Birth Order, Schooling, and Earnings. *Journal of Labor Economics, Vol. 4, No. 3, Part 2:*, S121-S145.

Thomas, D. (1994). Like father, like son; like mother, like daughter: Parental resources and child height. *Journal of Human Resources*, 950-988.

Waterlow, J. C., Buzina, R., Keller, W., Lane, J., Nichaman, M., & Tanner, J. (1977). The presentation and use of height and weight data for comparing the nutritional status of groups of children under the age of 10 years. *Bulletin of the World Health Organization, 55*(4), 489.

Yu Jing-Yuon , S. J., Chi-Hsien Tuan (1985). Population control in China: theory and applications.

Zajonc, R. B., & Markus, G. B. (1975). Birth Order and Intellectual Development. *Psychological Review, 82*(No.1), 74-88.

Zajonc, R. B., & Markus, G. B. (1982). Birth Order and Intellectual Development. *Psychological Review, Vol. 82. No. 1*, 74-88.

Zhu, B., Haines, K., Le, T., McGrath-Miller, K., & Boulton, M. (2001). Effect of the interval between pregnancies on perinatal outcomes among white and black women. *Am J Obstet Gynecol*(185(6)), 1403-1410.

Figure 1.1 One Child Policy Trend

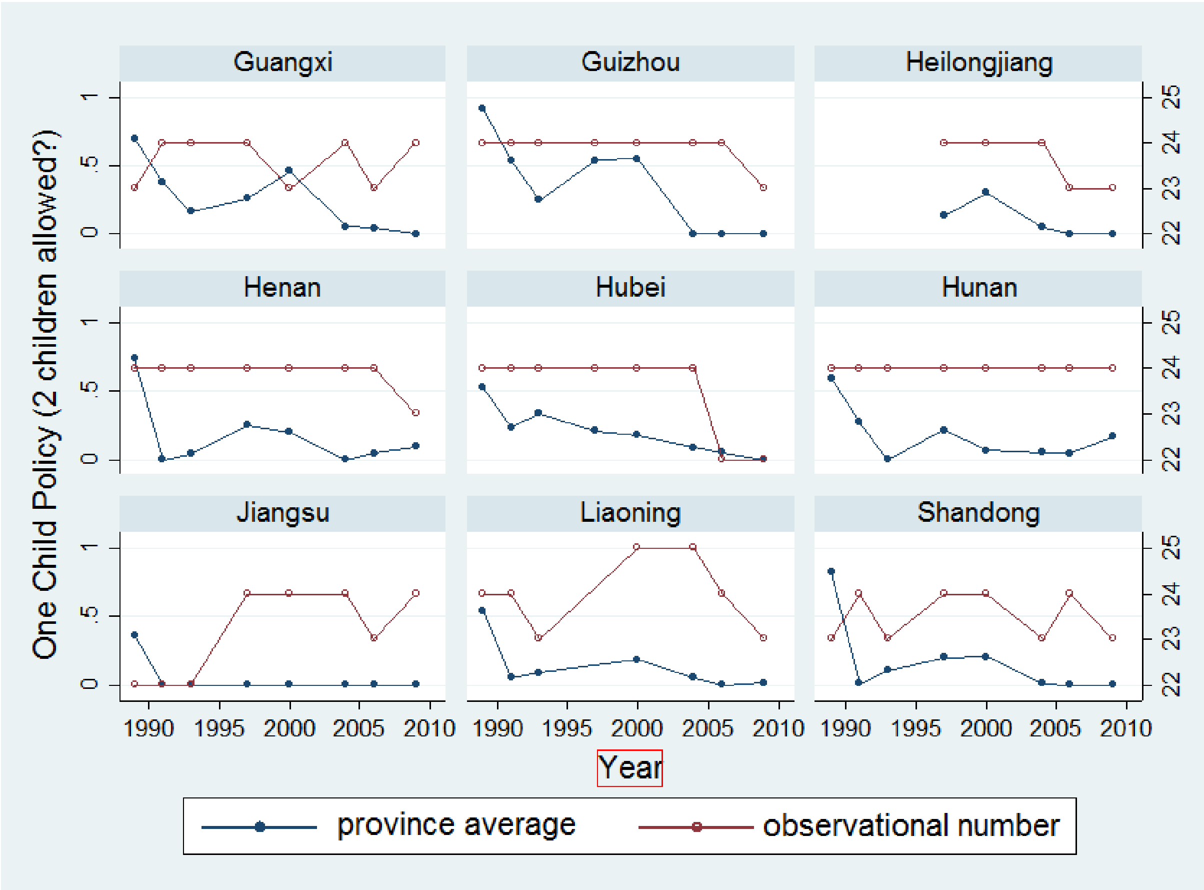


Figure 1.2 Birth Year Distribution

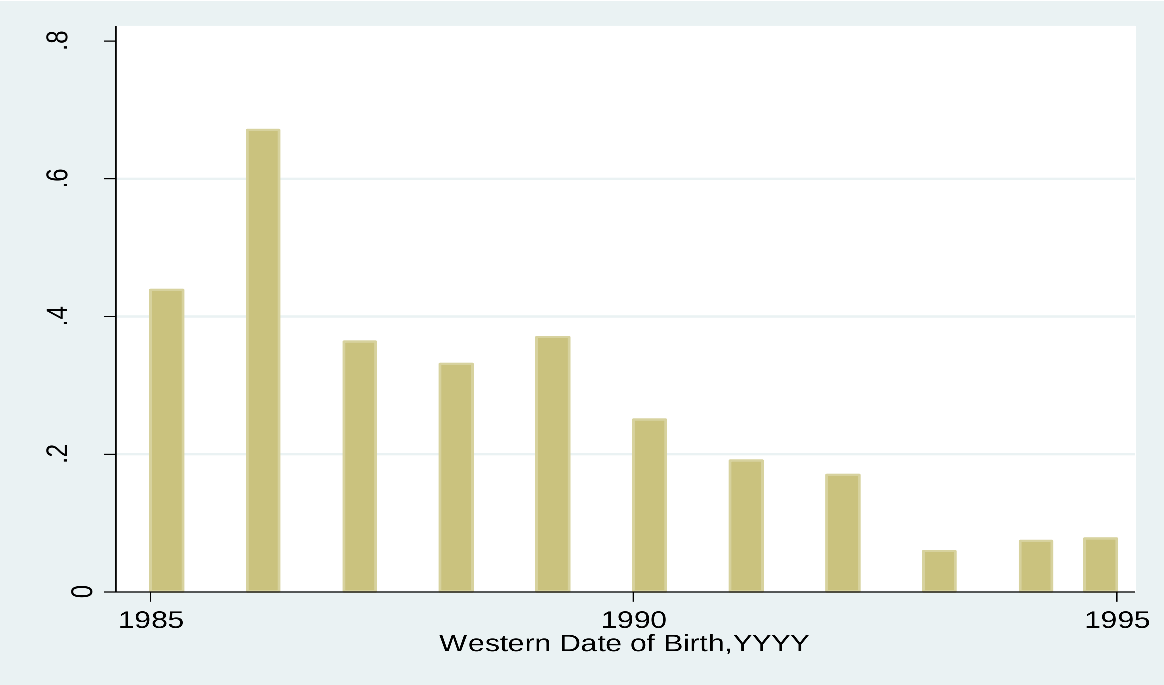
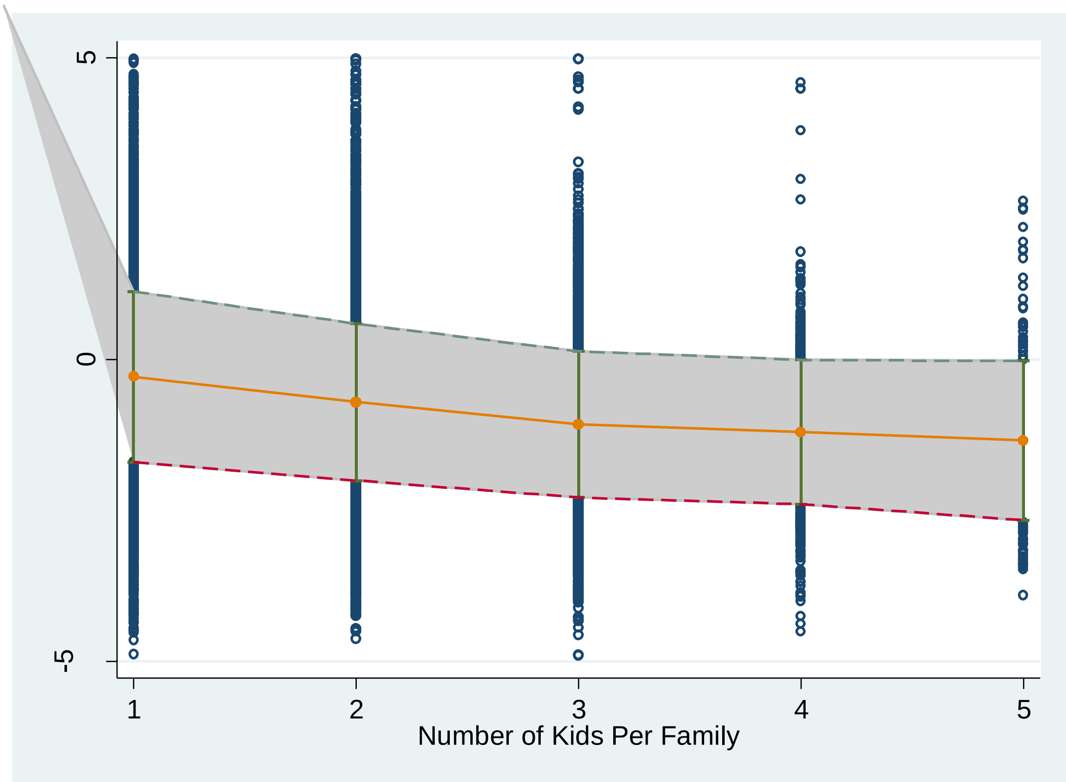


Figure 1.3 Mean of Standardized Height by Number of Kids



*The fence is at the value of 1 standard deviation. Orange line indicates the mean value.

Table 1.1 Summary Statistics

	Whole Sample	First Born after 1985	Treat 2 Not Allowed	Control 2 Allowed
Number of Kids in Family	1.81	1.36	1.23	1.52
Male	0.54	0.54	0.54	0.56
Age	11.52	9.33	9.69	8.98
Household Gross Income Log Value	9.05	9.20	9.43	8.88
Mother: Primary (%)	23.30%	22.20%	21.70%	22.50%
Mother: Lower Middle School (%)	29.60%	39.90%	39.30%	41.30%
Mother: Upper Middle School (%)	11.00%	16.30%	16.80%	14.90%
Mother: Technology Education (%)	2.79%	6.37%	8.84%	3.21%
Mother: University Degree (%)	1.45%	3.48%	5.26%	0.97%
Mother: Master Degree or Higher (%)	0.00%	0.02%	0.04%	0.00%
Mother's age at Birth	26.61	24.20	24.44	23.84
Father: Primary (%)	24.30%	16.50%	15.00%	18.20%
Father: Lower Middle School (%)	38.70%	46.50%	44.30%	49.10%
Father: Upper Middle School (%)	16.50%	20.50%	20.80%	19.70%
Father: Technology Education (%)	3.31%	5.94%	7.90%	3.93%
Father: University Degree (%)	2.74%	5.37%	7.90%	2.25%
Father: Master Degree or Higher (%)	0.07%	0.12%	0.23%	0.00%
Father's age at Birth	28.34	25.82	26.13	25.27
Standardized Height	-0.61	-0.16	0.07	-0.43
Standardized Weight	-0.64	-0.24	-0.05	-0.45
Calories Intake (cal)	1951.00	1775.00	1767.00	1802.00
Fat Intake (g)	53.58	57.34	59.57	54.07
Protein Intake (g)	58.59	54.60	54.76	54.76
Carbohydrate Intake (g)	305.00	258.00	248.60	274.30

Number of observation is 4,333 for the sample with first born after 1985.

Table 1.2 Community Characteristics Coefficients

No.	Variable	Policy
1	Population Density	0.0285
		(0.0220)
2	Economic Activity	-0.0133
		(0.00892)
3	Traditional Markets	-0.0167***
		(0.00535)
4	Modern Markets	-0.00721
		(0.00598)
5	Transportation Infrastructure	-0.00397
		(0.00913)
6	Sanitation	-0.0191
		(0.0133)
7	Communications	0.0446**
		(0.0164)
8	Housing	0.0192
		(0.0119)
9	Diversity	0.0463*
		(0.0258)
10	Health Infrastructure	-0.0120
		(0.0156)
11	Social services	0.0375***
		(0.0106)

The sample size is 1208. Data are collapsed at the community level. Gender, age, mother's education level and age at birth, household income, year fixed effects, province fixed effects and province and year interactive dummies are included as controls. Robust standard errors in parentheses.

