Access to Medical Resources and Infant Health

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Abstract

A methodological challenge when identifying the causal relationship between health care spending and infant health is unobserved characteristics of parents. If more "responsible" mothers take better prenatal care and have better insurance, they are more likely to have healthier infants and higher hospital charges. One might misinterpret this as higher spending causes better health. To identify the true relationship between health care spending and infant health, we introduce a new instrument: the number of infants born on a given day in a given hospital. During a "slow" time period an infant might be assigned to treatment whereas that same infant would not have been assigned to treatment if she had been born on a different day when the hospital would have been more crowded. Using detailed information on every hospital birth in California from 2002 to 2006, we find that treatment is less intensive when the hospital is more crowded. An additional infant born in a given hospital decreases the average hospital charge for all the infants born on the same day by about $30.

We first present evidence that the level of hospital crowdedness is orthogonal to underlying infant characteristics that may have independent impacts on spending and health. We then use crowdedness as an instrument for health care spending and find that on the margin the benefits from additional spending are negligible. In particular, additional spending does not reduce infant mortality rates and it has no consistent impact on rehospitalization rates in the first year of life.

Key Words: health care production function, infant health, medical spending, cost-effectiveness, instrumental variables

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I. Introduction

Health care spending consumes an ever larger portion of US GDP.[1] Existing evidence about the benefit of the marginal dollar of medical spending both overall and for newborn is mixed. Evidence from studies investigating the effectiveness of new therapeutic improvements tends to suggest that additional spending generate declines in overall and infant mortality. (Phibbs el. al., 2007; Richardson et. al., 2007; Almond et. al., 2010, 2011) However other studies suggest that the new technologies have expanded to the point where additional benefits are negligible. (Goodman et. al., 2002; Almond and Doyle, 2011)

A methodological challenge when identifying the causal relationship between health care spending and health is non-random selection of patients into treatment. Less healthy people are likely to receive more intensive hospital treatment confounding estimates of the returns to such care. If the negative selection into treatment is strong enough, one could be lead to the false conclusion that more intense hospital care decreases health. However, as Almond and Doyle (2011) point out, there is little potential for selection bias in studies on infants, because nearly all deliveries are performed in hospital. Studies investigating newborns are more likely to have upward bias because of unobservable characteristics of mothers. If unobservable characteristics - say responsible prenatal care, parenting, or better insurance - lead to additional or more expensive treatments and these characteristics are also positively correlated with healthier newborns, then naïve estimates will have upward bias. Indeed, the naïve regression between

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[1] In 2007, 17.4 percent of GDP was spent on health care. Childbirth is the most common medical procedure. According to Nationwide Inpatient Sample data (HCUP, 2005), almost 19 percent of all hospitalization were related to childbirth in 2005. Also, the average cost for newborn delivery has been rising. During the sample years, the average hospital charge for delivery went up from $10,989 in 2002 to $13,603 in 2006. Moreover, the second and third most expensive condition treated in US hospitals was “Mother’s pregnancy and delivery” and “newborn infants, which accounted for 5.2 percent and 4.3 percent of the national hospital bill in 2004, respectively. (Russo and Andrews, 2006)

hospital charges and infant mortality reports higher health care spending is associated with better infant health.

We propose a new approach for estimating the marginal returns to medical spending. To generate exogenous variation in health care spending, this paper introduces a new identifying variable (IV): the number of infants born on a given day in a given hospital. We examine the effectiveness of additional treatment that stems from the non-uniform distribution of birth dates within a given hospital. The thought experiment is on a "slow" day an infant may receive more care either because the resource constraints are temporarily weakened or because health care providers responded to the temporary income shock by performing additional procedures or by having the infants stay longer at the hospital. This change in treatment decisions in the presence of income threat is well documented in the supplier induced demand literature.[2]

This number of infants born on a given day in a given hospital is an ideal IV because, according to our first stage analysis, the number of other infants born on a given day in a given hospital is highly correlated with health care spending for the target infant. Additionally the number of other infants who share the target infant's birthday should not have any independent impact on the target infant's health other than through additional spending. Moreover, summary statistics show that after conditioning on the days of the week, infants born on slow versus busy days have very similar pregnancy characteristics, parents' demographic characteristics, proxies for infant health, labor complications, and insurance status. There is no indication that the level

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[2] One of the features of medical market is an agency relationship between doctors and patients. Because doctors have asymmetrically more knowledge about medical care than their patients do, doctors are expected to behave as patients' agents when making treatment decisions. However, studies find that when doctors face negative income shocks, doctors may exploit the agency relationship and provide more care in order to maintain their income. See Ch9. Physician Agency from the Handbook of Health Economics (McGuire, 2000) and Gruber and Owings (1996) for reviews of the supplier induced demand literature.

of crowdedness is correlated with underlying infant characteristics that may independently impact spending and infant health.

We compare health outcomes within the same hospital using variation in hospital spending per birth that arises from short-term hospital crowding. One advantage of exploiting the variation in crowdedness within the hospital is that our estimate is free of potential bias from the variations in infant care quality, resources, or capacity among hospitals. Using health service areas, Goodman et. al. (2001b) found a more than fourfold regional variation in clinically active neonatologists. If the infant care resources are not distributed randomly among hospitals, estimates on the infant care resources and infant health across hospitals might produce biased estimates. Since our only source of variation in health care spending is caused by *within hospital* variation in crowdedness, our estimate measures the effect of health care spending within a given hospital.

Previous studies have used exogenous sources such as legislation mandate, tort reform, or informal “rules of thumb” in physician practice to estimate the impact of additional treatment on birth outcomes. Most studies using legislation mandating minimum postnatal hospital stay find extended hospital stay do not have positive impact on infant health.[3] Existing studies utilizing the state-level mandates on the length of hospital stay measure the marginal benefit of an extra night for those infants who would have otherwise had been discharged. In other words, if the health

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[3] Using legislation mandating coverage of minimum postnatal hospital stays, Meara et. al. (2004) find rates of rehospitalization for jaundice within 10 days fell in the year after legislation was introduces, but rates of all-cause rehospitalization, dehydration, and infection diagnoses did not change. Madden et. al. (2002) find no health effect of extended hospital stay among infants with normal vaginal deliveries. Evans et. al. (2008) also find that additional one day hospital stay decreases readmission rate within 28 days by about one percentage point for subsamples of vaginal delivery with complications and cesarean delivery without complications. But they did not find any impact of mortality rate in any of the subsamples. Almond and Doyle (2011) find that infants born 10 minutes after midnight do not show better health status than infants born 10 minutes before midnight, despite longer hospital stay due to hospital billing practice. Moreover, using California’s minimum-insurance mandate which required insurance coverage for at least two days of hospitalization after birth, they find that no health gain is realized in both 1 to 2 nights stay margin and 2 to 3 nights stay margin.

care providers had been practicing effectively, it is not surprising that extending hospital stay for healthy infants (who would have been discharged before the mandate) does not produce any health gains. Using state-level variation in tort reform, Currie and Macleod (2008) find no impact of additional procedures such as caesarean section and inducement on newborn health. Again, their finding is not surprising because the procedures they examine are the procedures performed (or not performed) because of the law change, not because of the medical needs.

Using informal “rule of thumb” of birth weight of 1500 grams on neonatal intensive care unit (NICU) admission, Almond et al. (2010) estimate the cost of saving a life of a newborn with birth weight near 1500 grams.[4] However, their analysis is limited to small fraction of infants with birth weight of just below or above 1500 grams. Our analysis focuses on infants chosen by medical personnel from entire distribution of infants; hence they are the infants with marginal health conditions who would be the first ones to get more care if additional resources were available.

Additionally, while many studies examine the impact of the length of hospital stay or a particular procedure/treatment, we focus on the causal relationship between health care spending and infant health. Hospital charges contain more comprehensive information on the hospital care infants receive. As the best available summary measure of health inputs (Almond et al., 2010), hospital charge reflects length of stay, number of procedures, and kinds of procedures performed during the hospitalization. Health care spending is also often at the center of the policy debates.

