Trade Liberalization and Newborn Health: Evidence from US Exposure to Chinese Import Competition*

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Abstract

Economists have recently drawn attention to the relationship between international trade and human capital development. This paper focuses on how the birth outcomes of US children respond to exposure to Chinese import competition. The major challenge in this research agenda is to find exogenous sources of variation that affect child outcomes. This paper explores a regional variation in US exposure to Chinese import competition driven by China's supply-side productivity changes and falling in trade costs. In the first part of this paper, I find evidence that the rise of Chinese exports to the US is not harmful to newborn health and infant mortality; instead, the empirical results show that the percentage of low birth weight and premature infants in US counties is largely reduced by the rise of Chinese imports. The second part of the paper shows that the positive effect of Chinese import competition on the birth outcomes of US children is possibly resulting from reduction in air pollution and good prices.

Key words: Newborn health; Trade liberalization; Chinese import competition

JEL: F10, I10

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1 Introduction

Trade liberalization, especially import competition from low-wage countries, is known to affect good prices, household income and labor market outcomes of high-wage countries. The well-being of individuals in the open economies thus is largely affected by international trade. Economists and policymakers are increasingly interested in the relationship between trade liberalization and health outcomes. Earlier studies typically find a negative effect of import competition from less developed countries on adult health of developed countries. Pierce and Scott (2016) find that counties more exposed to changes in trade policy exhibit higher rates of suicide and related causes of death. The suicide rate is linked to relative loss of employment and income. McManus and Schaur (2016) find that import competition from China increases the injury rates and the injury risk in the competing US industries. Chinese import competition not only affects workers in the trade-exposed industries, but also impacts other family members. Marcus (2013) and Bubonya et al. (2014) find that job losses of workers have spillover effects on the mental well-being of their spouses. Marcus (2013) finds that unemployment due to firm closure decreased mental health by 27% of a standard deviation for unemployed individuals themselves and by 18% of a standard deviation for their spouses. Bubonya et al. (2014) present evidence that the mental well-being of wives declined following their husbands' job losses if those job losses result in a sustained period of unemployment or the family suffers pre-unemployment financial hardship.

Import competition from low-wage countries also affects the health outcomes of children whose parents are impacted by the extraordinary growth in international trade. However, previous studies mainly focus on child labor prevalence in developing countries (Edwords and Pavcnik, 2005) and mortality of teenagers (Levine and Rothman, 2006; Owen and Wu, 2007), little attention is paid on the impact of trade shocks on newborn health. This lack of research exists despite the well-known fact that early childhood human capital development plays a crucial role in later-life outcomes (Almond et al., 2005; Behrman and Rosenzweig, 2004; Currie et al., 2010), and the widespread interest in the inter-generational transmission of human capital. Prenatal disadvantaged children are at risk of worse outcomes in physical wellness in their later part of lives. They are also prone to adverse socioeconomic outcomes such as poor school performance in childhood, lower future wages and higher crime rates in adulthood. As a result, understanding the effects of trade liberalization on newborn health in the US may help policymakers effectively implement public health programs for disadvantaged children. To fill this gap in the literature, I study the effects of exposure to Chinese import competition on birth outcomes of US children.

Another limitation of existing studies on the health outcomes of newborns is the exclusive focus on birth weight. This paper provides a comprehensive analysis on the effect of trade liberalization on four health measures of newborns: birth weight, Apgar scores, length of gestation and infant mortality. This paper thus is able to show whether the import competition from China has a consistent impact on all indicators of newborn health.

This paper also contributes to the existing literature by providing analysis on the mechanisms through which import competition from China might affect newborn health in the US. There are broadly five mechanisms. First, exposure to Chinese import competition may have an impact on child outcomes through parental job losses. The reduction of production costs and trade barriers in less developed countries allow them to import more products to the US. Thus, US domestic manufacturing firms with comparatively higher labor costs reduce employment or even exit the market. The import competition thus may result in a decrease in local unemployment. A substantial literature provides theoretical models and empirical evidence for the negative relationship between Chinese import competition and the employment of US manufacturing workers (Egger and Kreickemeier, 2009; Autor et al., 2013; Pierce and Schott, 2012; Lake and Millimet, 2015; Acemoglu et al., 2016). The trade-induced job losses may have an impact on the birth outcomes of children through maternal nutrition deprivation because unemployed parents may lack money to buy food and nutritious supplements. Another impact of parental job losses on the health outcomes of newborns is through the mental stress of mothers during their pregnancy period, even if it is their spouses rather than themselves who lose jobs (Macus, 2013; Bubonya et al., 2014). It is probably due to the fact that mothers' mental stress may trickle down to their children in utero. Parents are also more likely to develop unhealthy habits such as smoking when they are stressful. Therefore, trade-induced job losses may have a negative impact on newborn health.

Second, import competition from China has an impact on the provision of public goods through its effect on local government revenue. Feler and Senses (2016) find that the increasing import competition from China leads to declines in housing prices and business activities, resulting in less government revenue. As shown by Feler and Senses (2016), funding for public services related to education and health care for low-income families is highly localized in the US, with heavy reliance on property and sales tax revenues. The reduction in the provision of public goods associated with prenatal health care thus may negatively affect the birth outcomes of US children.

Third, trade liberalization is known to provide households access to cheaper goods and a wide variety of consumption (Levine and Rothman, 2006; Freenstra and Weinstein, 2010; Tovar, 2012; Courtemanche et al., 2015). The idea that trade liberalization improves the living standard is supported by the theory of comparative advantage (Frankel and Romer, 1999), rent-seeking theory in the political economics (Dollar and Kraay, 2004), and substantial empirical evidence. For example, Amiti et al. (2017) find that China trade shock reduced the US manufacturing price index by 7.6 percent between 2000 to 2006, which is in principle driven by policy changes after China's accession to the World Trade Organization (WTO). Though trade liberalization may not directly affect the health care industry in the US, the availability of cheap imported materials may reduce production costs related to medical equipment and drugs. Moreover, the reduction in good prices has a direct income effect on US households. Thus, the accessibility to cheaper goods enables households to spend more on nutrition and health products. Consequently, trade liberalization may increase the health outcomes of US newborns through the reduction in good prices.