*** p<0.01, ** p<0.05, * p<0.1

Table 1.3 Main Results

VARIABLES	Standardized Height		Standardized Weight	
Policy	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)
Number of Kids	-0.169***	-0.681**	-0.234***	-0.396
	(0.0507)	(0.299)	(0.0454)	(0.303)
Primary School (Mother)	0.135	0.0893	0.0756	0.0611
	(0.0782)	(0.0781)	(0.0847)	(0.0896)
Lower Middle School (Mother)	0.380***	0.296***	0.214***	0.188**
	(0.0780)	(0.0826)	(0.0652)	(0.0806)
Upper Middle School (Mother)	0.613***	0.474***	0.447***	0.403***
	(0.0886)	(0.118)	(0.0809)	(0.113)
Technical Institute (Mother)	0.697***	0.488***	0.537***	0.471***
	(0.0977)	(0.126)	(0.102)	(0.147)
University Degree (Mother)	0.730***	0.525***	0.541***	0.477***
	(0.152)	(0.178)	(0.136)	(0.177)
Master Degree (Mother)	0.482***	0.580***	0.164	0.195
	(0.0951)	(0.135)	(0.197)	(0.181)
Log of Household Income	0.0625**	0.0522**	0.0555***	0.0523***
	(0.0223)	(0.0263)	(0.0171)	(0.0193)
Age	-0.137***	-0.0892***	-0.0712***	-0.0561*
	(0.0231)	(0.0344)	(0.0213)	(0.0334)
Sample Size	4,333	4,333	4,333	4,333

A community variable based on the question "Is every couple in your village/neighborhood allowed to have two children?" is used as the IV. Number of kids per family is the key explanatory variable. Province and year fixed effects are included. First stage coefficient for the IV approach is statistically significant at 1% level with a value of 0.17 and a standard deviation of 0.0516. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 1.4 Underlying Mechanism

VARIABLES	Log (Father's Care Time)	Log (Mother's Care Time	Smoking	Drinking	Index
Number of Kids	0.151	0.199	0.0132	0.0454	-0.259***
	(0.960)	(0.472)	(0.214)	(0.142)	(0.0819)
Sample Size	713	1,347	1,255	1,670	2,188

Child characteristics including gender and age and mother's educational attainment are included as controls. . Province and year fixed effects are also included. A community variable based on the question "Is every couple in your village/neighborhood allowed to have two children?" is used as the IV. First stage coefficient for is statistically significant at 1% level with a value of 0.17 and a standard deviation of 0.0516 for all the column except for the index column. For the index column, the first stage is 5% significant with a value of 0.148. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 1.5 Robustness Check

VARIABLES	Standardized Height	Standardized Weight
	Panel A: Insurance Status (N=3,913)	
Number of Kids	-0.683**	-0.391
	(0.283)	(0.298)
	Panel B: Father's Education and Age at Children's Birth (N=4,172)	
Number of Kids	-0.681**	-0.361
	(0.306)	(0.295)
	Panel C: Mother's height included in the regression (N=4,314)	
Number of Kids	-0.457*	-0.244
	(0.261)	(0.275)
	Panel D: Add in four significant community characteristics (N=4,333)	
Number of Kids	-0.605*	-0.347
	(0.318)	(0.307)

Child characteristics including gender and age and mother's educational attainment are included as controls. . Province and year fixed effects are also included. A community variable based on the question "Is every couple in your village/neighborhood allowed to have two children?" is used as the IV. First stage coefficient for Panel A is statistically significant at 1% level with a value of 0.172 and a standard deviation of 0.0539. First stage coefficient for Panel B is statistically significant at 1% level with a value of 0.163 and a standard deviation of 0.0492. First stage coefficient for Panel C is statistically significant at 1% level with a value of 0.163 and a standard deviation of 0.0483. First stage coefficient for Panel D is statistically significant at 1% level with a value of 0.169 and a standard deviation of 0.0506.
Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 1.6 Social Economic Status

VARIABLES	z height		z weight	
	Panel A: Income			
	Above Middle	Below Middle	Above Middle	Below Middle
Number of Kids	-0.428	-0.751***	-0.372	-0.348
	(0.574)	(0.281)	(0.576)	(0.377)
Sample Size	1,953	2,380	1,953	2,380
	Panel B: Mother's Education			
	Above High School	Below High School	Above High School	Below High School
Number of Kids	-0.107	-0.749*	-0.297	-0.348
	(1.502)	(0.399)	(0.874)	(0.375)
Sample Size	1,136	3,197	1,136	3,197

Child characteristics including gender and age and mother's educational attainment are included as controls. . Province and year fixed effects are also included. A community variable based on the question "Is every couple in your village/neighborhood allowed to have two children?" is used as the IV. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 1.7 Son Preference

	z height		z weight	
	Panel A: Children's Gender			
	Boys	Girls	Boys	Girls
Number of Kids	-0.408	-0.921***	-0.424	-0.485
	(0.369)	(0.350)	(0.431)	(0.323)
Sample Size	2,356	1,977	2,356	1,977
	Panel B: Household Income (First is a Girl)			
	>= Middle Class	< Middle Class	>= Middle Class	< Middle Class
Number of Kids	-0.934	-0.966**	-0.389	0.332
	(0.746)	(0.391)	(1.001)	(0.560)
Sample Size	873	1,104	873	1,104
	Panel C: Mother's Education (First is a Girl)			
	>= high school	< high school	>= high school	< high school
Number of Kids	0.289	-1.368**	-0.0971	-0.634
	(0.669)	(0.668)	(0.403)	(0.446)
Sample Size	518	1,459	518	1,459

Child characteristics including gender and age and mother's educational attainment are included as controls. . Province and year fixed effects are also included. A community variable based on the question "Is every couple in your village/neighborhood allowed to have two children?" is used as the IV. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 1.8 Children's Age

	Z Height			Z weight		
	Children's Age					
VARIABLES	Age < 7	7≤Age<14	14≤Age	Age < 7	7≤Age<14	14≤Age
Number of Kids	-0.911***	-0.660*	-0.154	-0.395	-0.464	0.120
	(0.400)	(0.342)	(0.703)	(0.456)	(0.387)	(0.734)
Sample Size	1,547	1,781	1,005	1,547	1,781	1,005

Child characteristics including gender and age and mother's educational attainment are included as controls. . Province and year fixed effects are also included. A community variable based on the question "Is every couple in your village/neighborhood allowed to have two children?" is used as the IV. First stage value for each column are: 0.164***, 0.197***, 0.107., Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Appendix Tables

Table A1.1 One Child Policy Changes over Time

Policy Rules	Announced by Program Leader	Codified in Central Document
Best is one, at most two; eliminate third birth	June 1978 (LG); January 1979 (BP)*	Oct-78
Best is one	Dec-79	Jan-80
One for all	Feb-80	Sep-80
One child with exceptions for rural couples with only a daughter**	Early 1984 (on trial basis); May 1988(formal policy)	April 1984(on trial basis) March 1988 (formal policy)

Note: *LG=Leading Group; BP=birth planning directors (at national meeting) **Known as the daughter –only or 1.5 child policy

These rules applied to the Han majority; ethnic minorities have enjoyed more lenient policies.

Source: Greenhalgh (2008)

Table A1.2 Twelve Community Characteristics Variables

No.	Variable	Description
1	Population Density	Total population of the community divided by community area, from official records
2	Economic Activity	Typical daily wage for ordinary male worker (reported by community official) and percent of the population engaged in nonagricultural work
3	Traditional Markets	Distance to the market (three categories), (1) within the boundaries of the community, (2) within the city but not in this community, or (3) notwithin the city/village/town); number of days of operation for eight different types of market (including food and fuel markets)
4	Modern Markets	Number of supermarkets, cafes, internet cafes, indoor restaurants, outdoor fixed and mobile eateries, bakeries, ice cream parlors, fast food restaurants, fruit and vegetable stands, bars within the community boundaries
5	Transportation Infrastructure	Most common type of road, distance to bus stop, and distance to train stop. (Distance is categorized as (1) within community, (2) <= 1 km from community, and (3) >= 1 km from community)
6	Sanitation	Proportion of households with treated water and prevalence of households without excreta present outside the home
7	Communications	Availability (within community boundaries) of a cinema, newspaper, postal service, telephone service; and percent of households with a computer, percent of households with a television, and percent of households with a cell phone.
8	Housing	Average number of days a week that electricity is available to the community, percent of community with indoor tap water, percent of community with flush toilets, and percent of community that cooks with gas
9	Education	Average education level among adults >21 years old
10	Diversity	Variation in community education level and variation in community income level
11	Health Infrastructure	Number and type of health facilities in or nearby (12 km) the community and number of pharmacies in community
12	Social services	Provision of preschool for children under 3 years old, availability of (offered in community) commercial medical insurance, free medical insurance, and/ or insurance for women and children

Chapter 2: The Financial Impacts of Ambulatory Surgery Centers On General Surgical Hospitals

1. Introduction

Forty years ago, almost all surgeries were carried out in hospitals (Ambulatory Surgery Center Association, 2012). The waiting period for such procedures could be long and recovery times could be lengthy. U.S. physicians thus took the lead in transforming the health care industry by developing the Ambulatory Surgical Center (ASC), a facility that performs surgical procedures exclusively on an outpatient basis. ASCs and other ambulatory health care facilities, including hospital outpatient departments (HOPDs) and physicians' offices, offer alternative sites for certain surgical procedures that do not require an overnight stay. ASCs have experienced tremendous growth over the last four decades. This paper analyzes the financial impact of ASCs on general surgical hospitals.

The first ASC was established in Phoenix, Arizona in 1970 by two physicians, Wallace Reed and John Ford. Their goal was to establish a high-quality, cost effective alternative to inpatient surgeries. Throughout the early 1970s, a small number of ASCs opened in the U.S. But by 1979, the number of ASCs had already reached triple digits. The year 1982 was marked by the approval of payments to ASCs by Medicare, and in 1988 the number of ASCs reached a new high: 1,000 nationwide. In 1995, Medicare expanded the list to cover more than 2,000 ASCs' procedures. In 2011, more than 5,300 ASCs were performing 23 million surgeries on an annual basis, and the Medicare program gave approval for ASCs to perform more than 3,500 procedures (Ambulatory Surgery Center Association, 2013).[1]

The cause of this rampant growth of ASCs is two-folded. From the demand side, patients desired health care with lower co-payments, more convenient locations, shorter waiting times, and easier scheduling and ASCs satisfied those needs (Koenig, Doherty, Dreyfus, & Xanthopoulos, 2009) partially because of the improvement in medical technology that allowed for faster patient recovery time and less surgical time.[2] Furthermore, Medicare on average paid ASCs only 58 percent of what it paid to hospital outpatient departments for performing the same service as of 2011 (Kaiser Family Foundation, 2012). For example, Medicare paid hospitals $1,670 for performing an outpatient cataract surgery, but paid ASCs only $ 964 for performing the same surgery (Ambulatory Surgery Center Advocacy Committee, 2015).[3] Like the CMS, private insurance companies similarly tend to pay at a lower rate (Ambulatory Surgery Center Advocacy Committee, 2015).[4] Therefore, all payers have the

---

[1] For more information about history of ASCs, please visit http://www.ascassociation.org/advancingsurgicalcare/whatisanasc/historyofascs.

[2] For example, the latest generation of surgical lasers offers treatments that are faster, safer and less invasive. Laser solutions are available across a wide range of surgical fields, from minimally invasive aesthetic surgical treatments (laser-assisted lipolysis and hyperhidrosis) to clinical surgical procedures such as endovenous laser ablation. See more at: http://www.fotona.com/en/surgery/. Also, minimally invasive techniques are allowing patients to recover more quickly from spine surgery. See more at: http://www.beckersspine.com/spine/item/20747-how-spine-surgeons-opening-ascs-will-impact-healthcare-delivery-costs.html.

[3] The use of different inflation measures contributed to this growing divergence in payments between hospitals and ASCs. The Centers for Medicare & Medicaid Services (CMS) uses the hospital market basket, which measures the cost of medical expenses, as the inflation rate for hospitals. In contrast, the CMS underestimates the inflation rate for ASCs by using the consumer price index-urban, which measures the cost of goods such as milk and bread as the inflation rate for ASCs (Ambulatory Surgery Center Advocacy Committee, 2015). ASCs can survive with a lower payment rate because they are more efficient (e.g. less perioperative time) (Hair, Hussey, & Wynn, 2012; Munnich & Parente, 2014) and as a result cost less to run ("Freestanding ambulatory surgery centers cost less to run than in-hospital ORs," 1999; Munnich & Parente, 2014).

[4] Even though the ASCs cost less, their quality of care does not appear to be compromised. Grisel and Arjmand (2009) find that ASCs have fewer unexpected safety events than hospital outpatient departments.

incentive to encourage their patients to visit ASCs instead of hospitals.

From the supply side, physicians had been experiencing frustrations, including but not limited to scheduling delays, limited operating room availability, slow operating room turnover times, and huge resistance from the bureaucracy of hospital administrative systems to buying new equipment or adopting new procedures(Ambulatory Surgical Care Associaion, 2011). At hospitals, physicians have to comply with the hospital rules and bureaucratic processes. In contrast, virtually all physicians have some ownership of ASCs (Ambulatory Surgical Care Associaion, 2011). Physicians thus favor ASCs over hospitals because of the professional autonomy over their work environment endowed by their ownership of ASCs (Koenig et al., 2009).