Our first stage result reports that one more infant born in a given hospital decreases the average hospital charge for all the infants born on the same day by about $30. We also discover

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[4] Barreca et al. (2011) criticized the findings of Almond et al. (2010) that the regression discontinuity design used is sensitive to the exclusion of observations due to lumping of the birth weights at 1500g. Almond et al. (2011) respond that the lumping at 1500g (concern that less healthy newborns may be disproportionately likely to have their birth weight rounded to 1500g) is not likely to cause bias because data show that infants with birth weight of 1500g are less likely to receive intensive care.

that the infants who receive additional treatment because they were born on slow days are disproportionally low birth weight infants. More specifically, one more infant born in a given hospital decreases the average hospital charge for low birth weight infants (less than 2001g) by $915. The second stage results suggest that the additional health care spending on infants does not improve infant health status measured by neonatal mortality, one year mortality, or hospital readmission within one year. When we examine the impact of hospital stay, similar null findings are obtained for length of stay. The infants who had longer hospital stay because they were born on slow days did not report any better health status.

This paper is organized as follows: Section II describes the dataset and presents the identification strategy. Section III discusses the relationship between crowdedness and receipt of care. Section IV discusses our main findings. Section V presents and discusses results from various robustness checks. Section VI concludes the paper.

II. Empirical Strategy

Data

The data used in this study are confidential data provided by the California Office of Statewide Health Planning and Development (OSHPD). The OSHPD data link infant hospital discharge records for the first year of life with infant vital statistics data (birth and death certificate data). The OSHPD data used in this paper include every hospital birth in California between 2002 and 2006. The OSHPD data provide birth date and birth hospital, which are used to generate our identifying variable, the hospital crowdedness on birth dates. It also provides detailed information on prenatal care, parents’ demographic information, and newborn characteristics. Health care use information including hospital charges[5] and length of hospital stay is also available. Number of procedures and length of wait for procedures are available only for 28 percent of observations. Because the data cover all subsequent hospitalization for the first year, we are able to identify whether a newborn was transferred or readmitted into a hospital. It also contains our outcome variables – neonate (28 days) and one-year mortality and rehospitalization during the first year.

In this study, hospital charge is the sum of hospital charges from all consecutive hospital stays after birth. If a newborn was transferred from the birth hospital, we tracked the newborn to the transferred hospitals until the newborn was discharged. Hospital stay is the length of consecutive hospital stay after the birth including transfers.

Initial data from OSHPD contained 2,675,440 birth records with birth date and birth hospital. About 11.6 percent of the birth records were missing hospital charge information. About 99 percent of births with missing charge information are Kaiser births because all Kaiser Foundation Hospitals are exempt from reporting charges. Instead of charging specifically for an inpatient stay, Kaiser Hospitals receive a constant monthly (capitated) payment from each member, whether or not that member is hospitalized. Thus we exclude the Kaiser Hospitals from the main analysis. Additionally, a small fraction of our sample (less than three percent) is born in a hospital where average number of births per day is less than two. Because there is not enough variation in the number of births, we exclude birth from these small hospitals. Two Hospitals that report birth for only one year are also excluded. We also drop infants born during the first and the last weeks of our sample period. When we extend our measure of crowdedness to the

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[5] Hospital charges include all charges for services rendered during the infants stay at the facility, based on the hospital fully established rates. Hospital-based physician fees are excluded. We assume that hospital charges and physician fees are positively correlated. Additionally hospital charges could be thought of as list prices, the actual prices paid by insurance companies are often lower. However we have no reason to believe that the negotiated price varies by the daily hospital crowdedness. Also, we control for type of insurance coverage in all regressions.

weighted number of infants born before or before/after, we cannot obtain the weighted number of infants born before or after for those infants born on the first or last week of the sample period. Our final sample contains 2,301,712 infants that are born between the years 2002 and 2006 in hospitals with average number of birth bigger than 2 and with all birth outcome variables, birth date, and hospital charge information.

Table 1

Table 1 reports the summery statistics for all infants and low birth weight infants (less than 2001g of birth weight). Table 1 suggests that parity and length of gestation have a large impact on birth weight. While only 2 percent of all births are multiple births, about 24 percent of low birth weight births are multiple births. Length of gestation of low birth weight infants is also significantly shorter than that of all infants. Length of gestation of low birth weight infants is shorter by 50 days. Additionally 63 percent of low birth weight infants are born by caesarean section while 30 percent of all births are caesarean section birth. Average hospital charges for our sample are around $13,110 per birth. Hospital charges for low birth weight infants are 19 times higher than charge for all infants. Low birth weight infants also stay almost 30 days longer at hospitals and have more procedures done[6]. While one year mortality of all infants is 0.5 percent, that of low birth weight infants is over 11 percent. Hospital readmission rates are 9 percent for the entire sample and 13.6 percent for the low birth weight subsample.

Table 2

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[6] The procedure information is available only for 30% of observations.

Since we generate the variation in hospital spending from the number of infants born on a given day in a given hospital, our identification strategy requires sufficient within hospital variation in the number of infants born on a given day. Table 2 reports descriptive statistics of number of births for selected representative hospitals. Based on the average daily number of births, the smallest, every 10th percentile, and the biggest hospitals are selected. Column 3 shows the mean average daily number of births. Column 4 contains the standard deviation. The fifth through ninth columns report minimum, the quartiles, and maximum number of infants born a day for each representative hospital. Table 2 shows there are sizable variations in the number of birth within a given hospital.

Figure 1 shows the distribution of the number of infants born a day in the median hospital in terms of average number of births. As is clear from the figures, there is a non-uniform distribution of birth dates.

Figure 1

Methodology

Infants Born on Slow vs. Busy Days

The underlying assumption for our identification strategy is that hospital crowdedness should be uncorrelated with any infant level observable (and unobservable) traits that may impact infant health. For instance, say that extremely warm weather induced early labor. If so warm days would be more "crowded" and those infants born on warm days would need more treatments due to shorter gestation lengths threatening our identification strategy. Another possible threat would be triage of mothers in labor (before birth) or transfer (after birth) between hospitals. Random triage of mothers or transfer of newborns will only make our first state weaker. However, if crowdedness increases either triages of mothers based on potential delivery complications or transfers of newborns with more serious health conditions, our estimates might be biased. To investigate this and other possibilities, Table 3 compares summary statistics of infants born on *busy days* and *slow days* in each region.

Table 3

For each infant, we classify its birthday as busy/slow if it is in the top/bottom quartile of number of births for that day of the week in a given hospital. For example, for each hospital, we rank all Mondays according to the number of infants born. We classify the 65 busiest Mondays (25% of all Mondays) in a given hospital as busy days and the 65 slowest Mondays as slow days. We repeat the procedure for the remaining days of the week. We condition on days of the week, because our data show that there are sizable differences in the number of infants born on weekends and weekdays with more infant on weekdays. Numerous authors have shown an association between weekend births and higher infant mortality rates (MacFarlane, 1978; Mathers, 1983; Hendry, 1981; Rindfuss et. al., 1979; and Mangold, 1981). Failure to condition on the weekend births would induce a correlation between crowdedness and health.

Table 3 reports summary statistics for the slowest and busiest days in the sample averaged across the hospitals. The average busy day has about twice as many births as the average slow day. The likelihood of a same day transfer to a different hospital is the same for slow and busy day infants. Moreover, for low birth weight infants, the likelihood of transfer on slow days is higher by 0.5 percent, suggesting that hospitals are not using transfers to relieve crowdedness.