Fourth, the rise of Chinese imports may reduce pollution in trade-exposed US counties as Chinese import competition prompts closure of inefficient manufacturing plants. Domestic companies are also able to import intermediate or final products of heavily polluted industries from China or outsource production to low-wage countries. Some of the literature is interested in the impact of air pollution on child health. Currie and Neidell (2005) and Chay and Greenstone (2005) both find that improvement in air quality reduces infant mortality. The World Health Organization (WHO) conducted an assessment of research on pollution and child health in 2005. The report, entitled "*Effects of air pollution on children's health and development*", shows that the risks posed by ambient air pollutants are related to various aspects of children's health.

Finally, the import penetration from China may also affect the health outcomes of US newborns through altering marriage and fertility decisions of young adults. Autor et al. (2017) find that import competition from China reduces the marriage rate and the fertility rate of young people in the US, and the reduction in fertility is not uniform across demographic groups. Since they find the fertility among younger mothers decreases proportionally less than the fertility among older mothers, the reduction of the fertility rate may positively affect birth outcomes of US children since younger women are normally more likely to deliver healthier babies.

In sum, exposure to import competition from China may impact health outcomes of US newborns either positively or negatively. Therefore, it is of interest to investigate this effect empirically and discusses the mechanisms that would explain the estimated results.

In this paper, I provide evidence on the causal effect of import competition from China on the health outcomes of US newborns. I use the instrumental variable method following Autor et al. (2013). The central identification assumption underlying this approach is that the surge of Chinese imports is driven by China's productivity growth and the trade cost reduction after China's openness to international trade. The empirical results suggest that US exposure to Chinese import competition reduces the percentage of newborns with low birth weight and premature births, while other birth outcomes are not significantly affected by trade exposure. Further, in order to provide a more comprehensive understanding of health consequences of import competition, I explore potential mechanisms behind my results. I find reduction in air pollution and availability of cheaper goods are possible channels that would improve the birth outcomes of US children. Another potential mechanism might be the increase in the share of young mothers in fertility (Autor et al., 2017). This paper contributes to the strand of literature on the effects of Chinese trade penetration on the welfare of US people. Though a substantial literature has shown evidence that Chinese import competition causes job loss for US low-skilled workers, this paper finds that trade between US and China is beneficial to US newborns.

The rest of the paper is organized as follows. Section 2 describes the empirical strategy used to examine the effect of Chinese import competition on newborn health. Section 3 describes the data. Section 4 presents and discusses the main results. Section 5 discusses the potential mechanisms through which exposure to Chinese import competition may positively affect the birth outcomes of US children. Section 6 concludes.

2 Empirical Strategy

Since exposure to Chinese import competition may be endogenous to newborn health, I explore the exogenous variation of local trade exposure via the county-level industry structure to examine the causal effect of Chinese trade penetration. The empirical strategy is based on Autor et al. (2013), who study the effect of Chinese import competition on US labor market using an instrumental variable approach.

The empirical model is a standard two-way fixed effects model at the US county level estimated by two-stage least squares. The regression model is

$$Y_{ct} = \alpha + \beta_1 IPW^u_{ct} + \beta_2 IPW^{u^2}_{ct} + \mathbf{X}^{'}_{ct}\beta + \lambda_c + \gamma_t + \varepsilon_{ct} \tag{1}$$

where Y_{ct} is the birth outcomes in county c and year t, and $\mathbf{X}_{it}$ is a vector of control variables including the demographic characteristics of the newborns and their mothers. λ_c and γ_t are county and year fixed effects, respectively. ε_{ct} is the error term. Since birth outcomes of children are more likely to be a result of the exposure to Chinese imports when children are in utero, the trade exposure variable IPW^u_{ct} takes the value of last time period. $IPW^{u^2}_{ct}$ is included to account for the fact that the fraction of adverse birth outcomes decline in a non-linear manner. Figure 1 shows that the predicted value of outcome variables are more likely to follow a non-linear pattern when they are regressed by the county level import per worker.

The exposure to Chinese import competition is measured by the concept of the per-capita change of Chinese import to the US.[1] The trade exposure variable IPW^u_{ct} is defined as the imports apportioned to US

[1] In the existing literature, there are several measures of exposure to trade competition. Jensen and Kletzer (2006) and Eliasson et al. (2012) use locational Gini coefficient to measure the industrial concentration of domestic regions. Bernard et al. (2003) measure an industrial exposure to imports from low-wage countries via the value share (VSH) of imports originating in these low-wage countries.

counties weighted by its share of national industry employment in the baseline year. Formally,

$$IPW_{ct}^{u} = \frac{1}{L_{c}^{1990}} \sum_{j} \frac{L_{cj}^{1990}}{L_{j}^{1990}} M_{jt} \tag{2}$$

where IPW_{ct}^{u} is the per-capita Chinese imports to the US in county c and year t. L_{c}^{1990} is the working population by county in the baseline year 1990, $\frac{L_{cj}^{1990}}{L_{j}^{1990}}$ is the ratio of county level industry employment to national industry employment in 1990 and M_{jt} is the imports of the US from China in industry j and in year t. The key explanatory variable IPW_{ct}^{u} is instrumented by the exposure to Chinese import competition on eight other high-income countries' IPW_{ct}^{o}.

Import per worker (IPW_{ct}) is widely used to study the effect of the exposure to import competition from low-wage countries on labor market outcomes. It is chosen as the measure of exposure to Chinese import competition in this study for two reasons. First, import per worker is related to both trade shock and local labor market. The impact of import competition on domestic employment is a potential mechanism that affects birth outcomes of children. The second reason is that import per worker measures county level exposure to Chinese import competition by weighting industry level imports with the county-industry labor share, though the imports of each US county is not directly observed in trade data.

The identification strategy relies on the assumption that the surge of Chinese imports to the US is driven mainly by the productivity growth and trade costs reduction of China. The productivity growth is due to China's transition to a market-oriented economy and the trade costs reduction is due to its openness to international trade, especially after China's accession to the WTO. Under this assumption, the rise of Chinese imports has common within-industry effects on trade sectors of the US and other high-income countries. The exposure to Chinese import competition of eight other high-income countries is thus used to instrument for the US trade exposure variable.[2] It captures the growth in imports from China that reflect technology shocks and demand shocks common to high-income countries.

3 Data

To implement the identification strategies, I utilize a panel of trade and health data from 1992 to 2004. I first combine the US-China trade data with US county-industry employment share calculated from the 1990 Census to obtain county level exposure to Chinese import competition. The data is then merged with the birth outcome data. The final panel has approximately 340 counties each year because the county identifiers in the National Vital Statistics data and are only available for around 460 large populated counties in the US.