It is important to look at the growth of ASCs because underlying this growth is a crucial economic question: is the revenue and operating expenses of the general acute and surgical hospitals affected by the entry of ASCs? The answer to that question has important implications for the future surgical care landscape because financial feasibility is an accurate predictor of the continuation of the health care business (Gugliotta, 2015). Even though ASCs only perform same-day surgical procedures, the financial situation of hospitals can be affected by their entries[5] and if the financial impact is negative, then a hospital's existence may be threatened.[6]

Also, changes in the surgical care landscape have a direct impact on patients' welfare. If ASCs drive some hospitals out of business, then the same day surgical market will become

[5] One possible scenario is that ASCs may attract hospital outpatients for the overlapped procedures.

[6] In Ohio, hospitals have already closed because of the competition from ambulatory care facilities. Hospitals are operating with few beds or closing all together to make way for new ambulatory care centers. In Lakewood, Ohio, the only hospital in the city has closed because its 200 beds were typically half empty (Evans, 2015).

increasingly dominated by ASCs. A less competitive health care market definitely will change the quality and cost of care, for better or for worse.[7] Therefore, a negative financial impact of ASCs on hospitals could greatly affect the surgical care market. Consequently, confirming the very existence of such negative financial impacts becomes a critical first step to investigate the market dynamics between ASCs and general surgical care hospitals.

I find that ASCs do have a negative financial impact on surgical hospitals in Pennsylvania. To reach this conclusion, I apply a two-stage least square model (2SLS) with hospital fixed-effects, time fixed-effects, and a hospital specific time trend; my instrumental variable is the product of change in over-65 population at the county level over the years studied and change in average Medicare payments rate for all ASCs' procedures over the same years. My main data sources are: the Pennsylvania Health Care Cost Containment Council (PHC4) inpatient and hospital financial data base, the American Hospital Association (AHA) annual surveys dataset, ASCs' survey dataset from the Division of Health Information in the PA Department of Health, and the Medicare payment rate for all ASCs' procedures from the Centers for Medicare & Medicaid Services (CMS).

I find that one more ASC in the region increases net patient revenue by an average of 6.81 percent at the hospital level and increases total operating costs by an average of 8.76 percent, resulting in a decrease in profit margin at the hospital level. Such a financial change likely is caused by increases in the severity of inpatients' conditions treated at hospitals when ASCs enter the same market. My results show that this change in severity composition is not

[7] There is evidence for and against provider competition. Some papers find that competition can improve health care outcomes and control health care costs while others find that provider competition has resulted in poor outcomes, duplicate costs, and inefficient allocation of resources (Penelope \& Meredith, 2010).

caused by ASCs transferring more of their sicker patients to ASCs. More likely, it is a negative spillover effect from induced demand, in that more severely ill patients go to hospitals voluntarily for their surgeries once they get to know the benefits of these surgeries through ASCs' advertisements or they are referred to the hospitals by their physicians before they receive any treatments at ASCs.

2. Literature Review

The literature on the financial impact of ASC on hospitals is scarce. The first study of their financial impact on hospitals was done by Carey, Burgess, and Young (2011). They estimate a hospital fixed effects model using data from Arizona, California, and Texas with a hospital fixed-effect model and find that ASCs tend to pull down revenues, costs, and profits in general hospitals. Their paper is groundbreaking, but it involves an unsolved endogeneity problem: the entry choice of individual ASCs may be driven by some co-founding unobservable factors. For example, if some unobserved factors that drive ASCs to establish in the area are also correlated with hospital financial performance, then the causality between ASCs' penetration rate in the market and general surgical hospital performance cannot be established. The authors argue that they can alleviate the endogeneity concern by using hospital fixed-effects. However, their hospital fixed-effects model can only capture unobserved time invariant factors that exist at the hospital level. Causality is still jeopardized if other omitted factors are correlated with both the dependent variable (i.e. hospital revenue and costs) and the independent variables (i.e. number of ASCs in a region). For instance, hospital fixed-effects can neither capture the community-level characteristics (e.g. community socioeconomic status) nor hospital-level time varying factors (e.g. changes in hospital management teams), that are correlated with the penetration of ASCs and hospital financial performances.

My first contribution to the literature is to apply the 2SLS model and address the endogeneity problem. I exploit the variation in the growth of the over-65 population at the county level and the average Medicare payments rate for all ASCs' procedures at national level by year in order to create a unique instrumental variable. To my knowledge, this paper is the first to address the endogeneity problem in this research topic.

My second contribution to the literature builds upon Carey, Burgess, and Young to explore the possible channels that might cause revenue and cost changes in hospitals when ASCs enter the region. Hospital managers have their own interpretation of how their financial situation changes upon the entry of ASCs: they believe that their financial situation worsens because ASCs have taken the lucrative patients (e.g. Medicare and privately insured patients) and left hospitals with the indigent patients (e.g. Medicaid patients). They also accuse ASCs of taking the healthier patients (Hylton, 2006) and their allegations are not groundless. Strope et al. (2009) find that patients with higher socioeconomic status are more likely to have procedures performed in ASCs. Additionally, there is evidence that ASCs not only attract affluent patients, but also select profitable procedures (Plotzke & Courtemanche, 2011). In fact, physician-owners of ASCs might be steering the ASCs toward profit-seeking behaviors, including but not limited to selecting patients and profitable procedures (Hollingsworth; et al., 2010; Seth A. Strope et al., 2009).

These studies suggest indirect causes for the negative impacts of ASCs on hospitals because these studies focus on the ASCs. Profit seeking behaviors in ASCs and hospitals are not mutually exclusive because both of them can carry out profit-seeking strategies. So just because ASCs are selecting patients, it does not necessarily mean hospitals are accepting poor, severely ill patients. In order to identify the possible direct causes of changing hospital profitability, we need to focus on hospital data and use it to ask whether there is any change on the hospital side upon ASCs' entry by controlling for other important co-factors and addressing the endogeneity problem.

3. Data

Hospital financial performance information--including hospital net patient revenue, total operating costs, and payer ratio of the net patient revenue--is from PHC4 Financial Analysis Volume One--General Acute Care Hospitals. I use the payer ratio times the net patient revenue to get the total insurance payment by payer types. Data on hospital characteristics are from the AHA Annual Survey of Hospitals. They include hospital names and locations, number of beds, number of total surgical operations[8] and number of inpatient surgical operations.

The Division of Health Information in the PA Department of Health has ASCs' survey data from 1996 to 2014. Those annual datasets include information such as facility names and locations, number of surgeries performed, number of beds, hospital referral region (HRR) number, and more. The HRR regions are defined by determining where patients were referred for major cardiovascular surgical procedures and for neurosurgery (“Data by Region ”, 2015). They are widely used to define health care markets.[9] Following Carey et al. (2011), I use the

[8] Total surgeries include inpatient and outpatient surgeries.

[9] Carey et al. (2011) define the hospital market by HRR and calculate the ASCs' penetration rate as the number of ASCs per HRR; Cutler and Scott Morton (2013) define the market by HRR to study hospital market share and consolidations; Chandra, Finkelstein, Sacarny, and Syverson (2013) use HRR market definition to explore procedures including emergent conditions and hip and knee replacements.

number of ASCs in each HRR region as the measurement of ASCs' penetration rate. [10] [11] In total, there are 15 HRRs in my sample.

Since the CMS revised the ASC payment system in 2008, observations after 2007 were excluded to avoid the potential co-founding effects. The ASC final rules provide for a four-year transition period for implementation of the rates calculated by using the methodology of the revised ASC payment system. In each year after 2008, there are multiple payments for the same procedures at different times because of the shock of implementing new rules. The payment system change essentially is about implementing a value-based purchasing (VBP) program for payments under the Medicare program for ASCs. The VBP also was applied to general acute hospitals in fiscal year 2013. Prior to the official launch of VBP to general hospitals, the Medicare program gradually had been moving toward its implementation starting with a pay-for-reporting program in July 2007 (e.g., the Hospital Inpatient Quality Reporting program and the Physician Quality Reporting Initiative) in general acute hospitals (Cheryl L. Damberg et al., 2014). All of those policies would have a direct impact on hospital financial situations since CMS always uses the payment rate as the incentive to enforce the policies (United States Government Accountability Office, 2015).

In addition, I cannot study time periods before 2001 because CMS only maintains a

---

[10] Hospital service area (HSA) is not appropriate for defining the markets in my paper for two reasons: 1. Patients who live outside of a particular HSA region but are referred to the hospital located in the HSA area will not be counted as part of the healthcare market. 2. HSA region is too small to capture the whole market of a hospital. The average number of ASCs in each HSA is 4.44 and the average number of ASCs in the market defined by the circle drawn around a hospital from which it attracts 65 percent of inpatients is 7.83.

[11] Variable radius approach is not used because of lack of outpatient data. Variable radius is defined by the circle around the hospital from which it attracts a certain percentage of all patients (Gresenz et al., 2004). Without outpatient data, the total patient population cannot be defined.

payment record for all ASCs' procedures starting from 2001. Because I am using the percentage change between consecutive years to calculate the IV, 2001 data would be missing. Effectively, I am studying the data from 2002 to 2007.

Hospital level data and ASC data are merged by HRR number and year. Initially, there were 275 unique hospitals in Pennsylvania in the AHA dataset from 2002 to 2007. After limiting the study to only acute care and general surgical hospitals, I have 166 unique hospitals left, over 6 years, with 899 observations in total at the hospital-year level.

The number of ASCs per HRR is the key explanatory variable which I use to measure the ASCs penetration rate. In Pennsylvania, the number of ASCs more than doubled from 102 in 2002 to 217 in 2007 (Figure 2.1). In Figures 2.2 and 2.3, I show that only three counties had more than three ASCs in 2002 but in 2007, thirteen counties had more than six ASCs, with the highest number of ASCs per county topping out at 22. The ASCs were highly concentrated around urban and suburban areas (e.g. Philadelphia, Harrisburg, Pittsburgh, and so on) in 2002, but by 2007, the ASCs had spread to a lot of other counties as well.

When I explore the possible mechanisms, I need to use inpatient characteristics as the dependent variables. I use the hospital name to link each inpatient record in the PHC4 with hospital level data. Data on inpatient characteristic--such as their age, race, gender, admission source (e.g. transferred from ASCs), insurance type, diagnosis and procedure codes, zip code of residence, drug charge, ancillary charge,[12] and total inpatient charges excluding professional

[12] Ancillary charges are charges for services that may include laboratory tests, supplies, medications, physical therapy, x-rays, operating room charges, and others.

fees per admission[13]--are from the PHC4 inpatient data base. I aggregate the data by hospital and year to get the mean value of all inpatient variables at the hospital-year level.

4. Empirical Model

The impact of ASCs on hospital financial outcomes can be expressed as

$$\mathrm{Y_{ikt}} = \alpha_0 + \alpha_1 NumASC_{kt} + W_{it}\alpha_3 + \eta_i + \tau_t + \epsilon_{ikt} \quad (1)$$

where $\mathrm{Y_{ikt}}$ is the financial measurement of total patient revenue or total operating expense in log values for hospital i in HRR k in year t. $NumASC_{kt}$ is the total number of ASCs in HRR k in year t. W_{it} represents other hospital characteristics for hospital i in year t, including a bed size categorical variable, teaching status, ownership status,[14] and a hospital-specific time trend. Hospital bed size is divided into four groups: below 100, 100-299, 300-499, 500 and more. η_i is the hospital fixed-effects and τ_t is the time fixed-effects.

The variation of the dependent variables in the data comes from two sources: inter-hospital (across hospital) variation and intra-hospital (within hospital) variation. Regressions that rely on inter-hospital variation are problematic because of omitted variable bias (e.g. endogenous hospital characteristics, such as management team competency, can make a huge difference in hospitals' financial performance). The solution is to focus on intra-hospital variations only by including the hospital fixed-effects η_i. In addition, time fixed-effects τ_t help us remove the time variant unobserved factors that are common to all hospitals. As

[13] Total inpatient charges excluding professional fees include total room and board charges, total ancillary charges, total drug charges, total equipment charges and total of other charges.

[14] Hospital teaching status and ownership status do change over time. For example, Sacred Heart Hospital in Allentown, Pennsylvania changed to a teaching hospital in 2006 and Altoona Hospital in Altoona, Pennsylvania changed from not-for-profit to for-profit in 2007. Hundreds of hospitals have switched from being nonprofit to for-profit over the past decade in U.S. (Joynt, Orav, & Jha, 2014). Therefore, it is necessary to include dummies for teaching status and non-for-profit status together with the hospital fixed-effects.

shown in Figure 2.5, there is a clear common trend, and hence the time fixed-effects become necessary.

I include a linear hospital trend as my main result but in the robustness checks I also test hospital quadratic trends to prove that the form of the hospital trend does not affect my results. Net patient revenue, total operating expenses, insurance payments and number of surgeries (total or inpatient)[15] [16] are highly skewed (Figure 2.4).[17] Therefore, I use the log transformation. Summary Statistics are shown in Table 2.1.

The ordinary least squares (OLS) estimates from the model described above are biased because the number of ASCs can be influenced by certain cofactors that also affect hospital financial performance. Thus after controlling for hospital and time fixed-effects and a hospital specific time trend, which can partially alleviate the endogeneity concern, we still need to address the endogeneity caused by omitted variables. None of the previous literature has addressed this important issue.

To address the endogeneity problem I use a 2SLS model with the product of change in over-65 population at the county level over the years studied and change in average Medicare payments[18] rate for all ASCs' procedures over the same years as my IV. The IV in 2002 is

[15] Inpatient charges and Charlson index are computed based on the 17 selected CCS coded procedures only. More details are discussed in section 7.