Generally, the differences in observable traits between infants born on slow and busy days are very, very small. Slow day infants and busy day infants received similar level of prenatal care. Parents of slow day infants tend to be younger and less educated. However the size of the difference is very small. For example, mothers of slow day infants are younger than mothers of busy day infants by 0.04 year, which is less than half a month difference. The difference in mother's education is only 0.06 years. Differences in fathers' education and age are even smaller. The gender and racial distribution of infant born on slow and busy days are almost identical. Slightly more multiple births happen on busy days, but this is to be expected because all else equals, multiple births lead to hospital crowdedness. Thus it is important to condition on parity in our analysis. Birth weight is one of the most commonly used indicators of newborn health. Infants born on slow days are slightly heavier by 31 grams, implying that infants born on slow days are, if anything, slightly healthier and less in need of medical attention. Gestation length is another indicator of infant healty. Slow day infants and busy day infants report identical length of gestation. There is only one percent point difference in Caesarean section rate. Insurance status also shows very similar coverage.

Overall, the summary statistics show that, once we condition on the day of the week and hospitals, there are no apparent differences in observable family background and health indicators. This suggests that the level of crowdedness is orthogonal to underlying infant characteristics that may impact spending and health.

Identification Strategy

To address the potential endogeneity of the health care spending, we use an IV strategy which utilizes the difference in health care spending that arises from the variation in the number of infants born on a given day in a given hospital. The first-stage equation for the IV estimate is:

$$\mathrm{Spending}_{\mathrm{ijt}} = \theta_1 \mathrm{Crowd}_{\mathrm{ijt}} + \theta_2 \sum\nolimits_1^7 \mathrm{T}_{1_{\mathrm{ijt}}} + \theta_3 \sum\nolimits_1^{12} \mathrm{T}_{2_{\mathrm{ijt}}} + \theta_4 \mathrm{H}_{\mathrm{ijt}} + \mathrm{X}'_{\mathrm{ijt}}\theta_5 + \lambda_{\mathrm{j}} + \varphi_{\mathrm{i}} + \omega_{\mathrm{ijt}} \quad (1)$$

where $\mathrm{Spending}_{\mathrm{ijt}}$ is hospital charge for infant *i* born in hospital *j* on day *t*. If infant *i* was transferred after birth, we traced all the transferred hospital stays and added all the hospital charges.

$\mathrm{Crowd}_{\mathrm{ijt}}$ is the number of infants born on a same day as infant *i*'s birthday in hospital *j* on day *t*. As a specification check, we will explore alternative measures of $\mathrm{Crowd}_{\mathrm{ijt}}$ by including the weighted number of infants born before and/or after the infant *i*'s birth date.

$\sum_1^7 \mathrm{T}_{1_{\mathrm{ijt}}}$ is a vector of dummy variables for the day of the week. Our data suggest that fewer infants are born on weekends. Numerous authors have shown an association between weekend births and higher infant mortality rates (MacFarlane, 1978; Mathers, 1983; Hendry, 1981; Rindfuss et. al., 1979; and Mangold, 1981). The authors speculate that low levels of staffing on the weekend (i.e. relatively busy hospital personnel) could be driving the poor outcomes. If this is the case, not controlling for the days of the week might give us biased result because fewer infants are born on weekends and these infant have poor outcomes. However, more recent works (Dowding et. al., 1987; Gould et. al, 2003; Hamilton and Restrepo, 2003) show that difference in underlying infants' health and family background across weekend and weekday birth can account for the difference in mortality rates. To purge our result of these problems, we control for the days of the week. $\sum_1^{12} \mathrm{T}_{2_{\mathrm{ijt}}}$ is a vector of dummy variables for month of the year the infant *i* was born. Studies suggest that maternal characteristics are not uniformly distributed throughout the year. (Buckles and Hungerman, 2008; Dehejia and Muney, 2004) More specifically, Buckles and Hungerman (2008) argue that mothers giving birth in the winter are more likely to be teenagers, less educated and less likely to be married. We use month of the year variables as control variables to account for possible systematic seasonal differences in infant health outcomes due to the nonrandom distribution of maternal characteristics and family background across seasons. $\mathrm{H}_{\mathrm{ijt}}$ is an indicator which equals 1 if infant *i* was born on any of four major holidays (New Year's Day, Independence Day, Thanksgiving Day, or Christmas) when we observe significant drop in the number of infants born. We also suspect the level and quality of hospital staffs and hospital care might be different on Holidays.

$\mathrm{X}'_{\mathrm{ijt}}$ is a vector of individual characteristics that include a rich set of information of infant *i* born in hospital *j* on day *t*. It includes pregnancy characteristics such as number of prenatal care visit, month the prenatal care began, and an indicator whether there were any pregnancy complications. Parental characteristics such as age and education of mother and father are included. To account for the nonlinear impact of age and education of parents on infant health, categorical dummy variables are used. Newborn characteristics such as gender, race, parity, and an indicator if the infant was the first born are also included. Birth characteristics such as birth weight, length of gestation in days and whether caesarean section[7] was performed are also included. Because of the nonlinear impact on infant health, birth weight is categorized at 500g intervals and length of gestation is categorized at two week intervals. This model also includes insurance status information. λ_{j} and φ_{i} are hospital and year fixed effects. Hospital fixed effects

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[7] We recognize caesarean section surgery is potentially endogenous to the number of infants born on a given day in a given hospital, and may be especially responsive to SID (see Baicker et. al. 2006). To investigate the sensitivity of our results we have estimated regressions excluding caesarean section from the set of control variables. We have also restricted our sample to vaginal delivery infants. In both cases, the results are very similar to our main findings.

control for any hospital specific characteristic that may impact infant health. This includes variation in level of technology, training of staff, resource capacity and patient mix. The year fixed effects control for the possible differences in health care price, resource capacity, and medical knowledge over time. Robust standard errors are clustered at the hospital and year level.

III. Impacts of Crowdedness on Hospital Spending

So far, crowdedness is measured by the number of infants born on a given day in a given hospital. However, average length of hospital stay in our sample is 3.38 days, thus a newborn might also compete with infants born a few days before and/or after its birth date for medical resources such as hospital beds, medical procedures, and hospital staffs. So we created two alternative measures of crowdedness – expected number of infants on birth date and expected number of infants during hospital stay. Equation (2) and (3) show how we constructed these measures.

$$\text{Expected Number of Infants on Birth Date}_{\text{ij}} = \sum_{s=0}^{7} \omega_s \times \text{Number of infants born}_{\text{ijs}} \qquad (2)$$

$$\text{Expected Number of Infants during Stay}_{\text{ij}} = \sum_{r=-7}^{7} \omega_r \times \text{Number of infants born}_{\text{ijr}} \qquad (3)$$

$\text{Expected Number of Infants on Birth Date}_{\text{ij}}$ is weighted sum of infants born before infant *i*'s birthday in hospital *j*. ω_s is the weight. It is the average percentage of *s* day old infants still in the hospitals. For example, on the infant's birthday, s is 0 and the weight (ω_0) is 1. When s is 1, ω_1 is 0.72, because according to our data, 72 percent of infants remain in the hospital one day after they are born. We account for the births that happened up to seven days before. By the seventh day, more than 96 percent of infants are discharged from hospitals and the weight of the number of infants born seven days before (ω_7) is 0.04. We dropped the first week of year 2002 because the data on the number of infants for the last week of year 2001 is not available.

$\text{Crowdedness\_BeforeAndAfter}_{ij}$ is constructed in a similar manner. It account for the number of infants born before and after infant *i*'s birth date. The weights of *r* days before (ω_{-r}) and *r* days after (ω_r) are the same. We excluded the first and last week of the sample due to lack of available data before and after our sample years. [8]

Table 4

Table 4 reports the first stage regression results of equation (1) using three different alternative measures of crowdedness. Column (1) reports regression result using the number of infants born on a given day. The regression result suggests that when the number of infants born on a given day in a given hospital increases by one, hospital charge per birth decreases by $29.35. Column (2) shows that when the normalized weighted lagged number of infants born before infant *i*'s birth date increases by one, hospital charge decreases by $29.77. Column (3) shows that when the normalized weighted lagged number of infants born before and after infant *i*'s birth date increases by one, hospital charge decreases by $24.34. The first stage results provide evidence that health care providers change the intensity of treatment based on the short-term fluctuations in crowdedness in the hospital. The magnitude of the result is robust to alternative measures of crowdedness.