[2]Following Autor et al. (2013), the eight other high-income countries are those that have comparable trade data covering the full sample period: Australia, Denmark, Finland, Germany, Japan, New Zealand, Spain, and Switzerland.

The number of counties that can be identified in the 1990 Census data is about 430. The county identifiers of small counties are not publicly available in these data sets.

3.1 US Exposure to Chinese Import Competition

The key explanatory variable is the county level exposure to Chinese import competition. I follow Autor et al. (2013) in using a regional variation in industrial composition to calculate local exposure to Chinese import competition.

In the first step, I use the 1990 Census 5% sample to construct the county-industry labor share. The Census data has rich information on labor statistics, including occupation and associated industry. The number of industries in the trade sectors that are used to construct county-industry employment share is 93. The county-industry employment share is the number of workers in one industry in each county over the total number of worker in this industry nationwide. It is fixed in a baseline year because the contemporaneous employment share might be endogenously affected by Chinese import competition through job reallocation. I chose 1990 as the baseline year because year 1990 is right before the study time period 1992-2004 and the Census data is available in 1990 for obtaining employment information.

In the next step, I construct the trade exposure variable import per worker (IPW_{ct}) by linking the county-industry employment share obtained from the 1990 Census to the industry level imports from China. The trade data is collected from the World Integrated Trade Solution (WITS) data set of the World Bank Group. The WITS provides information on trade volume and the impact of protection and tariff changes. Since the industry identifier in WITS is the Standard Industry Code (SIC) while the industry identifier in the 1990 Census data is a Census standard coded as "ind1990", I map the SIC to ind1990 to obtain a common industry identifier for the data combination. Import per worker is obtained by summing up the the products of county-industry employment and imports from China of all industries following equation (2) in Section 2. The final panel has a total number of observations of 6,034 from 1991 to 2004.[3]

3.2 Birth Outcomes and Family Characteristics

Birth outcome data are from the National Vital Statistics System (NVSS) of the National Center for Health Statistics (NCHS). The NVSS provides individual level data on vital events. It also provides rich information on the demographic and socioeconomic characteristics of the newborns and their mothers. In this study, I collapse the birth outcomes into county level by year to investigate county level trade shocks. This paper focuses on four major birth outcomes of children: the percentage of children with low birth

[3]US-China trade data in WITS is available from 1991.

weight, low Apgar scores, overweight, and premature birth.

Low birth weight (LBW) is defined as a birth weight of a live-born infant of 2,499 grams or less, regardless of gestational age. Low birth weight infants have a greater risk of poor health, which may require a longer period of hospitalization after birth They are also more likely to develop significant disabilities. Overweight birth, a birth weight of more than 4,000 grams, is another unusual birth weight state[4]. The Apgar score provides an accepted and convenient method for reporting the status of the newborn infants immediately after birth. A 5-minute Apgar score that is no more than 7 is considered to be a low score because the Apgar evaluation has to be taken every 5 minutes for infants whose score is below 7. Another useful criterion of newborn health is the gestation period of the newborn babies. Preterm birth, also known as premature birth, is defined by the National Institutes of Health (NIH) as the birth of a baby at fewer than 37-week gestational age. Premature infants are at greater risk for cerebral palsy, delays in development, hearing problems, and sight problems. Preterm birth is also the most common cause of death among infants worldwide. It is also believed that the earlier a baby is born, the higher the risk of adverse health outcomes.

I further examine the effect of exposure to Chinese import competition on the mortality rate of newborns since the estimation will be biased if healthier babies are selected into live births. The infant mortality rate is the number of deaths under one year old occurring per 1,000 live births in a given geographical area during a given year.

The infant mortality data is collected from the Compressed Mortality File (CMF), which is comprised of a county-level national mortality file and a corresponding national population file. The CMF is collected from the mortality files of the National Center for Health Statistics (NCHS), which record every death of a US resident annually from 1968 to 2016. The detailed mortality files contain an extensive set of variables collected from hospital death certificates. In this paper, I use the county level infant mortality data. However, like the National Vital Statistics System, the CMF only collects mortality data from high population-density counties, so the county level data does not include all counties in the US. The mortality data is merged with the birth outcome data described above by county. Table 1 shows summary statistics.

The control variable set contains the demographic and family characteristics of the newborns, including an infant's gender and birth order as well as her mother's race, residential information, education level, age at birth and marital status. Controls are aggregated at the county level as means or percentages.

The final step of the data management is to combine the county level health data (birth outcomes and mortality rate) with the trade data containing the county level import per worker variable. The final longitudinal data includes the trade exposure variable, health outcomes and family characteristics of newborns in each US county over time. Figure 1 shows the average percentage of low birth weight across all US counties

[4]Overweigth birth is defined by using the definition of "fetal macrosomia".

Table 1: Summary Statistics

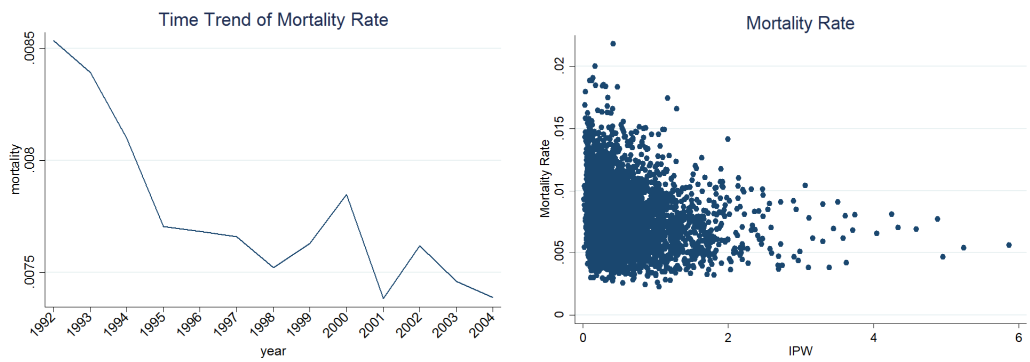
Variable	Mean	Min	Max	Observation
Birth Outcomes				
Low Birth Weight	0.075	0	0.202	4426
(Birth Weight<2500 grams)				
Overweight Birth	0.024	0	0.222	4426
(Birth Weight>4000 grams)				
Low Apgar Score	0.033	0	0.6	4304
(5 minutes Apgar Score≤7)				
Premature Birth	0.192	0	0.397	4426
(Gestation<37)				
Mortality Rate	0.008	0.002	0.022	4426
Trade Variables				
Import per worker (IPW)	0.549	0.018	5.866	4426
Mother Characteristics				
Mother's Age	27	24	34	4426
Married	0.677	0.261	1	4426
Mother's Education Level				
≤ High School	0.191	0	0.583	4426
High School	0.540	0	1	4426
College Degree	0.268	0	1	4426
Mother's Race				
White	0.779	0	1	4426
Black	0.152	0	0.802	4426
Other Race	0.069	0	1	4426
Child Characteristics				
Boy Ratio	0.512	0.222	0.600	5208
Birth Order	2.026	1.709	3.667	5208