[16] None of those variables have zero values.

[17] Only net patient revenue and total operating expenses graphs are shown as examples. Graphs of other variables are available upon request.

[18] County-level population data are intercensal estimates from the United States Census and county elder population change is exogenous to unobservable variables like hospital management teams. The Medicare payment rate for ASCs' procedures comes from archived data dating back to 2001 maintained by the CMS and varies by procedures and years. The standard ASC payment for most covered surgical procedures is calculated by multiplying the ASC conversion factor by the ASC relative payment weight for each separately payable procedure. The ASC conversion factor (CF) is adjusted for the purpose of budget neutrality by removing the

calculated by multiplying the change in population aged 65 and above between 2001 and 2002 and the change in the average Medicare payment across all ASC procedures from 2001 to 2002. The average Medicare payment rate over all ASC procedures by year is calculated at a national level and exogenous to any neighborhood characteristics or hospital characteristics. The downside of using the average national payment rate change is that the average payment rate only varies by year; there is no geographical variation. The change in population aged 65 and above over the years at county level is an ideal variable because it varies by region. Together these two factors determine a significant portion of the payment that health care suppliers receive and hence determine the number of ASCs in the region. I provide more evidence to support the exogeneity of my instrumental variables in Section 5.

5. Results

Table 2.2 displays the main results. Panel A shows the OLS results using hospital and year fixed-effects, without hospital time trend. It shows that with one more ASC in the region, net patient revenue decreases by 1.24 percent and total operating expenses decrease by 1.26 percent. This implies that the presence of ASCs reduces hospital's revenues and that hospital responded by lowering their operating costs in order to maintain their profitability. This result is similar to the findings of Carey et al. (2011).

After the linear hospital trend is added, the empirical results no longer support the conclusion above. As shown in Panel B, one more ASC in the HRR has no significant effects

---

effects of changes in wage index values for the upcoming year as compared to values for the current year (Center for Medicare & Medicaid Services, 2014).ASC CF and relative payment weight are exogenous to unobserved characteristics such as neighborhood socioeconomic status or changes in management teams; hence the Medicare payment rate change for ASCs' procedures also should be exogenous. Therefore, my IV should be exogenous.

on revenues but increases hospital operating costs by 1.86 percent. It is thus critical to include a hospital linear time trend in the model, because unobserved hospital characteristics which vary over time have a significant negative impact on hospital revenues and operating expenses. Therefore, all of the regression specifications described next must include a linear hospital trend.

Column 2 and 3 of Panel C in Table 2.2 present second stage results of 2SLS with hospital fixed-effects, year fixed-effects and a linear hospital trend. The first stage result of my 2SLS estimation is shown in column 1 of Panel C, Table 2.2: it is statistically significant at the 1 percent level with a t-value of 3.25 and an F-value of 10.59.[19] This shows that my IV is strong enough: the positive sign of the coefficient estimate implies that more elders and increases in the Medicare payment will attract more physicians to set up ASCs in the HRR region because of potential financial profitability. According to the second stage results, one more ASC in the HRR will increase net patient revenue at hospitals in the HRR region by 6.81 percent and increase their total operating costs by 8.76 percent. Both results are significant at the 1 percent level. Therefore, the revenue increases are not sufficient to cover the cost increases, which results in a decrease in the profit margin.

The increase in the coefficient scale after applying the IV implies that the correlation between the omitted variables and the number of ASCs is negative because the estimate bias is negative. There could be many potential unobservable. One example may be elders' preferences: elders might prefer to visit the outpatient department of general surgical hospitals because there they could be treated faster should any complications arise --- the elderly face a

[19] Both t and F value are rounded to the nearest tenth.

higher probability of complications as a group because of the presence of comorbidity (Byers, Yaffe, Covinsky, Friedman, & Bruce, 2010) . If elders prefer to visit hospitals over ASCs, then their preference would be negatively correlated with the number of ASCs in the region. Consequently, omitting such preferences would create a negative bias.

The effectiveness of my 2SLS strategy depends on the exogeneity of the IV. Empirically, there is no way to prove that an IV is exogenous with respect to the unobservable factors. But if the IV is exogenous to observable characteristics, then it is also very likely exogenous to unobservable characteristics. Table 2-3 shows the results of testing the correlation between IV and observable hospital characteristics and Table 2-4 shows the results of testing the correlation between IV and inpatient characteristics.[20] The regressions use the same specifications as Equation 1, including hospital fixed-effects, year fixed-effects, and a linear hospital trend. As shown in Tables 2-3 and 2-4, the IV is not correlated with any of the observable hospital and inpatient characteristics. This proves that my IV is exogenous to hospital and inpatient observable characteristics and implies that my IV likely is also exogenous to potential unobservable factors.

6. Robustness Checks

I perform robustness checks in four ways: first and foremost, instead of using the number of ASCs, I use the total number of surgeries in each HRR region as the measurement the ASC penetration rate to prove that different measurements of the penetration rate would not affect my results. The results are in Panel A. Panel A has a much smaller coefficient due to the fact

[20] Due to the difference in operating procedures between ASCs and hospital inpatient departments, I only focus on the overlapped procedures between ASCs and hospital inpatient departments when I test the correlation between inpatient characteristics and IV. More details are discussed in section 7.

that the number of ASC surgeries per HRR is very large.[21]

Second, I add average inpatient characteristics at the hospital level including race, gender, and age for hospital i in year t to see whether my model, without any inpatient characteristics, has successfully captured the effect of inpatient characteristics. I divide age into six groups: 0-19, 20-34, 34-49, 50-64, and 65 and above. Race is characterized as Black, White, Asian, and others. All of the patient data are aggregated to the hospital level. The coefficients in Panel B are very similar to the main results. That similarity shows that adding patient characteristics does not change the results significantly. This suggests that the change in patient severity is captured well by hospital fixed-effects, time fixed-effects and a linear hospital trend.

Third, as shown in the summary statistics, because the majority of ASCs are for-profit, I shall determine whether the results still hold when I drop all of the not-for-profit ASCs. If the results remain similar, then the for-profit ASCs are the key players affecting hospital financial performance. Results are shown in Panel C and indeed, they are very similar to the main result, suggesting that for-profit ASCs are the major force that impact hospitals' business.

Last but not the least, a quadratic hospital trend replaces the linear hospital trend to test whether my results are affected by different trend specifications. Panel D results demonstrate that different specifications of hospital trends have no effect on the main results. In the first three panels of the robustness check, the regressions include hospital fixed-effects, year fixed-effects and a linear hospital trend. The last panel replaces the linear hospital trend with a quadratic one. Across all four panels, the first stage estimates are all significant. The increase in total operating expense is larger than the increase in net patient revenue upon ASC entry,

[21] On average, there are approximately 20 ASCs in each HRR but around 70,000 surgeries.

implying a decrease in the profit margin.

7. Mechanisms

Next, I explore the possible mechanism by which could cause the hospital finances change when ASCs enter the market. I replace Y_{ikt} in Equation 1 with the log value of net patient revenue by payer type[22] and the number of total surgeries for all procedures. As shown in Table 2-6, Medicare and private payments increase by 5.09 percent and 7.31 percent on average, respectively, with one more ASC. Medicaid payments are not affected by ASC entry. These payment increases can explain why net patient revenue would increase when ASCs enter the market.

We can gain additional insights by looking at the change in the mix of inpatients following ASCs' entry. Due to the difference in operating procedures between ASCs and hospital inpatient departments,[23] I only focus on the overlapping procedures between ASCs and hospitals' inpatient departments. I first select the 25 most common ASC procedures[24] according to the Center for Medicare & Medicaid Services website. Those 25 procedures are marked by Current Procedural Terminology (CPT®) codes and are selected based on surgical volume in 2012.[25] [26] Inpatient procedures are classified by International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM). Using single-level clinical

---

[22] Insurance payment by payer type is calculated by multiplying the net patient revenue and payer payment ratio of net patient revenue.

[23] ASCs generally operate surgeries that do not require an overnight stay, whereas hospitals' inpatient departments provide extended support to surgeries that require more than a 24 hour stay.

[24] Procedure details can be found at https://www.cms.gov/Research-Statistics-Data-and-Systems/Research/HealthCareConInit/ASC.html

[25] Most common procedures in the years prior to 2012 are not available in CMS website.

[26] CPT is a proprietary coding system developed by the American Medical Association (AMA) for coding services provided by health care professionals.

classification software (CCS) from the Health Care Utilization Project (HCUP), we can classify both ICD-9-CM and CPT codes for 244 different procedure types. After classifying the 25 common ASC procedures and the ICD-9-CM into CCS codes, I select those common procedures with the same CCS code in inpatient and ASC settings. There are 17 CCS coded procedures in the end (Appendix).

I replace Y_{ikt} with the log value of ancillary charges, drug charges, Charlson index, number of inpatient surgeries, and number of total inpatient admissions at the hospital-year level. I also replace Y_{ikt} with a dummy variable indicating whether the admission source is from ASCs to investigate whether ASCs transfer patients to inpatient departments. Table 2-7 presents the results.

Because I focus only on patients who were treated under the 17 CCS categorical procedures, the average payment rate is calculated only over the 17 CCS coded procedures. Hence the IV should have a different value and consequently the first stage result will be different. Column 1 shows the first stage results: the coefficient of the IV is significant at the 1 percent level with an F statistic approximately equals to 12.1.

From column 2, we can tell that for the 17 selected categorical procedures, one more ASC in the HRR would not significantly change the number of patients transferred from ASCs to hospitals. This implies that ASCs do not transfer severe patients to hospitals' inpatient departments after treating them. However, it may be that ASCs refer the more seriously ill patients directly to hospitals without treating them, and such referrals would not be reflected in the admission source of hospitals.

The results in columns 3 and 4 show that the total number of inpatient surgeries and the total number of hospital inpatient admissions at the hospital-year level are not affected when ASCs enter the HRR market. This finding is consistent with Courtemanche and Plotzke (2010), who demonstrate that ASCs exert very little downward pressure on hospital surgical volume: the average reduction is only 2 - 4 percent if the ASC is close enough. And, they find no evidence that ASCs reduce inpatient volume. This implies that induced demand is created by ASCs possibly through promoting the benefits of surgeries with multiple channels including TV and mail advertisements.

So, why does hospital cost increase when ASCs enter the same HRR market? The Charlson index coefficient in column 5 indicates that hospital patients' severity increases with ASCs' presence. It is possible that ASCs are attracting affluent, less severely ill patients away from hospitals (S. A. Strope et al. (2009) indicate that patients of higher socioeconomic status are more likely to have procedures performed in ASCs). At the same time, the more severely ill patients may make an informed decision and go to the hospital voluntarily after seeing the advertisements from ASCs about the benefits of surgeries. Or, the severely ill patients may be referred by physicians to go to hospitals instead of ASCs before they are treated at ASCs. The bottom line is that if there is any sorting process, it happens before the patients are accepted at ASCs.

This suspicion is supported by the results shown in column 6 and 7: ancillary charges and drug charges increase by 4.85 percent and 9.35 percent respectively with one more ASC in the HRR. Those two variables measure treatment intensity and show that inpatient treatment intensity increases with ASCs' entry. This increase in treatment intensity could be caused by two possibilities. One possibility is that hospitals increase treatment intensity in order to compete with ASC. For example, hospital might buy a larger, new CT scanner to satisfy and attract obese patients, for example. The other possibility is that the cost of treatment increases with more severely ill patients. Because ASC entry is associated with the increases in the Charlson index at hospitals, the latter possibility is more likely. With more severely ill patients, hospitals' revenue would increase but their operating expense would increase even more. My finding is supported by Meyerhoefer, Colby and McFetridge (2012). They also find that ASCs benefit from the positive patient selection by using the data in Florida from 2004-2008.

8. Conclusion

With advances in medical technology that allow for more procedures to be done on an outpatient basis and incentives for containing health care costs, ASCs are becoming a key player in the health care sector. This paper contributes to an understanding of how market entry by ASCs affects hospitals' overall financial performance. My key contribution is to use an instrumental variable, the product of change in the county Medicare population and change in the average Medicare payment rate for all ASCs' procedures, to address the endogeneity of the number of ASCs in a hospital market. I also highlight the importance of including a hospital trend in the analysis. My results suggest that the emergence of ASCs actually increases both net patient revenue and operating costs for hospitals. Although their revenue rise, hospitals seem to be treating more severely ill patients with more intensive treatments that drive up operating costs, resulting in a decrease in profit margin.

My results suggest that ASCs are not dumping more severely ill patients to hospitals after they have been admitted to ASCs. Rather, it appears that the patient sorting process is complete before patients are admitted into ASCs. More severe patients do tend to end up at hospitals when ASCs enter the market, but the exact cause of this is not clear. There are at least two possibilities: more seriously ill patients are referred by physicians to hospitals without any treatment at ASCs, or these patients go to the hospitals on their own once they get to know the benefits of the surgeries, perhaps due to ASCs' advertising. Sicker patients may prefer to go to hospitals for surgeries if they think they may be treated faster should any complications arise. Physicians who own ASCs and have hospital admitting privileges may refer the sicker patients to hospitals, and the incentive for a referral does not have to be monetary. The sicker patients need more intensive care from hospitals; ASCs do not have the capability to treat patients with severe complications. In sum, the compositions change of inpatients upon ASCs' entry maybe more a negative spillover effect of induced surgical demand than anything else.