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[8] We ran regressions including the first and the last weeks of the sample years to investigate if dropping these weeks from the sample caused any bias. The results report similar pattern.

Figure 2

Figure 2 shows our first stage results graphically. It also sheds light onto which infants are more likely to receive more intensive treatment because they were born on slow days. Figure 2.1 graphically compares the health care spending of infants born top 25 percent busiest days and slowest days with the same birth weights. For ease of comparison, Figure 2.2 reports the differences in health care spending between busy and slow day infants per birth weight. It reveals that the slow day infants who incur more health care spending are disproportionately low birth weight infants. The difference in average hospital charge between infants born on slow and busy days is the biggest among low birth weight infants. There is almost no visible difference in health care spending among infants with healthy birth weight of over 2000g. Figure 2 suggests that the infants who received more intense hospital treatment because they were born on slower days are mostly low birth weight infants. Difference in hospital charge among low birth weight infants is sizable. The average hospital charge among slow day infants with birth weight less than 800 grams is $26,256 higher than the average hospital charge of their counterparts who were born on busy days. The huge difference in hospital charge among low birth weight infants and almost no difference among healthy birth weight infants suggest that the first stage estimate of increase in $29.35 is primarily driven by increase in spending on low birth weight infants born on slow days.

Preliminary evidence that the additional spending that occurs on slow days does not translate into better health outcomes can be found in Figure 3. Figure 3.1 shows one-year mortality rates for infants born on the busy days and slow days for various birth weight categories. For ease of comparison, Figure 3.2 reports the differences in infant mortality rate between busy and slow day infants by birth weight. It shows despite the higher spending, slow day infants seem to, if any, have higher mortality. As is clear in Figure 3, the additional spending that slow day infants receive does not appear to translate into better health outcome.

Figure 3

IV. Estimating the Effectiveness of the Health Care Spending on Newborn Health

To measure the causal effect of health care spending on infant health, we use equation (4) for the second stage estimation in our two-stage least square (2SLS) model:

$$y_{ijt} = \beta_1 \widehat{\mathrm{Spending}}_{ijt} + \beta_2 \sum_{1}^{7} T_{1_{ijt}} + \beta_3 \sum_{1}^{12} T_{2_{ijt}} + \beta_4 H_{ijt} + X'_{ijt}\beta_5 + \mu_j + \tau_i + \varepsilon_{ijt} \qquad (4)$$

where the dependent variable y_{ijt} is an indicator of the health of infant *i* who was born in hospital *j* on day *t*. We employ the following measures of infant health: neonatal mortality, one-year mortality, and hospital readmission within the first year.[9] $\widehat{\mathrm{Spending}}_{ijt}$ is predicted hospital charge for infant *i* from equation (1). The rest of the control variables are the same as in equation (1).

Table 5

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[9] We tried restricting the outcome variable to mortality rate from non-accidental causes only (excluding ICD-10 code 295-350). The results are similar to those when mortality from all causes is outcome variable.

Table 5 reports 2SLS regression results. The second stage results are multiplied by \$10,000 for ease of interpretation[10]. Column (1) presents the results with the number of infants born that day as a measure of crowdedness. The second stage results suggest that the additional spending on the infants who were born on slower days does not improve infant health as measured by neonatal, one-year mortality, or readmission with one year. Although statistically insignificant, the coefficients on mortalities are positive. Column (2) reports weakly statistically significant positive coefficient when outcome is one-year mortality, which might imply more hospital spending on slow day infants are more likely to die.

The impact on readmission rate is positive and statistically. These results are confirmed by the other measures of crowdedness that are reported in columns (2) and (3). For instance, the second stage results in column (3) suggest that an additional \$10,000 in spending have no impact on either neonatal or one-year mortality rate. Moreover, positive and statistically significant coefficients on readmission in columns (2) and (3) imply that, if anything, the additional health care spending harms the infants: a phenomenon known as iatrogenic harm. Numerous studies (Black, 1998; Ashton et. al., 2003; Fisher et. al., 2003; Jha et. al., 2003) find evidence consistent with iatrogenic harm.[11] These studies suggest that additional medical care might be harmful to patients because all treatments entail some risk. Other possible explanations are that greater use of diagnostic tests may find abnormality which would not have caused harm and that longer hospital stays increase the risk of infections.

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[10] The average hospital charge is \$12,967.

[11] Using a major reform of the Department of Veterans Affairs health care system, Ashton et. al. (2003) and Jha et. al. (2003) find that the major reduction in hospital utilization does not cause any adverse health consequences. Utilizing wide regional variations in per capita Medicare spending and practice, Fisher et. al. (2003) find that higher spending is associated with lower quality of care. Black (1998) warns the possibility of pseudo disease caused by overuse of diagnostic tests.

V. Robustness Tests

The Impact of Length of Hospital Stay

Length of hospital stay is another measure of treatment intensity. Although we believe hospital charge is the best available comprehensive measure of hospital care, one might suspect that the higher hospital charges on slower day infants are due to hospitals' failing to record and bill all the procedures performed[12]. If this is true, infants born on slower days and busier days might receive the same level of hospital care. Using crowdedness as an IV, we examine if crowdedness has any impact on the length of hospital stay and if longer hospital stays have beneficial impact on infant health.

Table 6

Panel A in Table 6 presents first stage results using the three different measures of crowdedness. Although the magnitude is very small, the first stage result is both negative and statistically significant for all measure of crowdedness. This confirms the main finding that the infants born on slower days receive more intense hospital treatment. Panel B reports the second stage regression results on the impact of hospital stay on neonatal and one-year mortality and rehospitalization. They are also consistent with our main finding. Shorter stays that arise because

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[12] We find no evidence of hospitals' failure to record procedures. Procedure data is available for 27.81 percent of infants born on busiest quartile days vs. 27.09 percent of infants born on slowest quartile days. We also identify four most commonly performed procedures – Circumcision (ICD9:640), Vaccination NEC(ICD: 9955), Insertion of endotracheal tube (ICD9: 9604), and Other phototherapy (other than ultraviolet, ICD:9983) . The differences in percentage of infant receiving each procedure are smaller than 1 percentage point for all four procedures. Moreover, except Circumcision, which is more physician-intensive, the percentages of newborns receiving other three most common procedures are higher among infants born on busier quartile days.

of hospital crowdedness do not adversely impact infant health. We find positive association between length of hospital stay and rehospitalization rate.

Low Birth Weight Infants

Figure 2 shows that differences in hospital charge between infants born on busy days and slow days are especially large among low birth weight infants, suggesting low birth weight infants receive more intense hospital treatment when hospitals are less crowded. Low birth weight infants also report the highest mortality and rehospitalization rates. To examine the impact of crowdedness on the subsample of low birth weight infants, we run regressions on low birth weight infants (less than 2001g). According to Table 1, about 11 percent of low birth weight infants are transferred to another hospital on the same day they are born. Because the crowdedness of the birth hospital should not have any impact on infants who transferred immediately after birth, we exclude low birth weight infants who are transferred on their birth date from this analysis.

Table 7

Panel A in Table 7 reports much larger first stage estimates than our main estimates of \$29 from all infants. When the number of infants born decreases by one, hospital spending per low birth weight infant increases by \$914. The first stage results in Table 7 confirm that the low birth weight infants receive more intense treatment when the hospital region is less crowded and the impact of crowdedness on health care spending is sizable for this population.

The second stage results report that the additional health care spending did not improve mortality measures. Moreover, regression on readmission reports positive coefficients suggesting the additional care is associated with slightly higher probability of rehospitalization within one year. Table 7 suggests that the additional hospital care provided to low birth weight infants do not produce any measurable improvement in mortality rate or rehospitalization rate.