Note: The summary statistics are from the county level data. The table describes the birth outcomes and family characteristics for each surveyed county from 1990 to 2004. Except for birth order and mother's age, which are in level, variables are in percentage form.

in every study year. It suggests that there was an increasing percentage of low birth weight newborns in the US after 1991, though medical technology and the health care industry were rapidly growing. The right panel of Figure 1 presents the relationship between the import per worker variable and the percentage of newborns with low birth weight by county, the OLS predicted results suggest a negative relationship between import per worker and low birth weight. Figure 2 shows the average mortality rate of newborns was decreasing after 1990, especially in the early 1990s. The scatter plot in the right panel also shows a negative relationship between import per worker and the county level mortality rate. In summary, the data shows that the percentage of low birth weight newborns grew over the study time period in the US, while the mortality rate declined in the same time period. However, the effects of import per worker on both the percentage of newborns with low birth weight and infant mortality are possibly negative.

Figure 1: Low Birth Weight

Figure 2: Mortality Rate



4 Empirical Results

4.1 Main Results

In this section, I empirically examine the effect of exposure to Chinese import competition on the health outcomes of US newborns, including the percentage of low birth weight, overweight, low Apgar scores, early delivery and the mortality rate of US newborns. Table 2 presents the results derived from the empirical model in Section 2. It shows that the trade exposure variable IPW_{ct} and its quadratic form IPW_{ct}^2 are jointly significant in impacting low birth weight and premature birth, while only the effect on low birth weight is statistically significant at a significance level of 1%. Also note that though IPW_{ct} and IPW_{ct}^2 do not significantly affect the outcome of low Apgar score individually, they have jointly significant impact on the fraction of low Apgar scores. Table 2 also shows the results of the first-stage F-test and the endogeneity test for the instrumental variable approach. It is shown that all IV regressions pass the F-test, which suggests that the import per worker of eight other high-income countries is a valid instrument for the import per worker of the US. In addition, four out of five birth outcomes pass the endogeneity tests. This suggests that an instrument is needed to address the endogeneity of the Chinese trade penetration.

Since the regression model includes the quadratic form of county level import per worker, the impact of exposure to Chinese import competition should be explained by the marginal effect of import per worker. Both the sign and the magnitude of the marginal effect of import per worker depends on the level of exposure to Chinese import competition. More specifically, exposure to Chinese import competition measured by import per worker (IPW_{ct}) reduces/increases the incidence of low birth weight and premature births if import per worker is below/above a certain threshold. For example, the marginal effect of IPW_{ct} on the percentage of low birth weight is negative when $IPW_{ct} < 3.5086$, which is true for nearly 99.7% of US counties in the data. The marginal effect of IPW_{ct} on the percentage of premature births is negative if $IPW_{ct} < 4.0969$, and nearly 99.8% of US counties are below that level of trade exposure. As a result, IPW_{ct} and IPW_{ct}^2 have a consistent negative impact on the percentages of newborns with low birth weight and low Apgar score in almost all US counties.

However, the marginal effect of IPW_{ct} on the incidence of low Apgar scores seems to be positive according to the estimation results shown in Table 2. This result is surprising because the relationship between IPW_{ct} and the percentage of newborns with low birth weight and low Apgar score are negative. Figure 2 plots the marginal effects of import per worker on the percentage of newborns with low birth weight, short gestational period, and low Apgar score. It shows that the marginal effects of import per worker on the percentage of low birth weight and premature birth is always below zero at the 5% confidence interval. However, the confidence interval of the marginal effect on the percentage of low Apgar scores includes negative values at the 5% significance level. Since the confidence interval is too wide to exclude null effect, passing the joint significance test does not necessarily ensure a significant positive effect of import per worker on the percentage of newborns with low Apgar scores at the 5% confidence interval.

Import competition from China may have differential impacts on birth outcomes of children with different parental human capital endowment through its direct effect on the local labor market. I thus analyze the effect of Chinese import competition on newborns whose mothers are in different levels of education. Mothers' education levels are classified into three categories: less than high school, high school diploma or college unfinished, and bachelor's degree and above. The incidence of low birth weight is reduced for all sub-samples of newborns, and the percentage of newborns whose mothers are less educated decreases more than those whose mothers are more highly educated.[5] It suggests that Chinese import competition might have a greater benefit on disadvantaged children.

[5] The estimation results are shown in Appendix A.

Table 2: Effect of IPW on Aggregate birth outcomes (2SLS)

Birth Outcome	Low Birth Weight	Overweight	Low Apgar Score	Premature	Mortality
IPW_{ct}	-.0044***	0.0001	0.0110	-0.0034*	-0.0001
	(0.0001)	(0.0004)	(0.0090)	(0.0018)	(0.0002)
IPW_{ct}^2	0.0006***	0.00004	-0.0006	0.0004	0.0000
	(0.0002)	(0.0001)	(0.0028)	(0.0003)	(0.0000)
Joint Significance	0.0000	0.1828	0.0172	0.0630	0.3416
First-stage F-test	0.0000	0.0000	0.0000	0.0000	0.0000
Test of Endogeneity	0.0000	0.0000	0.0180	0.1319	0.0000

Note: The control set includes county level average mother's age at birth; percentage of mothers with less than high school, high school and college education; percentage of married mothers; percentage of mothers who are white, back and other race; ratio of male newborns by county.
The US trade exposure variable IPW_{ct} is instrumented by the exposure to Chinese import competition of eight other high-income countries.
The table presents test results in p-value.
The regression is also weighted by the inverse of county population squared.
*** Indicates significant at the 1% level.
** Indicates significant at the 5% level.
* Indicates significant at the 10% level.