Future research could include a more comprehensive study, by utilizing hospital outpatient data together with inpatient data and defining the hospital market more accurately by applying the variable radius approach. Also, my conclusion about the mechanism that causes the financial situation change in hospitals when ASCs enter the HRR market is only suggestive. Future research could try to definitively identify the cause.

References

Ambulatory Surgery Center Advocacy Committee. (2015). Payment Disparities Between ASCs and HOPDs. Retrieved from http://www.ascassociation.org/advancingsurgicalcare/reducinghealthcarecosts/paymentdisparitiesbetweenascsandhopds.

Ambulatory Surgery Center Association. (2012). History of ASCs. Retrieved from http://www.ascassociation.org/advancingsurgicalcare/whatisanasc/historyofascs.

Ambulatory Surgery Center Association. (2013). History of ASCs. Retrieved from http://www.ascassociation.org/AdvancingSurgicalCare/whatisanasc/historyofascs.

Ambulatory Surgical Care Associaion. (2011). Benefits of Physician Ownership. Retrieved from http://www.advancingsurgicalcare.com/whatisanasc/benefitsofphysicianownership.

Byers, A. L., Yaffe, K., Covinsky, K. E., Friedman, M. B., and Bruce, M. L. (2010). High Occurrence of Mood and Anxiety Disorders among Older Adults: The National Comorbidity Survey Replication. *Archives of General Psychiatry*, 67(5), 489-496.

Carey, K., Burgess, J. F., Jr., and Young, G. J. (2011). Hospital Competition and Financial Performance: The Effects of Ambulatory Surgery Centers. *Health Economics*, 20(5), 571-581.

Center for Medicare \& Medicaid Services. (2014). Ambulatory Surgical Center Fee Schedule. Retrieved from https://www.cms.gov/Outreach-and-Education/Medicare-Learning-Network-MLN/MLNProducts/downloads/AmbSurgCtrFeepymtfctsht508-09.pdf.

Chandra, A., Finkelstein, A., Sacarny, A., and Syverson, C. (2013). Healthcare Exceptionalism? Productivity and Allocation in the US Healthcare Sector. *National Bureau of Economic Research Working Paper 19200*.

Damberg, Cheryl L., Melony E. Sorbero, Susan L. Lovejoy, Grant R. Martsolf, Laura Raaen and Daniel Mandel. (2014) Measuring Success in Health Care Value-Based Purchasing Programs: Summary and Recommendations. Santa Monica, CA: RAND Corporation. Retrieved from http://www.rand.org/pubs/research_reports/RR306z1.

Courtemanche, C., and Plotzke, M. (2010). Does Competition from Ambulatory Surgical Centers Affect Hospital Surgical Output? *Journal of Health Economics*, 29(5), 765-773.

Cutler, D. M., and Scott Morton, F. (2013). Hospitals, Market Share, and Consolidation. *Journal of the American Medical Association*, 310(18), 1964-1970.

Evans, M. (2015). Hospitals Face Closures as 'A New Day in Healthcare's Dawns. Modern Healthcare. Retrieved from http://www.modernhealthcare.com/article/20150221/MAGAZINE/302219988.

No Authors Listed. (1999). Freestanding Ambulatory Surgery Centers Cost Less to Run than In-Hospital ORs. *Health Care Cost Reengineering Report*, 4(10):158-9.

Grisel, J., and Arjmand, E. (2009). Comparing Quality at an Ambulatory Surgery Center and a Hospital-based Facility: Preliminary Findings. *Otolaryngol Head Neck Surgery*, 141(6), 701-709.

Gugliotta, G. (2015). Rural Hospitals, Beset by Financial Problems, Struggle to Survive. The Washington Post. Retrieved from https://www.washingtonpost.com/national/health- science/rural-hospitals-beset-by-financial-problems-struggle-to- survive/2015/03/15/d81af3ac-c9b2-11e4-b2a1-bed1aaea2816_story.html.

Hair, B., Hussey, P., and Wynn, B. (2012). A Comparison of Ambulatory Perioperative Times in Hospitals and Freestanding Centers. *American Journal of Surgery*, 204(1), 23-27.

Hollingsworth;, J. M., Ye;, Z., Strope;, S. A., Krein;, S. L., Hollenbeck;, A. T., and Hollenbeck, B. K. (2010). Physician-Ownership of Ambulatory Surgery Centers Linked To Higher Volume Of Surgeries. *Health Affairs*, 29, 683-689.

Hylton, H. (2006). The Hospital Wars. *Time Magazine*.

Joynt, K. E., Orav, E., and Jha, A. K. (2014). Association Between Hospital Conversions to For-Profit Status and Clinical and Economic Outcomes. *The Journal of the American Medical Association*, 312(16), 1644-1652.
Kaiser Family Foundation. (2012). Medicaid-to-Medicare Fee Index. Retrieved from http://kff.org/medicaid/state-indicator/medicaid-to-medicare-fee-index.
Koenig, L., Doherty, J., Dreyfus, J., and Xanthopoulos, J. (2009). An Analysis of Recent Growth of Ambulatory Surgical Centers. KNG Health Consulting. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.512.4498&rep=rep1&type=pdf.
Munnich, E. L., and Parente, S. T. (2014). Procedures Take Less Time at Ambulatory Surgery Centers, Keeping Costs Down and Ability to Meet Demand Up. *Health Affairs*, 33(5), 764-769.
Penelope Dash and David Meredith (2010). When and How Provider Competition Can Improve Health Care Delivery. *Health International.*
Plotzke, M. R., and Courtemanche, C. (2011). Does Procedure Profitability Impact Whether an Outpatient Surgery Is Performed at an Ambulatory Surgery Center or Hospital? *Health Economics*, 20(7), 817-830.
Strope, S. A., Daignault, S., Hollingsworth, J. M., Ze, Z., Wei, J. T., and Hollenbeck, B. K. (2009). Physician Ownership of Ambulatory Surgery Centers and Practice Patterns for Urological Surgery: Evidence from the State of Florida. Medical Care, 47(4), 403-410. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2743534/.
Strope, S. A., Sarma, A., Ye, Z., Wei, J. T., and Hollenbeck, B. K. (2009). Disparities in the Use of Ambulatory Surgical Centers: A Cross Sectional Study. *BMC Health Service Resarch*, 9, 121.
United States Government Accountability Office. (2015). Report to Congressional Committees: Hospital Value Based Purchasing. Retrieved from http://www.gao.gov/assets/680/672899.pdf.
Meyerhoefer CD1, Colby MS, McFetridge JT.(2012). Patient mix in outpatient surgery settings and implications for Medicare payment policy. *Medical Care Research and Review 69(1):62-82*