Analysis at the Region Level

While the smallest units where infants compete for health care resources are their birth hospitals, analysis at the hospital level might not perfectly capture the impact of possible triage in mothers in labor or transfer. Table 1 reports while less than 1 percent of newborns are transferred out on the same day they were born, more than 11 percent of low birth weight infants are transferred on their birth day. To include analysis on transferred infants, we expand our unit of crowdedness measure to region level. We use health service area (HSA) defined by the OSHPD. There are 14 HSA in California.[13]

To account for the sizable differences in the number of infants born a day among regions, we normalize the number of infants born a day in each region. We assume the number of infants born in each region has normal z-distribution. To convert the raw number of infants to z-score, we demean the number of infants born, and then divide by standard deviation in each region. Transforming the number of infants born into normalized distribution let us have more uniformed interpretation of the coefficients. Our first stage coefficient is interpreted as the change in healthcare spending when the number of infants born increases by one standard

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[13] The HSA are Northern California, Golden Empire, North Bay, West Bay, East Bay, North Ssan Joaquin, Santa Clara, Mid-Coast, Central, Santa Barbara/Ventura, Los Angeles County, Inland Counties, Orange County, San Diego/Imperial HSAs.

deviation in each region[14]. The average number of daily births at the region level is 157, and mean standard deviation is 25.7. If we conduct analysis similar to that in Table 3 at the HSA level, we again find no difference in observable traits between those infant born on dates when the HSA region is crowded and those born on uncrowded days once we condition on day of the week.

Table 8

Table 8 presents regression results using normalized crowdedness measured at the region level (in z-scores). The first stage results report that the crowdedness has a sizable impact on health care spending at region level regardless of the measures of crowdedness. The second stage results suggest that the higher health care spending on infants born on slow days did not improve any mortality rates. If anything, higher spending increased the probability of rehospitalization within one year. Overall, regression results using crowdedness at hospital level report similar pattern as in our main analysis.

Table 9

Since low birth weight infants are more likely to be transferred, we also examine the impact of crowdedness on low birth weight infants (<2001g) at the region level. Table 9 reports that as the number of infant born in a given region increases by one standard deviation (25.7 births), the average hospital charge for low birth weight infants decreases by $4,957. This confirms the regression result at the hospital level that the low birth weight infants are receiving

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[14] Results are robust to using the raw number of infants born a day in a region.

additional treatments when the hospitals or hospital regions are less crowded. Other crowdedness measures also report much bigger impact for low birth weight infants. Panel B reports that the additional spending on low birth weight infants do not translate into better health outcomes.

VI. Conclusions

Using the hospital level of crowdedness on an infant's birth date as an IV, we estimate the impact of additional health care measured by hospital spending and length of hospital stay on infant health. Our study finds that the intensity of hospital treatment is closely related to the crowdedness at both the hospital and the region level. Infants born on slow days receive more care than infants born on busy days with identical underlying health status. We also identify that the infants who receive more intense hospital care are disproportionally low-birth weight infants. The second stage results suggest that the additional hospital care performed on infants born on slower days does not translate to better infant health outcomes measured by neonatal, one-year mortality rates, and rehospitalization rate within one year. If anything, we find that the additional hospital spending increases the probability of rehospitalization.

An advantage of our analysis comes from the types of infants that our estimates come from. Because the infants receiving additional procedures or longer hospital stays on slow days are likely to be in "marginal" health condition or the additional procedures given are likely to be of "marginal value", our second stage results will identify the health consequences of the hospital care on infants who received the additional services solely because they were born on slow days. More precisely, we are comparing the health outcomes of infants born on slow days with infants born on busy days in the same hospital who have identical underlying health characteristics and family background. This is precisely the information from which the policy debates about staffing ratio and the number of newborn intensive care units benefit.

Our study suggests that we are at the so-called “flat part of the curve” where additional health care spending does not improve health status. This finding suggests that efforts such as new hospital construction or changes in staffing requirements that reduce crowdedness in maternity wards will lead to additional per infant hospital charges without increasing infant health status. However, our result should be interpreted cautiously. While we measure infant health outcome using mortality and rehospitalization rates and these are the best available proxy for infant health, they are not the perfect measures of health status. It is possible that additional spending has benefits like decreased levels of pain or improved parental satisfaction that we are unable to measure. Additionally, because resources and commitment to prenatal health may differ across states and countries, our results might not be generalized beyond California.

Lastly, the new IV we introduce in this paper, crowdedness, could be applied other settings where there is little possibility of timing the onset of medical need. For example, the impact of emergency room care for heart attack patients could benefit from employing the crowdedness measure as an IV.

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Figure 1. Number of Birth in the Median Crowdedness Hospital
(Community Memorial Hospital-San Buenaventura)