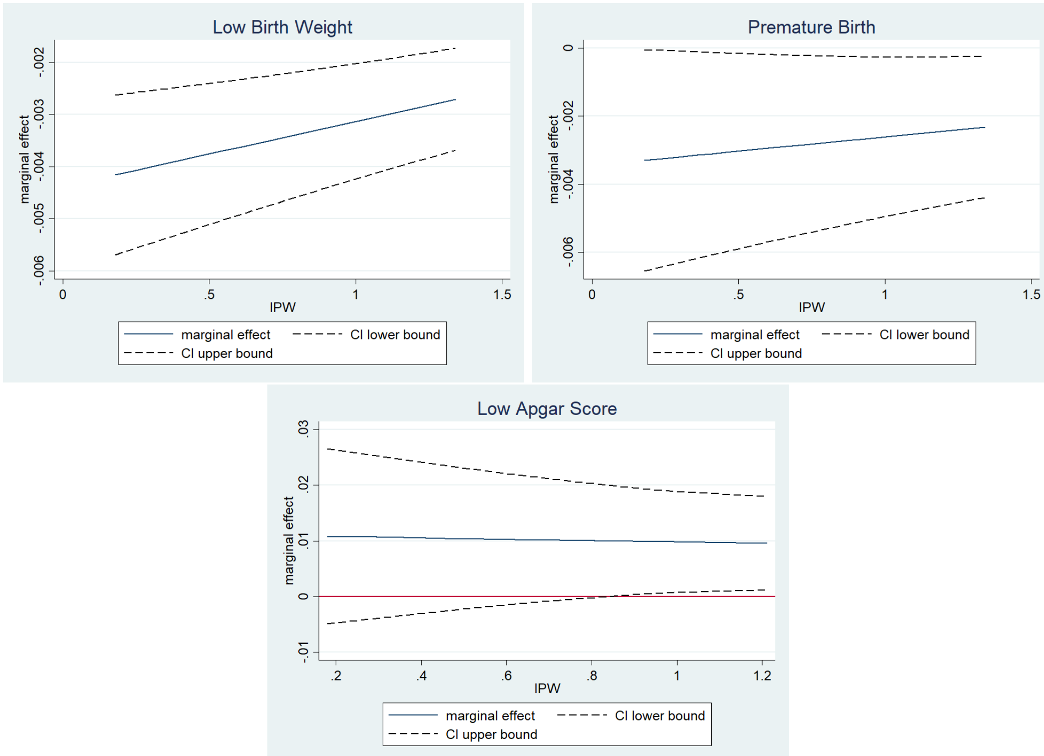
To conclude, the estimation results suggest exposure to Chinese import competition improves the health outcomes of the newborns in almost all US counties. It is also found that other birth outcomes and infant mortality are unresponsive to the Chinese trade penetration. The empirical results thus suggest no evidence that higher exposure to Chinese import competition harms the health outcomes of newborns in the US; instead, the rise of Chinese imports improves newborn health In the US in terms of newborns' birth weight and gestational age. Moreover, the empirical evidence shows a larger impact of Chinese import competition on the birth outcomes of children with disadvantaged human capital endowment.

The positive effect of import competition on newborn birth weight and gestation might be explained by lower prices of goods important to prenatal health, the reduction in air pollution, and the a higher percentage of younger women of childbearing age. It is also possible that the positive labor market effect in non-import competing and trade-beneficiary sectors exceeds the negative effect on import-competing trade sectors. Therefore, the effect of Chinese import competition is positive on average.

4.2 Potential Mechanisms

In this section, I discuss three potential mechanisms through which exposure to Chinese import competition may have a positive impact on newborn health: reduction in air pollution, income effect from the availability of cheaper goods and increase in the share of young women giving birth.

Figure 3: Marginal Effects of IPW with Confidence Interval



4.2.1 Trade Exposure and Air Pollution

I start by analyzing whether the positive effect of exposure to Chinese import competition on newborn health is through the reduction in air pollution, since China's comparative advantage in labor-abundant manufacturing sectors may result in the closure of heavily polluted manufacturing plants in the US. Chintrakarn and Millimet (2006) and McAusland and Millimet (2016) find evidence of a beneficial impact of expanded trade on the environmental quality. Currie and Neidell (2005) and Chay and Greenstone (2005) find that the improvement in air quality reduces infant mortality.

I use the same empirical model in Section 2 to regress air pollution outcomes on the trade exposure variable IPW_{ct}. The regression results explain the effect of import competition from China on the air quality of differently exposed US counties. The air quality data is collected from the United States Environmental Protection Agency (EPA), which collects air quality data at outdoor monitors across the United States. The Air Quality Index Report (AQI) of the EPA displays annual summaries of AQI values in every county or city. I transfer the number of days in each AQI category into percentage forms because the total number of days under monitoring per year is not uniform across counties. I also study the effect of import per worker on the percentage of days when the AQI is attributed to criteria pollutants, such as PM2.5 and SO_2.

Table 3 shows the estimation results. The marginal effect of IPW_{ct} and IPW_{ct}^2 on the percentage of good days is positive when $IPW_{ct} < 2.7668$, which is true for nearly 98.8% of US counties in the data. The marginal effect of IPW_{ct} on the percentage of unhealthy days is negative when $IPW_{ct} < 3.4681$, and nearly 99.4% of US counties have an exposure level below 3.4681. The results suggest that IPW_{ct} improves air quality by increasing the percentage of days of good and decreasing the percentage of unhealthy days in AQI categories.

Table 3 also shows the effect of IPW_{ct} on air pollution attributed to each criteria pollutant. Three out of five toxic gaseous pollutants (CO, NO_2, and Ozone) are not significantly affected by the exposure to Chinese import competition. The particle pollution measured by PM2.5 in the US is reduced by trade shocks. The marginal effect of IPW_{ct} on PM2.5 is negative when $IPW_{ct} < 2.9928$, which is true for nearly 99% of US counties. However, the emission of SO_2 increases and the marginal effect of IPW_{ct} on SO_2 is positive for all US counties in the data. The negative effect of trade exposure on the criteria pollutant SO_2 may be canceled out by the reduction in other criteria pollutants. Therefore, we observe an overall positive effect of Chinese import competition on the percentage of days of good air quality.