Figure 2.1 Numbers of ASCs in Pennsylvania

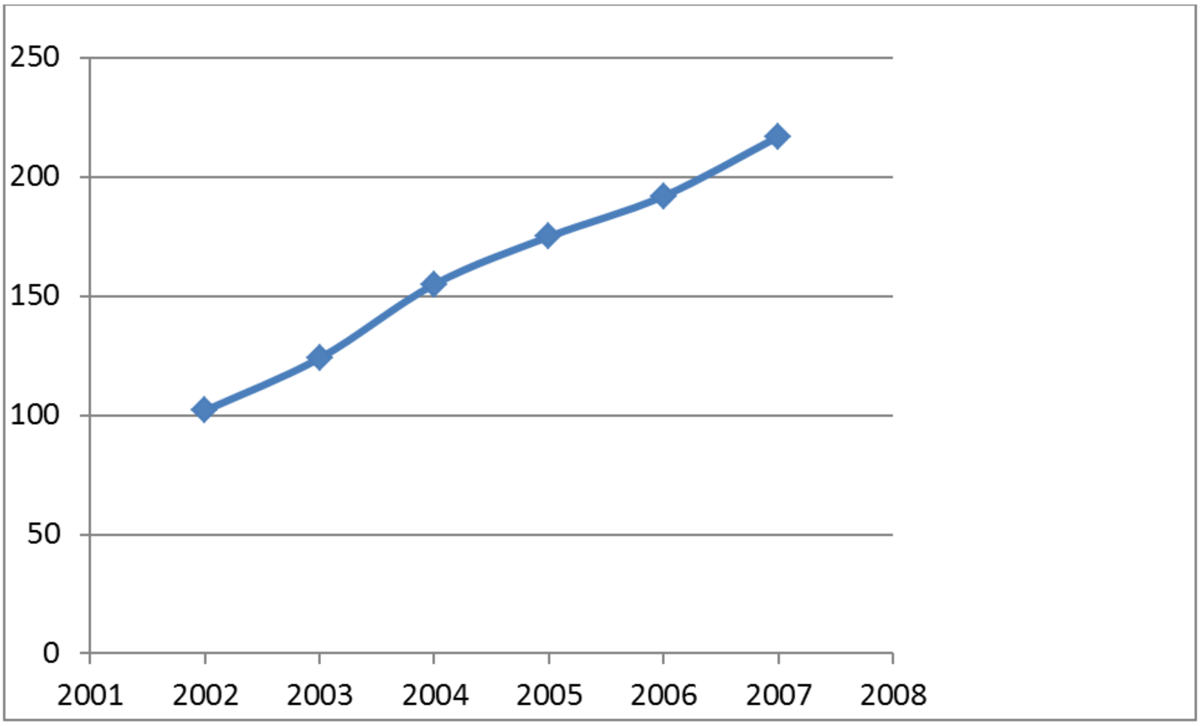


Figure 2.2 Numbers of ASCs by County in 2002

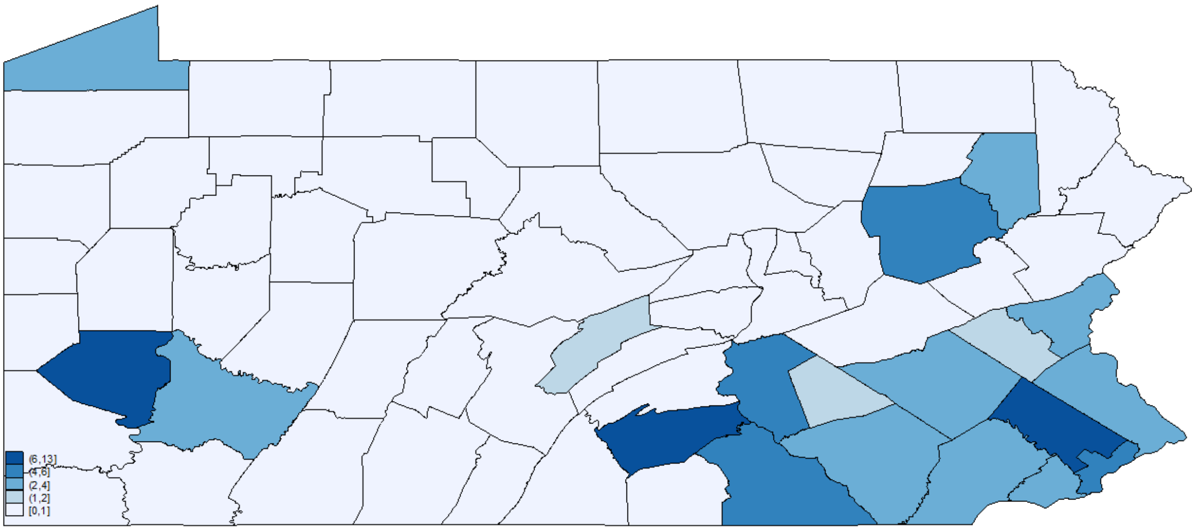


Figure 2.3 Numbers of ASCs by County in 2007

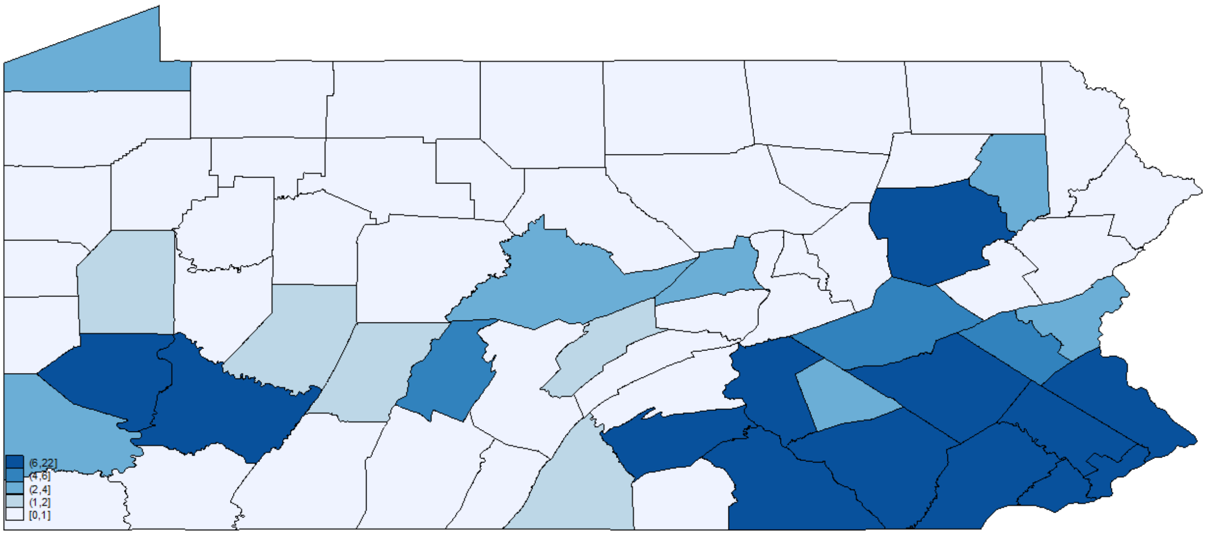


Figure 2.4 Distributions of Financial Measurements

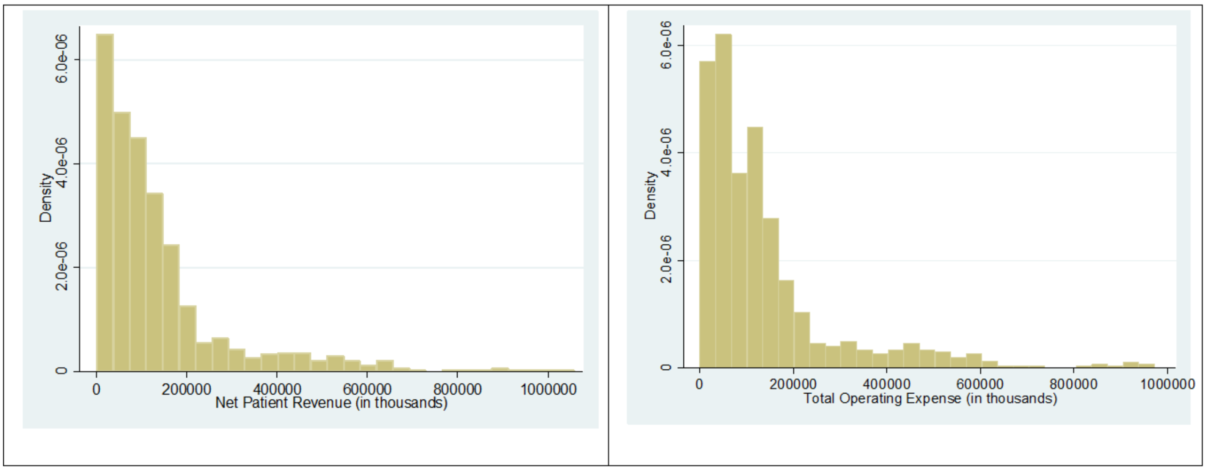
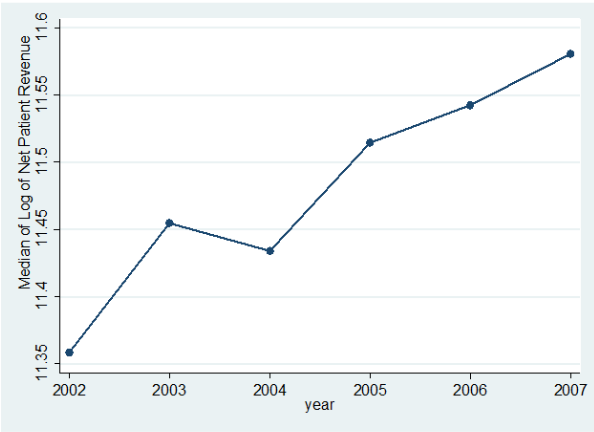


Figure 2.5 Median of the Log Value of Financial Measurements



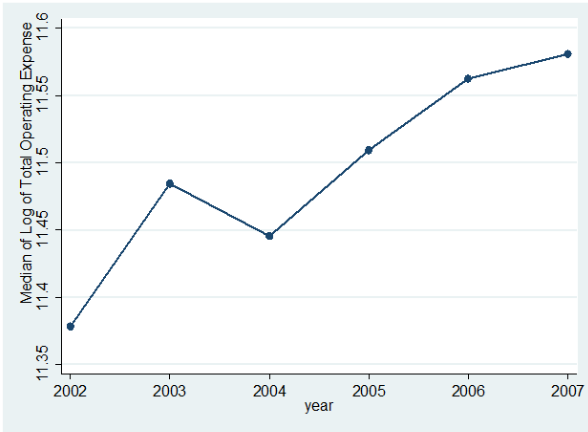


Table 2.1 Summary Statistics

Variables	Mean	Standard Deviation
Panel A: Dependent Variables		
Log of Net Patient Revenue	11.34	1.064
Log of Total Operating Costs	11.367	1.045
Log of Medicare Payment	10.421	1.084
Log of Medicaid Payment	8.505	1.264
Log of Private Payment	10.45	1.143
Log of Total Number of Surgeries	8.744	0.928
Log of Total Inpatient Charge Per Patient	9.758	0.681
Log of Ancillary Charges	8.888	0.071
Log of Drug Charges	7.844	0.754
Log of Charlson Index	-0.214	0.307
Log of Inpatient admissions	5.382	1.189
Log of Inpatient Surgeries	7.537	1.181
Transferred from ASCs to Hospitals*	3.05×10^{-6}	10^{-4}
Panel B: Independent Variables		
Hospital Bed Size Category 2 : 100-299	0.552	0.496
Hospital Bed Size Category 3 : 300-499	0.155	0.363
Hospital Bed Size Category 4 : 500 and more	0.078	0.268
Hospital Not-for-profit Status	0.925	0.263
Teaching Hospital	0.207	0.405
Male	0.422	0.052
Age Group 2 : 20 -34	0.116	0.054
Age Group 3 : 35-49	0.15	0.043
Age Group 4 : 50-64	0.191	0.04
Age Group 5 : 65 and above	0.489	0.115
Race_Black	0.079	0.13
Race_Asian	0.004	0.006
Race_White	0.88	0.164
Panel C: Instrumental Variables		
Number of ASCs in each HRR	20.634	16.637
Number of ASCs Surgeries in each HRR	69779.81	55818.53
Number of For-Profit ASCs in each HRR	18.081	14.347

Net patient revenue, total operating expense, Medicare payment, Medicaid payment, private payment are all measured in thousands at hospital level. Medicare payment, Medicaid payment and private payments are calculated by multiplying total net patient revenue and payment ratio of net patient revenue for different insures respectively. Number of observations is 899.

Table 2.2 Financial Impacts of ASCs on Surgical Hospitals

	(1)	(2)	(3)
	First Stage	Log of Net Patient Revenue	Log of Total Operating Expense
	Number of ASCs	OLS	OLS
Panel A: Ordinary Least Squares without Hospital Linear Trend			
Number of ASCs		-0.0124***	-0.0126***
		-0.00271	-0.00255
Panel B: Ordinary Least Squares with Hospital Linear Trend			
Number of ASCs		0.0166	0.0186*
		-0.011	-0.0101
Panel C: Two Stage Least Squares with Hospital Linear Trend			
Number of ASCs		0.0681***	0.0876***
		-0.0252	-0.0259
IV	247.4***		
	-76.01		

Net patient revenues and total operating expense (in thousands) are in log values. Bed-size categories, teaching status, ownership status, hospital fixed-effects and year fixed-effects are included. Instrumental variable is defined as the product of change of population aged 65 or above (measured by thousands) at county level and the change in average Medicare payment rates for all ASCs' procedures. Number of observations is 899. Robust standard errors are in parentheses. Standard errors are clustered at HRR level. *** p<0.01, ** p<0.05, * p<0.1

Table 2.3 Exogeneity Test of Instrumental Variables (Hospital Characteristics)

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Hospital Bed Size Group 1 (<100)	Hospital Bed Size Group 2 (100-299)	Hospital Bed Size Group 3 (300-499)	Hospital Bed Size Group 4 (500 and more)	Not-For-Profit	Teaching Hospital
IV	2.573	0.866	-3.643	0.205	-0.536	-2.325
	-3.104	-4.382	-2.497	-3.192	-1.162	-6.555

Bed size in hospital is divided into 4 groups: below 100, 100-299, 300-499, 500 or more. Hospital fixed-effects, year fixed-effects and a linear hospital trend are included. Number of observations is 899. Robust standard errors are in parentheses. Standard errors are clustered at HRR level. Instrumental variable is defined as the product of change of population aged 65 or above (measured by thousands) at county level and the change in average Medicare payment rates for all ASCs' procedures. *** p<0.01, ** p<0.05, * p<0.1

Table 2.4 Exogeneity Test of Instrumental Variables (Inpatient Characteristics)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
		Age Group 2	Age Group 3	Age Group 4	Age Group 5			
VARIABLES	Male	(20-34)	(35-49)	(50-64)	(65 and above)	Black	Asian	White
IV	-0.198	0.254	0.0833	0.0799	-0.437	-0.0275	-0.0574	-1.584
	-0.917	-0.433	-0.635	-0.655	-0.786	-0.561	-0.138	-1.324

Bed size in hospital is divided into 4 groups: below 100, 100-299, 300-499, Age is divided into 5 groups: below 19 (base group), 20 to 34, 35 to 49, 50 to 64 and 65 and above. Hospital fixed-effects, year fixed-effects and a linear hospital trend are included. Number of observations is 899. Robust standard errors are in parentheses. Standard errors are clustered at HRR level. Instrumental variable is defined as the product of change of population aged 65 or above (measured by thousands) at county level and the change in average Medicare payment rates for selected ASCs' procedures. For the first stage result, please refer to Table 6. *** p<0.01, ** p<0.05, * p<0.1

Table 2.5 Robustness Checks

	(1)	(2)	(3)
	First Stage	Net Patient Revenue	Total Operating Expense
	Number of ASCs/Surgeries	2SLS	2SLS
Panel A: Use Number of Surgeries in Each HRR as ASCs Penetration Measurement			
Number of Surgeries		1.72e-05***	2.21e-05***
		-5.66E-06	-5.58E-06
IV	978,919***		
	-297,590		
Panel B: 2SLS with Added Inpatient Characteristics			
Number of ASCs		0.0676**	0.0868***
		-0.028	-0.0284
IV	250.0***		
	-74.22		
Panel C: 2SLS with Number of For-Profit ASCs only			
Number of ASCs		0.0639*	0.0821**
		-0.0371	-0.0416
IV	263.7**		
	-102.6		
Panel D: 2SLS with hospital quadratic trend			
Number of ASCs		0.0690***	0.0983***
		-0.0243	-0.0285
IV	238.5***		
	-73.26		

Net patient revenues and total operating expense (in thousands) are in log values. Bed-size categories, teaching status, ownership status, hospital fixed-effects, year fixed-effects and a linear hospital trend are included for Panel A, Panel B and Panel C. The linear hospital trend is replaced with a quadratic trend in Panel D. Number of observations is 899. Robust standard errors are in parentheses. Standard errors are clustered at HRR level. *** p<0.01, ** p<0.05, * p<0.1

Table 2.6 Overall Mechanisms

Variables	(1) First Stage	(2) Medicare Payments	(3) Medicaid Payments	(4) Private Insurance Payments
Number of ASCs		0.0509*	0.0232	0.0731***
		-0.0295	-0.0222	-0.0218
IV	247.4***			
	-76.01			

Bed-size categories, teaching status, ownership status, hospital fixed-effects, year fixed-effects and a linear hospital trend are included. Medicare payment, Medicaid payment, and private payment (in thousands) are all measured in log value at hospital level. Payments are calculated by multiplying total net patient revenue and payment ratio of net patient revenue for different insures respectively. Instrumental variable is defined as the product of change of population aged 65 or above (measured by thousands) at county level and the change in average Medicare payment rates for all ASCs' procedures. Number of observations is 899. Robust standard errors are in parentheses. Standard errors are clustered at HRR level. *** p<0.01, ** p<0.05, * p<0.1

Table 2.7 Inpatient Mechanisms

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Variables	First Stage	Transfer from ASCs	Inpatient Surgeries	Inpatient admissions	Charlson Index	Ancillary Charge	Drug Charge
Number of ASCs		-5.38E-06	-0.0316	-0.0184	0.0610*	0.0485*	0.0935**
		-6.23E-06	-0.0474	-0.0323	-0.0324	-0.0261	-0.0371
IV	278.4***						
	-80.07						

All values are in log values except for the dummy variable in column 2. Patients sample is limited to those who were treated under the 17 CCS coded selected procedures. All data values are aggregated at hospital level before taking the log. Bed-size categories, teaching status, ownership status, hospital fixed-effects, year fixed-effects and a linear hospital trend are included. Instrumental variable is defined as the product of change of population aged 65 or above (measured by thousands) at county level and the change in average Medicare payment rate for selected ASCs' procedures by year. Number of observations is 899. Robust standard errors are in parentheses. Standard errors are clustered at HRR level. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Appendix Tables

Table A2.1 CCS code and Procedure Names

CCS code	Procedures
5	Insertion of catheter or spinal stimulator and injection into spinal canal
6	Decompression peripheral nerve
8	Other non-OR or closed therapeutic nervous system procedures
14	Glaucoma procedures
15	Lens and cataract procedures
20	Other intraocular therapeutic procedures
69	Esophageal dilatation
76	Colonoscopy and biopsy
85	Inguinal and femoral hernia repair
100	Endoscopy and endoscopic biopsy of the urinary tract
107	Extracorporeal lithotripsy, urinary
116	Diagnostic procedures, male genital
130	Other diagnostic procedures, female organs
142	Partial excision bone
143	Bunionectomy or repair of toe deformities
151	Excision of semilunar cartilage of knee

Chapter 3: The Persistence of the Effectiveness of the Hospital Readmission Program in Reducing Hospital Readmissions

1. Introduction

Hospital readmission costs a lot of manpower and resources. According to a statistical brief from AHRQ (Anika L. Hines, Marguerite L. Barrett, H. Joanna Jiang, & Claudia A. Steiner, 2014), there were approximately 3.3 million readmissions in the United States across all payers in Medicare beneficiaries aged 65 years and older and individuals aged 18 –64 years who were privately insured, uninsured, or covered by Medicaid in 2011. Readmissions add $41.3 billion (Anika L. Hines et al., 2014) in total hospital costs. And among those readmissions, Medicare has the largest share (55.9 percent) and Medicaid has the second largest share (20.6 percent). Similarly, Jencks , Williams , and Coleman (2009) estimate that the cost to Medicare of unplanned readmission in 2004 was $ 17.4 billion.