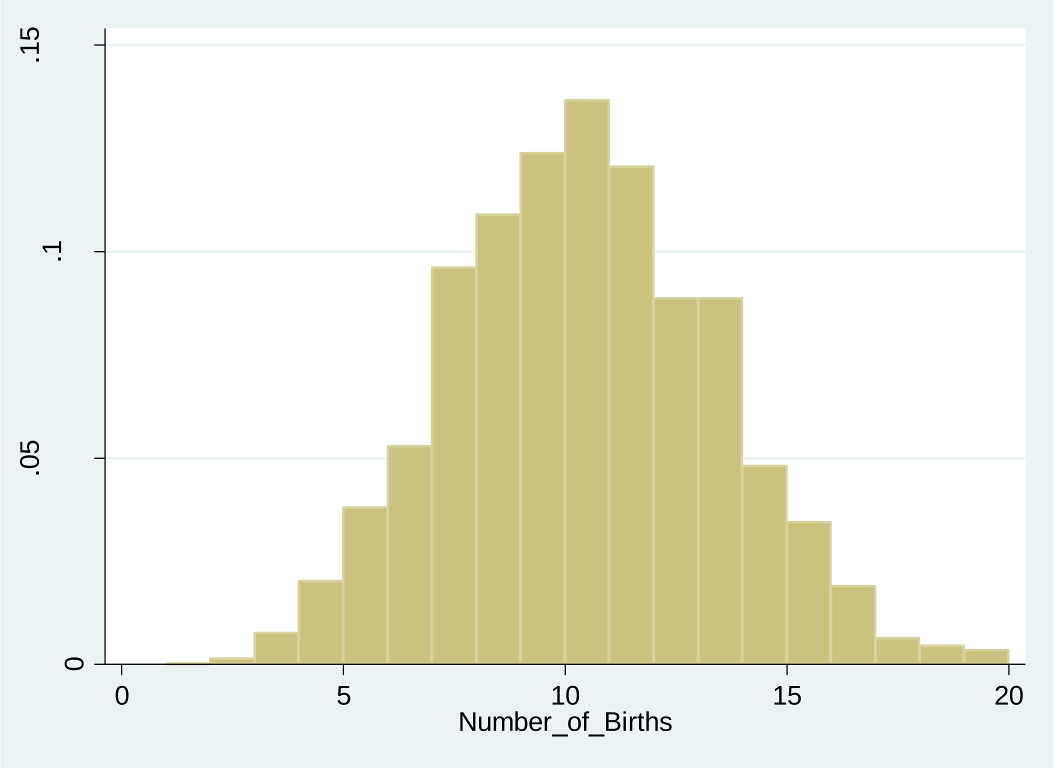
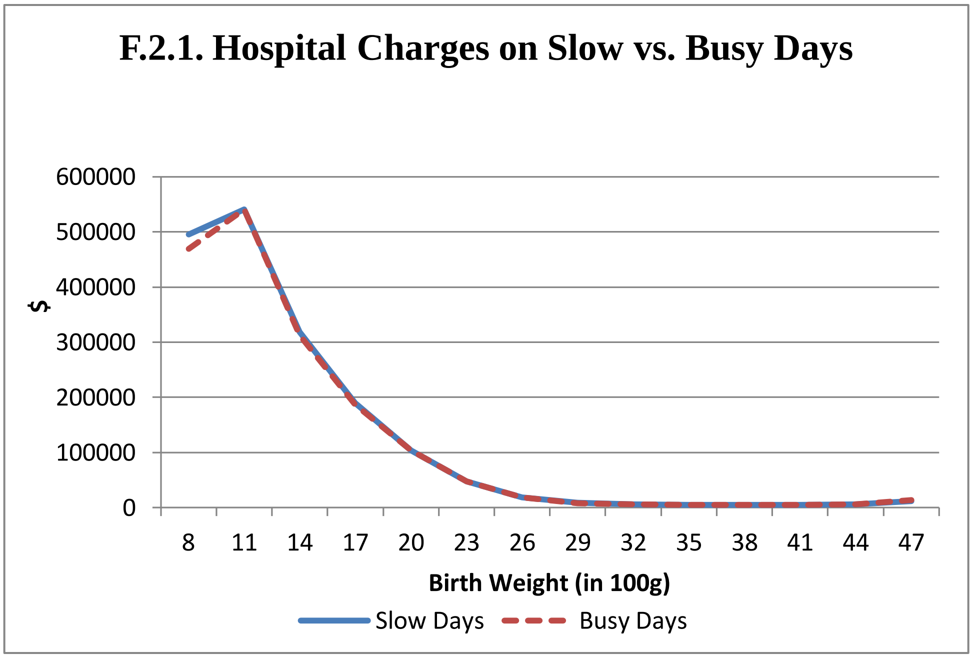
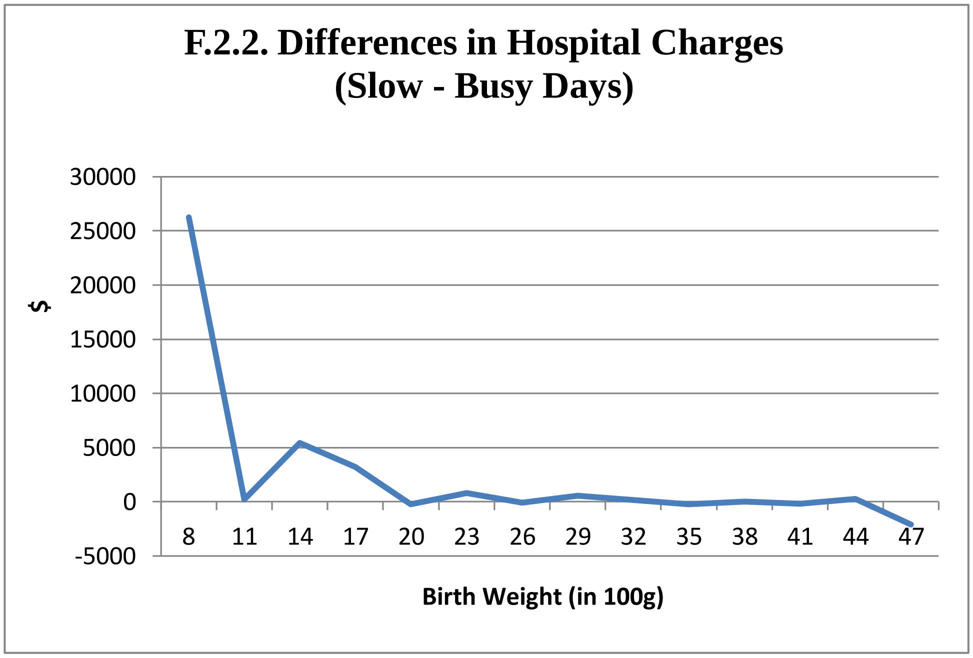


Figure 2. Hospital Charges on Infants Born on Slow vs. Busy Days

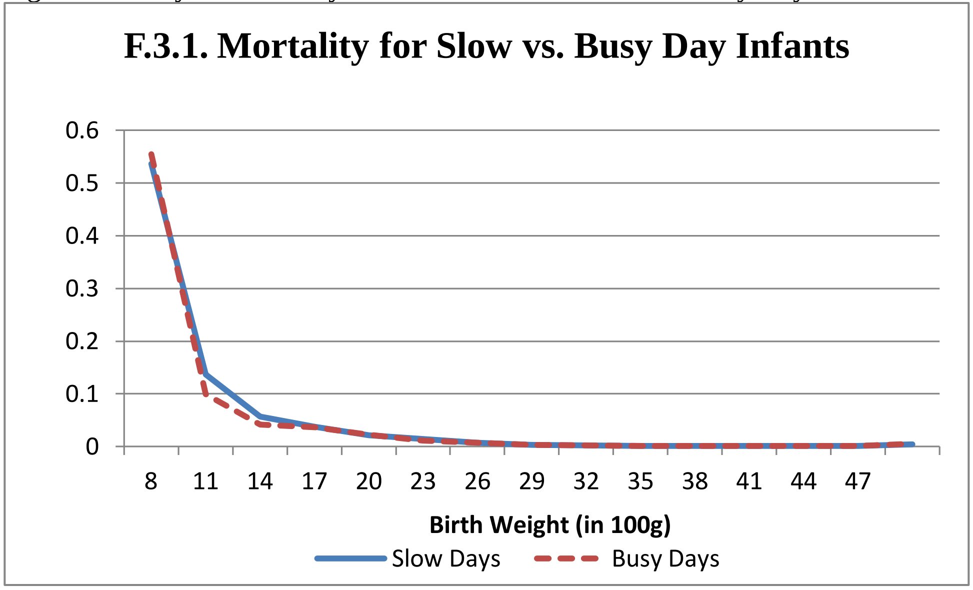


F.2.1. Hospital Charges on Slow vs. Busy Days



F.2.2. Differences in Hospital Charges (Slow - Busy Days)