Table 3: Trade Exposure and Air Pollution Condition

Pollution Outcomes	Good (Days)	Moderate	Unhealthy	Very Unhealthy	Hazardous
IPW_{ct}	0.0296**	-0.0165	-0.0051**	-0.0004	0.00002
	(0.0127)	(0.0106)	(0.0022)	(0.0012)	(0.00004)
IPW_{ct}^2	-0.0054**	0.0032	0.0007*	0.0001	-0.0000
	(0.0022)	(0.0018)	(0.0004)	(0.0002)	(0.0000)
Joint Significance	0.0442	0.2008	0.0685	0.6368	0.5713
First-stage F-test	0.0000	0.000	0.000	0.000	0.000
Test of Endogeneity	0.0000	0.0000	0.2300	0.8926	0.5214
	CO	NO_2	Ozone	SO_2	PM2.5
IPW_{ct}	0.0053	0.0095	-0.0180	0.0185	-0.0439**
	(0.0115)	(0.0102)	(0.0178)	(0.0121)	(0.0186)
IPW_{ct}^2	-0.0017	0.0005	0.0028	-0.0008	0.0073**
	(0.0020)	(0.0017)	(0.0030)	(0.0021)	(0.0032)
Joint Significance	0.4881	0.6092	0.5994	0.0216	0.0569
First-stage F-test	0.000	0.000	0.000	0.000	0.000
Test of Endogeneity	0.4129	0.0418	0.0076	0.5352	0.0000
Number of Obs.	4,820	4,820	4,820	4,820	4,820

Data Source: United States Environmental Protection Agency.
The results are from using fixed effect model and instrumental fixed effect model.
The US trade exposure variable IPW_{ct} is instrumented by the exposure to Chinese import competition of eight other high-income countries.
No other control variables are used in the estimation.
The table presents test results in p-value.
The regression is also weighted by the inverse of county population squared.
*** Indicates significant at the 1% level.
** Indicates significant at the 5% level.
* Indicates significant at the 10% level.

Since the import data is available at the industry level, the import competitive industries can be further categorized into ‘dirty’ (heavily polluted) and ‘clean’ (light polluted) industries. The industries are defined to be dirty if they belong to mining and quarrying, manufacturing, electricity, gas, steam and air conditioning supply, water supply, sewerage, waste management or remediation activities. I calculate the import per worker of dirty and clean industries, and then examine the effects of trade exposure of the two types of import competitive industries on newborn health separately. I find that the marginal effect of import per worker from heavily polluted industries on the percentage of low birth weight is negative for most of the US counties, however, import competition in clean industries, including the food sectors, increases the percentage of low birth weight.[6] The results suggest import competition from heavily polluted industries is more likely to improve the health outcomes of US newborns.

In summary, the empirical results suggest that air quality improvement is likely to be a mechanism that leads to a positive health impact of exposure to Chinese import competition on US children. This is despite a negative effect on the unemployment in the US labor market.

4.2.2 Trade Exposure and Access to Cheaper Goods

International trade is well-known to reduce prices for consumers and provide consumers a wide variety of goods and services. Thus, the rise of Chinese imports may affect the average birth outcomes of differently trade-exposed counties through the reduction in prices of goods and the improvement in the living conditions of local families. Since data on household consumption or food expenditure is hard to obtain for the study time period, I use the number of Walmart stores and supercenters in each county to proxy for accessibility of cheap goods. Courtemanche et al. (2015) suggest that being close to Walmart stores can help reduce food insecurity. The number of Walmart stores in each county, however, does not consider households who live near county borders and are closer to a Walmart store in a nearby county. Therefore, the estimation using the growth in the number of Walmart stores in each county may underestimate the effect of accessibility to cheap goods.

The locations of Walmart stores and supercenters across the US is obtained from the Remote Sensing Data, which is collected from the aerial photography and NASA satellite imagery.[7] The location data is further collapsed into county level and merged with the import data in Section 3.1. The empirical strategy follows the model in Section 2. The key explanatory variable is the import per worker, and the dependent variable is the growth in the number of Walmart stores and supercenters in each county.

Table 4 shows that exposure to Chinese import competition increases the growth of Walmart stores in more trade-exposed counties. The marginal effect of IPW_{ct} on the number of Walmart stores in each county

[6]The estimation results are shown in Appendix B.

[7]The data of location of Walmart and Target stores is ready in the project of Using GIS and Remote Sensing to Teach Geoscience in the 21st Century. https://serc.carleton.edu/NAGTWorkshops/gis/activities2/48030.html

Table 4: Trade Exposure and Number of Walmart Stores by County

	Number of Walmart Stores
IPW_{ct}	0.4579***
	(0.0764)
IPW_{ct}^2	-0.0596***
	(0.0002)
Joint Significance	0.0000
First-stage F-test	0.0000
Test of Endogeneity	0.0003
Number of Obs.	4,411

Data Source: Remote Sensing Data.
Note: The results are from using fixed effect model and instrumental fixed effect model.
The US trade exposure variable IPW_{ct} is instrumented by the exposure to Chinese import competition of eight other high-income countries.
No other control variables are used in the estimation.
The table presents test results in p-value.
The regression is also weighted by the inverse of county population squared.
*** Indicates significant at the 1% level.
** Indicates significant at the 5% level.
* Indicates significant at the 10% level.

is positive when $IPW_{ct} < 3.8388$. This fact suggests that almost all counties (99.5%) are below this trade exposure threshold. Therefore, Chinese import competition might improve newborn health through its effect on the prices of goods.

The increasing availability of cheap goods is more likely to have a greater impact on poorer families or poorer counties. Previous literature has shown that the increasing number of Walmart scores may reduce the poverty rate of US counties (Courtemanche et al., 2015). This study, thus focuses on the effects of import per worker interacting with county level poverty rates on the health outcomes of US newborns. Like the county-industry employment share defined in Section 3.1, the contemporaneous poverty rate might be endogenously affected by Chinese import competition; hence I use county level poverty rates in 1990 as the baseline poverty rates. The regression model is then given by

$$Y_{ct} = \alpha + \beta_1 IPW_{ct}^{u} + \beta_2 IPW_{ct}^{u^2} + \beta_3 IPW_{ct}^{u} \times poverty_c + \beta_4 IPW_{ct}^{u^2} \times poverty_c + \mathbf{X}_{ct}^{'}\beta + \lambda_c + \gamma_t + \varepsilon_{ct} \tag{3}$$

where $poverty_c$ is the poverty rate of each county in 1990, and $\mathbf{X}_{ct}$ contains all the control variables in Equation (2) and Table 2.