In order to reduce readmissions, Section 3025 of the Affordable Care Act added section 1886(q) to the Social Security Act establishing the Hospital Readmissions Reduction Program (HRRP), which requires Centers for Medicare & Medicaid Services (CMS) to reduce payments to inpatient perspective payment system (IPPS) hospitals[1] with excess readmissions, effective for discharges beginning on October 1, 2012.

The leverage that CMS uses to force hospitals to try to reduce readmissions is a penalty.

[1] Section 1886(d) of the Social Security Act (the Act) sets forth a system of payment for the operating costs of acute care hospital inpatient stays under Medicare Part A (Hospital Insurance) based on prospectively set rates. This payment system is referred to as the inpatient prospective payment system (IPPS). (https://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/AcuteInpatientPPS/index.html?redirect=/acuteinpatientpps/). The acute care hospital that stays under Medicare Part A plan are referred as the IPPS hospitals.

CMS publishes a readmissions adjustment factor for each IPPS hospital to indicate the weight of its penalty, which ranges from 0.9700 (reflecting the maximum 3% penalty for FY 2015) to 1.00 (indicating no penalty) (Hoffman, 2015). However, CMS does not publish an estimated final penalty for individual hospitals.

This paper assesses the effectiveness of the HRRP program at a quarterly basis by focusing on acute myocardial infarction (AMI) and heart failure (HF) patients. By using a difference in differences method, I find that HRRP has not been effective at reducing readmissions three quarters after the program was implemented.

2. Literature Review

Papers which discuss the HRRP are still scarce, let alone ones which assess the effectiveness of the HRRP. According to James (2013), CMS reported to Congress in February 2013 that the all-cause Medicare readmission rate had dropped to 17.8 percent in the last quarter of 2012, down from the historic level of 19 percent. However, whether such a decrease is caused by the HRRP is unknown. Berenson , Paulus , and Kalman (2012) pointed out that implementing a new system or revising a current system to reduce readmission itself is costly for each hospital and if that cost is greater than the penalty from CMS for high readmission rates, there is no financial incentive for hospitals to reduce their readmission rate. They also point out that there can be a decrease in revenue from readmission reduction. Their paper does not address the effectiveness of the HRRP program empirically.

Zuckerman, Sheingold, Orav, Ruhter, and Epstein (2016) find that HRRP is effective in reducing the readmissions within one month of discharge among Medicare elderly beneficiaries. Carey and Lin (2015) find similar conclusions by focusing on the New York hospitals.

There are many papers studying the effectiveness of one or more approaches to reducing the readmission rate for one group of patients with a specific diagnosis or insurance (e.g Medicare).[2] Cloonan, Wood, and Riley (2013) summarize the suggestions based on current literature and suggest that enhancing patient-centered discharge processes, focusing on medication reconciliation, improving coordination with community-based providers, and effective patient self-management of their disease and treatment could reduce readmissions. Hansen, Young, Hinami, Leung, and Williams (2011) studied three kinds of interventions which are used to decrease readmissions: predischarge interventions including patient education, medication reconciliation, discharge planning, and scheduling of a follow-up appointment before discharge; postdischarge interventions including follow-up telephone calls, patient-activated hotlines, timely communication with ambulatory providers, timely ambulatory provider follow-up, and postdischarge home visits; bridging interventions including transition coaches, physician continuity across the inpatient and outpatient setting, and patient-centered discharge instruction. They conclude from empirical studies is that no single intervention alone was associated with reduced risk for 30 day re-hospitalization. However, none of the literature above assessed the effectiveness of the HRRP program directly.

3. Data

The main data source for this paper is the Pennsylvania Health Care Cost Containment Council (PHC4). PHC4 has data on inpatient characteristics--such as age, race, gender, diagnosis and procedure codes and hospital ID. Since the HRRP went into effect in October 2012, I include data three quarters before and after the fourth quarter of 2012. Because I am using a difference in differences approach, the fourth quarter of 2012 is dropped. Therefore, I have data from the first quarter of 2012 through the third quarter of 2013, except for the fourth quarter of 2012.

---

[2] List of papers: Atienza et al., 2004; Bourbeau, Julien, Maltais, & et al., 2003; Brandao et al., 2014; Butler & Kalogeropoulos, 2012; Costantino, Frey, Hall, & Painter, 2013; Daly, Douglas, Kelley, O'Toole, & Montenegro, 2005; Epstein, Jha, & Orav, 2011; Feltner et al., 2014; Fonarow et al., 1997; Gattis, Hasselblad, Whellan, & O'Connor, 1999; Jack et al., 2009; Jha , Orav , & Epstein 2009; Kaboli et al., 2012; Koehler et al., 2009; Kripalani, Theobald, Anctil, & Vasilevskis, 2014; Krumholz et al., 2011; Lawson et al., 2013; Marcantonio et al., 1999; Mayo, Richman, & Harris, 1990; McCarthy, Johnson, & Audet, 2013; Novak, Hastanan, Moradi, & Terry, 2012; Puhan, Scharplatz, Troosters, & Steurer, 2005; Rich, 2003; Rich et al., 1995; Shih, Ryan, Gonzalez, & Dimick, 2015; Tuso et al., 2013; Williams, 2013.

I focus on AMI and heart failure patients in Pennsylvania. I divide hospitals into three groups based on their average Medicare population prior to the introduction of the HRRP. The treatment group is defined as the top tercile and the control group is defined as the bottom tercile.

After excluding observations with missing values, Table 3.1 reports the summary statistics. The treatment group has more White patients and fewer Black and Asian. The treatment group also has a higher average age which is expected since the treatment group has a higher than average Medicare population. I specifically want to point out that the Charlson index, which is an indication of comorbidity seriousness, is very similar in both groups.

Table 3.2 lists the control variables and compares the pre-treatment summary statistics of the treatment and control group. Similarly to Table 3.1, the treatment group has a higher average age. The treatment group also has slightly more white patients and fewer black patients. Later, I will perform a formal test to prove that the treatment and control groups share a common pre-treatment trend.

4. Empirical Models

The main empirical model in this paper is

$$Y_{iht} = \beta_0 + \beta_1(Treat_h * Post_t) + \beta_2 X'_{iht} + \beta_3 * Treat_h + \beta_4 * Post_t + \alpha_h + \gamma_t + \varepsilon_{iht}, \quad (1)$$

where Y_{iht} is the readmission dummy variable for patient *i* of hospital *h* in time *t*. $Treat_h$ is a dummy variable for whether hospital h is in the treatment group and $Post_t$ indicates whether period *t* is after the implementation of the HRRP. β_1 is the difference-in-differences coefficient and it captures the difference between the effects of the HRRP on the treatment and control groups. X'_{iht} is a vector of patient characteristics for age, race and the Charlson index. α_h is the hospital fixed effect, whereas γ_t is the time fixed effect.[3] ε_{iht} represents the error term.

[3] I use the quarter fixed effect in the main model and year fixed effect in the robustness check.

HRRP defines readmission as an admission to a subsection hospital within 30 days of a discharge.[4] Since I only have information on quarter of admission, I define readmission as an admission to a subsection hospital within a quarter of a discharge. CMS has adopted readmission measures for applicable conditions such as AMI and HF and hence my patient sample are those diagnosed with AMI and HF.

HRRP adopted the risk adjustment methodology endorsed by the National Quality Forum for the readmission measures to calculate the readmission ratios, which includes adjustments for factors that are clinically relevant, including certain patient demographic characteristics and comorbidity. For this reason, I include the patients' demographic characteristics and Charlson index which is a measurement of comorbidity in my regression equation.

Robust standard errors are clustered at the hospital level. The number of clusters is large enough to waive the need of using the t-distribution with degrees of freedom equal to the number of clusters minus one as the hypothesis testing distribution. The standard normal distribution is assumed.

In order to show the common pre-treatment trend, I use the following model:

$$Y_{ht} = \beta_0 + \alpha_h + \gamma_t + \beta_{-2}D_{-2h} + \beta_{-1}D_{-1h} + \beta_1 D_{1h} + \beta_2 D_{2h} + \beta_3 D_{3h} + \varepsilon_{ht}$$

where Y_{ht} is the average readmission ratio for hospital *h* in time *t*. α_h is the hospital fixed effect and γ_t is the quarterly time fixed effect. D_{-2h} is the interaction between the quarter time dummy and treatment indicator. The -2 indicates that it is two quarters prior to the treatment. Similar definitions also apply to $D_{-1h}, D_{1h}, D_{2h,}$ and D_{3h}, where positive numbers indicate the number of quarters after the treatment. If the outcome trends between treatment and control groups are the same, then β_{-2} and β_{-1} should be insignificant.

5. Robustness Check

[4] ARRA defines a hospital as a Medicare subsection (d) hospital, which is a general, acute care, short-term hospital.

I estimate several variations of equation (1) as robustness checks. First, I changed the quarterly trend to a yearly trend in case the trend only appears on an annual basis. If the trend only happens at a broader time window, the annual trend should be more appropriate. Next, I use age groups instead of age and age squared to capture the effect of age. Third, I change the cutoff of the treatment and control groups from tercile of the percentage of the Medicare patients to the median of the percentage of the Medicare patients. Finally, I change the cutoff of the treatment and control groups again to the mean value of the Medicare patient's percentages.

6. Results

Pre-treatment test results are presented in Table 3.3. None of the coefficients are statistically significant. Therefore, the "parallel path" assumption necessary for using a difference in differences model is confirmed.

The main results are shown in Table 3.4. The baseline specification is equation (1) without the Charlson index, hospital fixed effects and time fixed effects. Column 1 is the difference in differences coefficient. I added the Charlson index to control the effect of patients' comorbidity in specification 2. In specification 3, I add the hospital fixed effects and lastly I add time fixed effects at a quarterly level in specification 4. Based on the results in column 1, none of the coefficients are statistically significant. Based on the results in column 2 of Table 3.4, the treatment group tends to have a higher readmission rate. This result is not surprising since treatment hospitals have more Medicare patients who tend to be elderly and are more likely to be readmitted.

Robustness checks are presented in Table 3.5 and all the changes are made based on specification 4 in Table 3-4: changing the quarterly fixed effects to yearly fixed effects, using age categories instead of actual age, using the median of Medicare patients' percentage as the cutoff for treatment and control groups and using the mean of Medicare patients' percentage as the cutoff. None of these variations leads to a significant difference-in-differences coefficient.

However, the last three variations lead to a significant treatment coefficient which indicates that hospitals in the treatment group tend to have a higher readmission rate. Together those results suggest that HRRP is not effective in the longer time span (i.e. three quarters after the policy implementation).

7. Conclusion

Reducing hospital readmissions has long been a health policy goal because it presents an opportunity to lower health care expenses and improve patients' quality of life. CMS implemented the HRRP to accomplish such a goal. This paper uses PHC4 data to examine the effectiveness of the HRRP in the longer run.

I fail to find any persistent significant effects from the HRRP. Given that there are papers suggesting that hospitals are responsive to HRRP to reduce the readmissions within one month of discharge, it is possible that hospitals are postponing the readmissions. I do not find any literature that specifically focuses on diffusion speed in the health care system but such insignificant effect can come from the slow diffusion speed of medical technology or systems (i.e. hospitals upgrade their systems or technology slowly) or the lagging time effect (i.e. it takes time for the effect of certain changes to show up). Research focusing on the long run is much needed to accurately measure the effect of the HRRP.

References

Adamson, A., Rugg-Gunn, A., Butler, T., Appleton, D., & Hackett, A. (1992). Nutritional intake, height and weight of 11–12-year-old Northumbrian children in 1990 compared with information obtained in 1980. *British Journal of Nutrition, 68*(03), 543-563.

Angrist, J., Lavy, V., & Schlosser, A. (2010). Multiple Experiments for the Causal Link between the Quantity and Quality of Children. *Journal of Labor Economics, 28*(4), 773-824. doi:10.1086/653830

Angrist, J. D., & Evans, W. N. (1998). Children and Their Parents' Labor Supply: Evidence from Exogenous Variation in Family Size. *The American Economic Review, Vol. 88, No. 3*, 450-477.

Anika L. Hines, P. D. M. P. H., Marguerite L. Barrett, M. S., H. Joanna Jiang, P. D., & Claudia A. Steiner, M. D., M.P.H. (2014). Conditions With the Largest Number of Adult Hospital Readmissions by Payer, 2011. *AHRQ Statistical Brief 172*.

Becker, G. S., & Lewis, H. G. (1974). Interaction between Quantity and Quality of Children. *Economics of the Family: Marriage, Children, and Human Capital*.