Figure 3. One-year Mortality for Infants Born on Slow vs. Busy Days



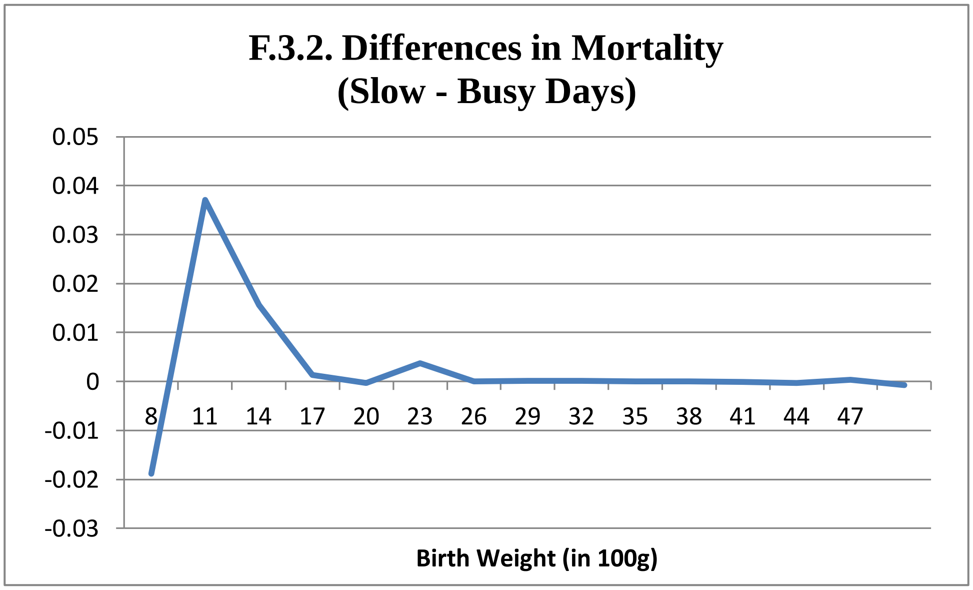


Table 1. Summary Statistics

	All Births		Low Birth Weight (<2001g)	
Variable	Mean	S.D.	Mean	S.D.
Pregnancy Characteristics				
Month prenatal care began	2.24	(1.40)	2.09	(1.35)
Number of prenatal visits	12.39	(4.05)	11.06	(6.26)
No pregnancy complication	0.34	(0.47)	0.23	(0.42)
Parents' Characteristics				
Mother's age	27.92	(6.37)	28.81	(7.06)
Mother's education (years)	12.22	(3.43)	12.36	(3.30)
Father's age	30.85	(7.21)	31.51	(7.90)
Father's education (years)	12.19	(3.59)	12.25	(3.53)
Newborn Characteristics				
Boy	0.51	(0.50)	0.51	(0.50)
White	0.72	(0.45)	0.65	(0.48)
Black	0.07	(0.26)	0.13	(0.34)
Asian	0.09	(0.28)	0.08	(0.27)
Hispanic	0.56	(0.50)	0.52	(0.50)
First born	0.38	(0.49)	0.40	(0.49)
Single birth	0.97	(0.17)	0.71	(0.46)
Multiple birth (twin or more)	0.02	(0.15)	0.24	(0.43)
Normal Newborn	0.77	(0.42)	0.03	(0.16)
Birth Characteristics				
Birth weight (g)	3,318	(574)	1,431	(458)
Gestation (days)	275	(24)	225	(44)
C-section	0.30	(0.46)	0.63	(0.48)
Primary Payer				
Medicaid	0.51	(0.50)	0.46	(0.50)
Private	0.44	(0.50)	0.43	(0.50)
Self pay	0.02	(0.15)	0.02	(0.14)
Variables of Interest				
Hospital charges	13,121	(78,839)	254,792	(367,817)
Hospital Stay (days)	3.38	(8.13)	33.74	(33.82)
Number of procedures	0.43	(1.07)	3.29	(3.70)
Probability of the Same Day Transfer	0.01	(0.09)	0.11	(0.31)
Outcome Variables				
Neonatal Mortality	0.003	(0.058)	0.096	(0.294)
One-year Mortality	0.005	(0.071)	0.113	(0.316)
Readmit within a year	0.090	(0.286)	0.136	(0.343)
Observations	2,301,172		56,468	

1. Data on procedures done are available for only 28 percent of the observations.

Table 2. Descriptive Statistics of Number of Births for Selected Hospitals

	Number of All Births	Mean (Daily Births)	Standard Deviation	Min	25th Percentile	50th Percentile	75th Percentile	Max
Smallest Hospital	1,026	2	0.98	1	1	2	3	5
10 Percentile Hospital	5,818	4.35	1.86	1	3	4	6	10
20 Percentile Hospital	8,120	5.79	2.31	1	4	6	7	13
30 Percentile Hospital	10,451	6.94	2.58	1	5	7	9	16
40 Percentile Hospital	12,020	8.01	2.89	1	6	8	10	17
50 Percentile Hospital	13,028	8.76	3.25	1	6	9	11	20
60 Percentile Hospital	16,000	9.94	2.99	1	8	10	12	20
70 Percentile Hospital	18,141	11.57	3.66	1	9	12	13	25
80 Percentile Hospital	22,824	13.80	3.67	3	11	14	16	26
90 Percentile Hospital	29,147	17.43	4.40	3	14	17	20	31
Biggest Hospital	37,113	22.37	5.79	4	15	23	26	42
All (non-Kaiser) Hospitals	2,301,712	9.92	3.15	1	5	9	13	42
Kaiser Hospitals	305,671	9.42	3.79	1	7	9	12	26
Number of Hospitals	226							
Number of Kaiser Hospitals	23							

Table 3. Summary Statistics of Infants Born on Top 25% Slowest and Busiest Days

	Slow Days		Busy Days		
Variable	Mean	S.D.	Mean	S.D.	Difference
Number of infants born	6.41	(4.16)	12.89	(6.43)	-6.48
Same Day Transfer	0.009	(0.090)	0.009	(0.097)	0.000
Same Day Transfer: Low Birth Weight	0.119	(0.323)	0.113	(0.317)	0.005
Pregnancy Characteristics					
Trimester prenatal care began	2.25	(1.40)	2.25	(1.40)	0.00
Number of prenatal visits	12.34	(3.99)	12.40	(4.11)	-0.06
No pregnancy complication	0.33	(0.47)	0.34	(0.47)	-0.01
Parents' Characteristics					
Mother's age	27.89	(6.37)	27.93	(6.38)	-0.04
Mother's education (years)	12.19	(3.42)	12.25	(3.43)	-0.06
Father's age	30.82	(7.20)	30.86	(7.21)	-0.03
Father's education (years)	12.16	(3.57)	12.21	(3.60)	-0.05
Newborn Characteristics					
Boy	0.51	(0.50)	0.51	(0.50)	0.00
White	0.73	(0.45)	0.73	(0.45)	0.00
Black	0.07	(0.26)	0.07	(0.26)	0.00
Asian	0.09	(0.28)	0.09	(0.28)	0.00
Hispanic	0.56	(0.50)	0.57	(0.50)	-0.01
First born	0.39	(0.49)	0.38	(0.49)	0.00
Multiple birth (twin or more)	0.01	(0.12)	0.04	(0.18)	-0.02
Normal Newborn	0.77	(0.42)	0.77	(0.42)	0.00
Birth Characteristics					
Birth weight (g)	3,335	(564)	3,303	(581)	31
Gestation (days)	275	(24)	275	(24)	0
C-section	0.29	(0.46)	0.30	(0.46)	-0.01
Primary Payer					
Medicaid	0.51	(0.50)	0.52	(0.50)	0.00
Private	0.45	(0.50)	0.44	(0.50)	0.00
Self pay	0.02	(0.15)	0.02	(0.15)	0.00
Observations	745,236		726,652		

Table 4. First Stage Regression Results

	Number of Births	Expected Number of Newborns on Delivery Day	Expected Number of Newborns during Stay
Coefficient	-29.11	-29.68	-24.29
Robust Standard Error	(15.86)*	(11.88)**	(10.12)**
F-Statistics	120.38	118.65	117.83
R-squared	0.3552	0.3552	0.3552
Observations	2,301,712	2,301,712	2,301,712

Standard errors are in parentheses and clustered at the hospital X year level.

Control variables are

* Statistically significant at 10% level.

** Statistically significant at 5% level.

Control variables are days of the week, months, and year indicators, birth weight categorized 500g interval (less than 500g, 501-1000g,…, 4001-4500, over 4500g), gestation in two weeks interval (less than 32 weeks, 33-34 weeks,…, over 43 weeks), baby's race, gender, parity, trimester prenatal care, began, number of prenatal visits, caesarean section, insurance status indicators, mother and father's age and education.

Table 5. Second Stage Regression Results

	OLS Result	IV Results		
		Number of Births	Expected Number of Newborns on Delivery Day	Expected Number of Newborns during Stay
			Neonatal Mortality	
Health Care Spending	-0.0001	0.0011	0.0012	0.0004
(X 10,000)	(0.0000)***	(0.0013)	(0.0009)	(0.0009)
			One-year Mortality	
Health Care Spending	-0.0000	0.0013	0.0029	0.0020
(X 10,000)	(0.0000)***	(0.0027)	(0.0017)*	(0.0016)
			Readmission within a Year	
Health Care Spending	0.0010	0.1480	0.0976	0.0975
(X 10,000)	(0.0000)***	(0.0239)***	(0.0192)***	(0.0209)***
Observations	2,301,712	2,301,712	2,301,712	2,301,712

Standard errors are in parentheses and clustered at the hospital X year level.

All second stage coefficients are multiplied by $10,000.

* Statistically significant at 10% level.

*** Statistically significant at 1% level.

Control variables include the variables listed in Table 4.