Table 5 shows the estimation results of Model (3). The marginal effect of import per worker on the health outcomes of newborns now depends not only on county level exposure to Chinese import competition, but also on county level poverty rates. For example, the marginal effect of import per worker on the percentage of newborns with low birth weight is given by

$$ME_{IPW} = 0.0028 - 2 \times 0.0001 IPW - 0.0651 poverty + 2 \times 0.0055 IPW \times poverty \tag{4}$$

Equation (4) shows that both the sign and the magnitude of the marginal effect of IPW_{ct} depend on IPW_{ct} and the poverty rate of each county. The marginal effect is more likely to be positive if a county with a higher poverty rate is more exposed to Chinese import competition. It is easier to show the marginal effect in a graph. Figure 3 presents the marginal effects of average import per worker on the percentage of newborns with low birth weight at different percentiles of poverty rates. It shows that the marginal effect of IPW_{ct} on the percentage of low birth weight is negative for most counties, and as the poverty rate increases from a lower percentile to a higher percentile, the negative effect becomes larger.

Table 5: Effect of IPW on Aggregate Birth Outcomes (2SLS) with Interaction with County Level Poverty Rate

Birth Outcome	Low Birth Weight	Overweight	Low Apgar Score	Premature	Mortality
IPW_{ct}	0.0028**	-0.0027***	-0.0253**	-0.0048*	0.0007***
	(0.0012)	(0.0006)	(0.0122)	(0.0027)	(0.0003)
IPW_{ct}^2	-0.0001	0.0008***	0.0248***	0.0031**	-0.0064
	(0.0006)	(0.0003)	(0.0064)	(0.0013)	(0.0002)
$IPW_{ct} \times poverty_c$	-0.0651***	0.0299***	0.3478***	0.0334	-0.0064**
	(0.0123)	(0.0055)	(0.0936)	(0.0264)	(0.0001)
$IPW_{ct}^2 \times poverty_c$	0.0055	-0.0081	-0.2268***	-0.0304**	-0.0014
	(0.0064)	(0.0029)	(0.0561)	(0.0138)	(0.0013)
Joint Significance	0.0000	0.0000	0.0156	0.0085	0.0000
First-stage F-test	0.0000	0.0000	0.0000	0.0000	0.0000
Test of Endogeneity	0.0000	0.0000	0.0118	0.0000	0.0000

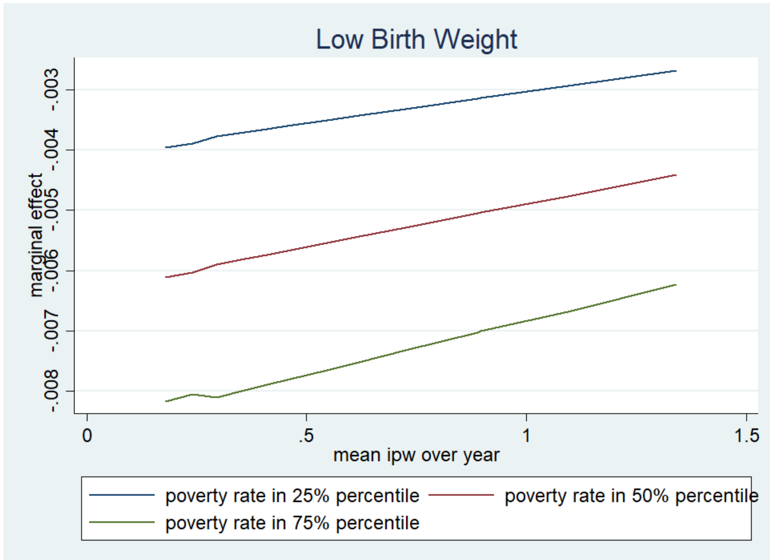
Note: The control set includes the county level average of mother's age at birth; the percentage of mothers with less than high school education, high school and college education; the percentage of married mothers; the percentage of mothers who are white, back and other race; ratio of male newborns by county.
The US trade exposure variable IPW_{ct} is instrumented by the exposure to Chinese import competition of eight other high-income countries.
The regression is also weighted by the inverse of county population squared.
The presented coefficients are rounded to 4 decimal digits. 0.000 does not mean null effect. The significance level is shown by the symbol of *.
The table presents test results in p-value.
*** Indicates significant at the 1% level.
** Indicates significant at the 5% level.
* Indicates significant at the 10% level.

I also examine the effect of exposure to Chinese import competition interacting with time-variant county level per capita income (in 10,000 dollars). Similarly, the regression model is given by

$$Y_{ct} = \alpha + \beta_1 IPW_{ct}^u + \beta_2 IPW_{ct}^{u^2} + \beta_3 IPW_{ct}^u \times pcinc_{ct} + \beta_4 IPW_{ct}^{u^2} \times pcinc_{ct} + \mathbf{X}_{ct}^{'}\beta + \lambda_c + \gamma_t + \varepsilon_{ct} \tag{5}$$

where $pcinc_{ct}$ is the per capita income of counties each year, and $\mathbf{X}_{ct}$ contains all the control variables in

Figure 4: Marginal Effects of IPW at Different Percentile of Poverty



Equation (2).

Table 6 shows the estimation results of Model (5). The marginal effect of import per worker on the percentage of newborns with low birth weight is now given by

$$ME_{IPW} = 0.0190 - 2 \times 0.0079 IPW - 0.0047 pcinc + 2 \times 0.0018 IPW \times pcinc \quad (6)$$

Note that the marginal effect of per capita income also depends on the level of trade exposure, so that

$$ME_{pcinc} = 0.0014 - 0.0047 IPW_{ct} + 2 \times 0.0018 IPW_{ct} \times pcinc_{ct} \quad (7)$$

The marginal effect of import per worker interacting with per capita income tells a similar story to the marginal effect of import per worker interacting with county level poverty rates, though the per capita income variable is time variant. Equation (6) shows that the sign of the marginal effect of import per worker depends on both the trade exposure and the per capita income of a county. Suppose that $1.2 \leq IPW \leq 1.36$, the first part of the marginal effect $0.019 - 2 \times 0.0079 IPW \leq 0$, and as $4.71 - 2 \times 1.76 IPW > 0$, the second part of Equation (6) is also negative. In this case, the marginal effect of IPW on the percentage of low birth weight is negative and it decreases as the per capita income increases. However, the trade exposure of only 3% of the studied counties is between 1.2 and 1.36. For the remaining 97% of counties whose import per worker is below 1.2 or above 1.36, the sign of the marginal effect is determined simultaneously by the interaction between county level trade exposure and per capita income.