Berenson , R. A., Paulus , R. A., & Kalman , N. S. (2012). Medicare's Readmissions-Reduction Program — A Positive Alternative. *New England journal of medicine, 366*(15), 1364-1366. doi:doi:10.1056/NEJMp1201268

Black, S. E., Devereux, P. J., & Salvanes, K. G. (2005). THE MORE THE MERRIER? THE EFFECT OF FAMILY SIZE AND BIRTH ORDER ON CHILDREN'S EDUCATION. *The Quarterly Journal of Economics*.

Blake, J. (1981). Family Size and the Quality of Children. *Demography,, Vol. 18, No. 4*, 421-442.

Cadogan, J., Eastell, R., Jones, N., & Barker, M. E. (1997). Milk intake and bone mineral acquisition in adolescent girls: randomised, controlled intervention trial. *Bmj, 315*(7118), 1255-1260.

Carey, K., & Lin, M. Y. (2015). Readmissions To New York Hospitals Fell For Three Target Conditions From 2008 To 2012, Consistent With Medicare Goals. *Health Aff (Millwood), 34*(6), 978-985. doi:10.1377/hlthaff.2014.1408

Cloonan, P., Wood, J., & Riley, J. B. (2013). Reducing 30-day readmissions: health literacy strategies. *J Nurs Adm, 43*(7-8), 382-387. doi:10.1097/NNA.0b013e31829d6082

Conley, D., & Glauber, R. (2006). Parental Educational Investment and Children's Academic Risk: Estimates of the Impact of Sibship Size and Birth Order from Exogenous Variation in Fertility. *Journal of Human Resources*, 722-737.

Coser, R. L. (1986). *American Journal of Sociology, 91*(4), 990-992. doi:10.2307/2779972

Duncan, T. (1994). Like Father, like Son; Like Mother, like Daughter: Parental Resources and Child Height. *Journal of Human Resources, 29*(4), 950-988. Retrieved from http://ideas.repec.org/a/uwp/jhriss/v29y199441p950-988.html

Duncan Thomas, J. S. a. M.-H. H. (1991). How Does Mother's Education Affect Child Height? *The Journal of Human Resources, Vol. 26, No. 2*, 183-211.

Gary M. Chan, M., Karen Hoffman, & Martha McMurry, M. (1994). Effects of dairy products on bone and body composition in pubertal girls. *The Journal of Pediatrics, 126*(4), 551-556. doi:10.1016/S0022-3476(95)70348-9

Gibson, R., Vanderkooy, P., MacDonald, A., Goldman, A., Ryan, B., & Berry, M. (1989). A growth-limiting, mild zinc-deficiency syndrome in some southern Ontario boys with low height percentiles. *The American journal of clinical nutrition, 49*(6), 1266-1273.

Gilbert, D. (2002). *The American Class Structure in an Age of Growing Inequality*: Wadsworth Publishing.

Goux, D., & Maurin, E. (2005). The effect of overcrowded housing on children's performance at school. *Journal of Public Economics, 89*(5-6), 797-819. doi:10.1016/j.jpubeco.2004.06.005

Greenhalgh, S. (2008). *Just One Child: Science and Policy in Deng's China* (1st ed.): University of California Press.

Greenhalgh, S., & Winckler, E. (2005). *Governing China's Population: From Leninist to Neoliberal Biopolitics* (1st ed.): Stanford University Press.

Guo, G., & VanWey, L. K. (1999). Sibship Size and Intellectual Development: Is the Relationship Causal? *American Sociological Review, Vol. 64, No. 2*, 169-187.

Hansen, L. O., Young, R. S., Hinami, K., Leung, A., & Williams, M. V. (2011). Interventions to Reduce 30-Day Rehospitalization: A Systematic Review. *Annals of Internal Medicine, 155*(8), 520-528. doi:10.7326/0003-4819-155-8-201110180-00008

Hanushek, E. A. (1992). The Trade-off between Child Quantity and Quality. *Journal of Political Economy, Vol. 100, No. 1*, 84-117.

Hoffman, J. (2015). Overview of CMS Readmissions Penalties for 2015.

James, J. (2013). Medicare Hospital Readmissions Reduction Program. *Health Policy*.

Jencks , S. F., Williams , M. V., & Coleman , E. A. (2009). Rehospitalizations among Patients in the Medicare Fee-for-Service Program. *New England journal of medicine, 360*(14), 1418-1428. doi:doi:10.1056/NEJMsa0803563

Johnston Jr, C. C., Miller, J. Z., Slemenda, C. W., Reister, T. K., Hui, S., Christian, J. C., & Peacock, M. (1992). Calcium supplementation and increases in bone mineral density in children. *New England journal of medicine, 327*(2), 82-87.

Jones-Smith, J. C., & Popkin, B. M. (2010). Understanding community context and adult health changes in China: development of an urbanicity scale. *Social Science & Medicine, 71*(8), 1436-1446.

Kagan, J., & Moss, H. A. (1959). Parental correlates of child's IQ and height: a cross-validation of the Berkeley growth study results. *Child Development*, 325-332.

Lee, J. (2008). Sibling Size and Investment in Children's Education: An Asian Instrument. *Journal of Population Economics, 21 (4)*, 855-875.

Lee, W. T., Leung, S. S., Leung, D. Y., Tsang, H. S., Lau, J., & Cheng, J. C. (1995). A randomized double-blind controlled calcium supplementation trial, and bone height acquisition in children. *British Journal of Nutrition, 74*(01), 125-139.

Leger, J., Limoni, C., Collin, D., & Czernichow, P. (1998). Prediction factors in the determination of final height in subjects born small for gestational age. *Pediatric research, 43*(6), 808-812.

Li, H., Zhang, J., & Zhu, Y. (2008). THE QUANTITY-QUALITY TRADE-OFF OF CHILDREN IN A DEVELOPING COUNTRY: IDENTIFICATION USING CHINESE TWINS. *Demography, Volume 45-Number 1*, 223–243.

Liu, H. (2013). The quality–quantity trade-off: evidence from the relaxation of China's one-child policy. *Journal of Population Economics, 27*(2), 565-602. doi:10.1007/s00148-013-0478-4

Pluske, J., Williams, I., & Aherne, F. (1996). Maintenance of villous height and crypt depth in piglets by providing continuous nutrition after weaning. *Animal Science, 62*(01), 131-144.

Prynne, C. J., Mishra, G. D., O'Connell, M. A., Muniz, G., Laskey, M. A., Yan, L., . . . Ginty, F. (2006). Fruit and vegetable intakes and bone mineral status: a cross-sectional study in 5 age and sex cohorts. *The American journal of clinical nutrition, 83*(6), 1420-1428.

Qian, N. (2009). Quantity-Quality and the One Child Policy:The Only-Child Disadvantage in School Enrollment in Rural China. *NBER Working Paper No. 14973*.

Rosenzweig, M. R., & Schultz, T. P. (1987). Fertility and Investments in Human Capital: Estimates of the Consequences of Imperfect Fertility Control in Malaysia. *ECONOMIC DEVELOPMENT CENTER, Bulletin Number 87-1*.

Rosenzweig, M. R., & Wolpin, K. I. (1980). Testing the Quantity-Quality Fertility Model: The Use of Twins as a Natural Experiment. *Econometrica, Vol. 48, No. 1*, 227-240.

Rosenzweig, M. R., & Zhang, J. (2009). Do Population Control Policies Induce More Human Capital Investment? Twins, Birth Weight and China's "One-Child" Policy. *Review of Economic Studies, 76*(3), 1149-1174. doi:10.1111/j.1467-937X.2009.00563.x

Savage, T., Derraik, J. G. B., Miles, H. L., Mouat, F., Hofman, P. L., & Cutfield, W. S. (2013). Increasing Maternal Age Is Associated with Taller Stature and Reduced Abdominal Fat in Their Children. *PLoS One, 8*(3), e58869. doi:10.1371/journal.pone.0058869

Sharma, M., & Mishra, S. (2013). Maternal risk factors and consequences of low birth weightin Infants. *IOSR Journal Of Humanities And Social Science, 13*(4), 39-45.

Taubman, J. R. B. a. P. (1986). Birth Order, Schooling, and Earnings. *Journal of Labor Economics, Vol. 4, No. 3, Part 2:*, S121-S145.

Thomas, D. (1994). Like father, like son; like mother, like daughter: Parental resources and child height. *Journal of Human Resources*, 950-988.

Zajonc, R. B., & Markus, G. B. (1975). Birth Order and Intellectual Development. *Psychological Review, 82*(No.1), 74-88.

Zhu, B., Haines, K., Le, T., McGrath-Miller, K., & Boulton, M. (2001). Effect of the interval between pregnancies on perinatal outcomes among white and black women. *Am J Obstet Gynecol*(185(6)), 1403-1410.

Zuckerman, R. B., Sheingold, S. H., Orav, E. J., Ruhter, J., & Epstein, A. M. (2016). Readmissions, Observation, and the Hospital Readmissions Reduction Program. *N Engl J Med, 374*(16), 1543-1551. doi:10.1056/NEJMsa1513024

Table 3.1 Summary Statistics

	Total	Treatment	Control
Readmission Dummy	0.1274	0.1433	0.1132
	(0.3334)	(0.3503)	(0.3168)
Race_white	0.8668	0.9103	0.8277
	(0.3398)	(0.2857)	(0.3776)
Race_black	0.0848	0.0617	0.1055
	(0.2786)	(0.2406)	(0.3072)
Race_asian	0.0049	0.0038	0.0059
	(0.0700)	(0.0616)	(0.0768)
Male dummy	0.5504	0.5046	0.5914
	(0.4975)	(0.5000)	(0.4916)
Age	70.4310	74.1296	67.1149
	(16.0811)	(14.3934)	(16.7769)
Charlson Index	1.6715	1.7135	1.6339
	(0.4949)	(0.4644)	(0.5179)
Number of Observations	43811	20711	23100

Only hospitals which occupy the top and the bottom tercile percentage of Medicare patients are included. Standard errors are in the parenthesis.

Table 3.2 Pre-Treatment Means and Standard Deviations

	Treatment	Control
Readmission Dummy	0.1478	0.1140
	(0.3549)	(0.3178)
Race_white	0.9131	0.8309
	(0.2817)	(0.3749)
Race_black	0.0604	0.1058
	(0.2383)	(0.3076)
Race_asian	0.0035	0.0060
	(0.0592)	(0.0770)
Male dummy	0.5056	0.5879
	(0.5000)	(0.4922)
Age	74.2035	67.0410
	(14.4052)	(16.6664)
Charlson Index	1.7114	1.6328
	(0.4655)	(0.5146)
Number of Observations	10242	11221

Only hospitals which occupy the top and the bottom tercile percentage of Medicare patients are included. Standard errors are in the parenthesis.

Table 3.3 Common Pre-Trend Test

	Coefficient	Standard Errors
β_{-2}	0.0267954	0.0466262
β_{-1}	0.0246234	0.0464395
β_{1}	0.0029508	0.0463986
β_{2}	-0.0228089	0.0464521
β_{3}	0.0185511	0.0463626

Hospital and quarter time fixed effects are included as controls. Number of observations is 1016. *** p<0.01, ** p<0.05, * p<0.1

.

Table 3.4 Effects of Readmission Reduction Program

	Treat*After	Treat	After
1.Baseline Specification	-0.0075	0.0318**	-0.0016
	(0.0061)	(0.0104)	(0.0040)
2. With Charlson index	-0.0076	0.0306**	-0.0017
	(0.0306)	(0.0103)	(0.0040)
3.Hospital Fixed Effects	-0.0049	0.1045***	-0.0038
	(0.0060)	(0.0129)	(0.0039)
4.Quarterly Fixed Effects	-0.0048	0.1015***	-0.0078
	(0.0060)	(0.0131)	(0.0059)

Race is included as one of the controls and classified as White, Black, Asian and others. The other controls included in all models are age and male dummy. Standard errors are clustered at the hospital level. Robust standard errors are in the parenthesis. *** p<0.01, ** p<0.05, * p<0.1

Table 3.5 Robustness Check

	Treat*After	Treat	After
1. Change quarter trend to year trend	-0.0025	0.0171	-0.0025
	(0.0056)	(0.0117)	(0.0036)
2. Use age categories instead the actual age and age square	-0.0020	0.0262***	-0.0060
	(0.0056)	(0.0117)	(0.0049)
3. Use median as the cutoff of the treatment and control group	-0.0042	0.0865***	-0.0033
	(0.0058)	(0.0103)	(0.0058)
4. Use mean as the cutoff of the treatment and control group	0.0002	0.0885***	-0.0102
	(0.0071)	(0.0129)	(0.0066)

Race is included as one of the controls and classified as White, Black, Asian and others. The other controls included in all models are age and male dummy. Standard errors are clustered at the hospital level. Robust standard errors are in the parenthesis. *** p<0.01, ** p<0.05, * p<0.1

Biography

Cheng Wang was born in Nanjing, China. He attended the Lee Kong Chian School of Business at Singapore Management University where he earned his bachelor degree in Business Management in 2010. During his undergraduate studies, he was the president of the Quantitative Finance Society and the Dean of Students. He continued his graduate studies in the doctoral program in Business and Economics at Lehigh University in the fall of 2010. He was supported by teaching and research assistantships. His fields of specialization include health economics, applied econometrics, and applied microeconomics.