Table 6. Impact of Hospital Stay

Crowdedness	Number of Births	Expected Number of Infants on Delivery Day	Expected Number of Infants during Stay
Panel A: 1st Stage Results			
Coefficient	-0.0057	-0.0062	-0.0054
Robust S.E.	(0.0015)***	(0.0012)***	(0.0010)***
F-Statistics	404.65	402.90	401.40
R-squared	0.4682	0.4682	0.4682
Panel B: 2nd Stage Results			
		Neonatal Mortality	
Hospital Stay (1Day)	0.0006	0.0006	0.0002
	(0.0007)	(0.0004)	(0.0004)
		One-year Mortality	
Hospital Stay (1Day)	0.0007	0.0014	0.0009
	(0.0014)	(0.0008)*	(0.0007)
		Readmission	
Hospital Stay (1Day)	0.0769	0.0466	0.0440
	(0.0123)***	(0.0092)***	(0.0094)***
Observations	2,301,712	2,301,712	2,301,712

Standard errors are in parentheses and clustered at the hospital X year level.

* Statistically significant at 10% level.

*** Statistically significant at 1% level.

Control variables include the variables listed in Table 4.

Table 7. Regression Results for Low Birth Weight Infants (<2001g)

	Number of Births	Expected Number of Infants on Delivery Day	Expected Number of Infants during Stay
Panel A: 1st Stage Results			
Coefficient	-914.54	-607.58	-592.73
Robust Standard Error	(442.29)**	(304.54)**	(240.79)**
F-Statistics	124.72	124.83	126.50
R-squared	0.4148	0.4149	0.4148
Panel B: 2nd Stage Results			
		Neonatal Mortality	
Health Care Spending	0.0012	0.0035	0.0015
(X 10,000)	(0.0021)	(0.0021)*	(0.0018)
		One-year Mortality	
Health Care Spending	0.0003	0.0026	0.0012
(X 10,000)	(0.0027)	(0.0028)	(0.0022)
		Readmission	
Health Care Spending	0.0077	0.0089	0.0076
(X 10,000)	(0.0050)	(0.0053)*	(0.0040)*
Observations	46,693	46,693	46,693

Standard errors are in parentheses and clustered at the hospital X year level.

All second stage coefficients are multiplied by $10,000.

* Statistically significant at 10% level.

** Statistically significant at 5% level.

Control variables include the variables listed in Table 4.

Table 8. Regression Results at the Region Level (HSA)

	(1)	(2)	(3)
Panel A: 1st Stage Results			
Coefficient	-211.08	-304.36	-281.67
Robust Standard Error	(77.34)***	(79.29)***	(89.49)***
F-Statistics	332.42	329.64	
R-squared	0.3488	0.3488	0.3488
Panel B: 2nd Stage Results			
		Neonatal Mortality	
Health Care Spending	0.0001	-0.0003	-0.0002
(X 10,000)	(0.0010)	(0.0007)	(0.0008)
		One-year Mortality	
Health Care Spending	0.0019	0.0008	0.0019
(X 10,000)	(0.0019)	(0.0011)	(0.0013)
		Readmission	
Health Care Spending	0.0426	0.0610	0.0685
(X 10,000)	(0.0196)**	(0.0168)***	(0.0209)***
Observations	2,301,712	2,301,712	2,301,712

(1) Normalized number of infants born

(2) Normalized weighted expected number of infants on delivery day

(3) Normalized weighted expected number of infants during hospital stay

Standard errors are in parentheses and clustered at the region X month level.
All second stage coefficients are multiplied by $10,000.
Control variables include the variables listed in Table 4 except hospital fixed effect replaced by region fixed effect.

** Statistically significant at 5% level.

*** Statistically significant at 1% level.

Table 9. Regression Results for Low Birth Weight Infants (<2001g) at the Region Level (HSA)

	(1)	(2)	(3)
Panel A: 1st Stage Results			
Coefficient	-5,010	-8,380	-7,966
Robust Standard Error	(2,442)**	(2,330)***	(2,479)***
F-Statistics	1,604.03	1,573.92	1,598.78
R-squared	0.2396	0.2397	0.2397
Panel B: 2nd Stage Results			
		Neonatal Mortality	
Health Care Spending	0.0031	0.0020	0.0032
(X 10,000)	(0.0032)	(0.0017)	(0.0018)*
		One-year Mortality	
Health Care Spending	0.0022	0.0033	0.0055
(X 10,000)	(0.0039)	(0.0020)*	(0.0022)**
		Readmission	
Health Care Spending	0.0042	0.0066	0.0076
(X 10,000)	(0.0052)	(0.0030)**	(0.0034)**
Observations	56,468	56,468	56,468

(1) Normalized number of infants born

(2) Normalized weighted expected number of infants on delivery day

(3) Normalized weighted expected number of infants during hospital stay

Standard errors are in parentheses and clustered at the region X month level.

All second stage coefficients are multiplied by $10,000.

Control variables include the variables listed in Table 4 except hospital fixed effect replaced by region fixed effect.

* Statistically significant at 10% level.

** Statistically significant at 5% level.

*** Statistically significant at 1% level.

Can possibly add as robustness check

Table . Impact of Crowdedness on Mom and Infant Charge

	Number of Births	Expected Number of Newborns on Delivery Day	Expected Number of Newborns during Stay
Panel A: 1st Stage Results			
Coefficient	-50.94	-47.65	-37.89
Robust Standard Error	(17.11)***	(14.03)***	(12.31)***
F-Statistics	140.18	138.85	137.77
R-squared	0.3841	0.3841	0.3841
Panel B: 2nd Stage Results			
Health Care Spending	0.0006	0.0008	0.0002
(X10,000)	(0.0008)	(0.0006)	(0.0005)
Health Care Spending	0.0007	0.0018	0.0013
(X10,000)	(0.0015)	(0.0011)*	(0.0010)
Health Care Spending	0.0844	0.0608	0.0625
(X10,000)	(0.0137)***	(0.0119)***	(0.0134)***
Observations	2,288,028	2,288,028	2,288,028

Standard errors are in parentheses and clustered at the hospital X year level.

All second stage coefficients are multiplied by $10,000.

* Statistically significant at 10% level.

*** Statistically significant at 1% level.

Control variables include the variables listed in Table 4.

Log charge & log number of births

Table . Log number of infant & log charge

	Number of Births	Expected Number of Newborns on Delivery Day	Expected Number of Newborns during Stay
Panel A: 1st Stage Results			
Coefficient	-0.0134	-0.0308	-0.0382
Robust Standard Error	(0.0025)***	(0.0066)***	(0.0101)***
F-Statistics	661.90	629.06	617.26
R-squared	0.5203	0.5203	0.5203
Panel B: 2nd Stage Results			
Health Care Spending	0.0004	0.0023	-0.0008
	(0.0024)	(0.0017)	(0.0017)
Health Care Spending	-0.0014		0.0003
	(0.0047)	(0.)	(0.0031)
Health Care Spending	0.3044		0.2199
	(0.0404)***	(0.)	(0.0347)***
Observations	2,301,650	2,301,650	2,301,650

Standard errors are in parentheses and clustered at the hospital X year level.

All second stage coefficients are multiplied by $10,000.

* Statistically significant at 10% level.

*** Statistically significant at 1% level.

Control variables include the variables listed in Table 4.

Log Charge & log number of birth for small infants (2000g)

Table . Log number of infant & log charge

	Number of Births	Expected Number of Newborns on Delivery Day	Expected Number of Newborns during Stay
Panel A: 1st Stage Results			
Coefficient	-0.0369	-0.0480	-0.0734
Robust Standard Error	(0.0158)**	(0.0256)*	(0.0300)**
F-Statistics	408.57	419.97	408.29
R-squared	0.4999	0.4999	0.4999
Panel B: 2nd Stage Results			
Health Care Spending	-0.0520	0.0050	-0.0081
	(0.0483)	(0.0562)	(0.0439)
Health Care Spending	-0.0862	-0.0475	-0.0372
	(0.0617)	(0.0692)	(0.0506)
Health Care Spending	0.1975	0.2520	0.1959
	(0.1183)*	(0.1435)*	(0.1072)*
Observations	46,691	46,691	46,691

Standard errors are in parentheses and clustered at the hospital X year level.

All second stage coefficients are multiplied by $10,000.

* Statistically significant at 10% level.

*** Statistically significant at 1% level.

Control variables include the variables listed in Table 4.