Table 6: Effect of IPW on Aggregate Birth Outcomes (2SLS) with Interaction with County Level Per Capita Income

Birth Outcome	Low Birth Weight	Overweight	Low Apgar Score	Premature	Mortality
IPW_{ct}	0.0190***	-0.0002	0.0421*	0.0474***	0.0047***
	(0.0030)	(0.0008)	(0.0222)	(0.0065)	(0.0006)
IPW_{ct}^2	-0.0079***	0.0007	-0.0232***	-0.0118***	-0.0016***
	(0.0011)	(0.0002)	(0.0005)	(0.0023)	(0.0002)
$IPW_{ct} \times pcinc_{ct}$	-0.0047***	-0.0001	-0.0101*	-0.0118***	-0.0010***
	(0.0006)	(0.0003)	(0.0056)	(0.0013)	(0.0001)
$IPW_{ct}^2 \times pcinc_{ct}$	0.0018***	-0.0001	0.0065***	0.0028***	0.0003***
	(0.0002)	(0.0001)	(0.0022)	(0.0005)	(0.0000)
$pcinc_{ct}$	0.0014*	-0.0001	0.0187***	0.0068***	0.0007***
	(0.0007)	(0.0003)	(0.0056)	(0.0015)	(0.0002)
Joint Significance	0.0000	0.0207	0.0156	0.0000	0.0000
First-stage F-test	0.0000	0.0000	0.0000	0.0000	0.0000
Test of Endogeneity	0.0000	0.0000	0.0786	0.0000	0.0000

Note: The control set includes county level average mother's age at birth; percentage of mothers with less than high school, high school and college education; percentage of married mothers; percentage of mothers who are white, back and other race; ratio of male newborns by county.
The US trade exposure variable IPW_{ct} is instrumented by the exposure to Chinese import competition of eight other high-income countries.
The regression is also weighted by the inverse of county population squared.
The presented coefficients are rounded to 4 decimal digits, 0.000 does not mean null effect, the significance level is shown by the symbol of *.
The table presents test results in p-value.
*** Indicates significant at the 1% level.
** Indicates significant at the 5% level.
* Indicates significant at the 10% level.

4.2.3 Trade Exposure and Fertility

Autor et al. (2017) study the effect of trade shock from China on the marriage rate and the fertility rate of young US people. Following Autor et al. (2013), the marriage and fertility decisions of young US people are affected by the labor market impact of import competition. They show evidence that one unit import shock lowers births per thousand women aged between 20-39 by 4%. But this decline is not uniform across demographic groups. Fertility among younger (including teens) and unmarried women falls proportionately less than fertility among older and married women.

Though the increase in out-of-wedlock birth share may have a long-run adverse effect on child outcomes, the decline in the share of fertility among older women may result in an increase in average birth weight. Younger women are less likely to have premature or low-birth-weight babies than older women. This is because pregnancy is often physically easier for women in their 20s, and young women have a lower risk of having gynecological problems. As a result, Chinese trade penetration may potentially reduce the incidents of poor outcomes at birth by increasing the share of young women giving birth.

5 Conclusion

This paper uses an instrumental variable fixed effect model to examine the causal effect of an increasing exposure to Chinese import competition on newborn health in the US. Despite the strong evidence that US exposure to Chinese imports has negative impacts on labor market outcomes and adult health, I find no evidence of adverse effects on newborn health or infant mortality. In fact, there is evidence of a reduction in the incidence of low birth weight and premature birth.

This paper investigate three potential mechanisms through which trade shock from China may positively affect the birth outcomes of US children. I find that exposure to Chinese import competition improves the average air quality of more trade-exposed US counties, and the benefit of trade on air quality may lead to an improvement in newborn health. The empirical evidence also shows that the reduction in prices of goods induced by the rise of Chinese imports is another mechanism that may drive down the incidence of adverse birth outcomes. Moreover, Chinese import competition has a larger impact on the average birth outcomes of a US county that has a higher poverty rate or a lower level of per-capita income. Finally, previous studies have shown that exposure to Chinese import competition reduces the fertility rate of US young couples while increasing the share of young women giving birth. Hence, early childbearing improves the average birth outcomes of US children.

In conclusion, this paper makes a contribution to the existing literature by suggesting the benefits of free trade on newborn health, and provides detailed analysis on the mechanisms through which trade shocks might affect the health outcomes of young children.

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Appendix A

Heterogeneous Effect of IPW on Newborn Health

Table A1: Effect of IPW on aggregate birth outcomes of children with higher educated mothers

Birth Outcome	Low Birth Weight	Overweight	Low Apgar Score	Premature
IPW_{ct}	-0.0119***	-0.0018***	0.0480***	-0.0171***
	(0.0011)	(0.0005)	(0.0113)	(0.0018)
IPW_{ct}^2	0.0019***	0.0003***	-0.0082***	0.0023***
	(0.0002)	(0.0001)	(0.0030)	(0.0003)
First-stage F-test (p-value)	0.0000	0.0023	0.0000	0.0000
Test of Endogeneity (p-value)	0.0000	0.6772	0.0000	0.0636

Note: Same as Table 2.
Higher educated mothers are defined as mothers with a college or above degree.
*** Indicates significant at the 1% level.

Table A2: Effect of IPW on aggregate birth outcomes of children with high school education level mothers

Birth Outcome	Low Birth Weight	Overweight	Low Apgar Score	Premature
IPW_{ct}	-0.0035***	-0.0001	0.0068	0.0015
	(0.0010)	(0.0005)	(0.0122)	(0.0021)
IPW_{ct}	-0.0000***	0.0001	-0.0014	-0.0007
	(0.0002)	(0.0001)	(0.0041)	(0.0005)
First-stage F-test (p-value)	0.0000	0.0067	0.0012	0.1694
Test of Endogeneity (p-value)	0.0000	0.0188	0.7686	0.0010

Note: Same as Table A1.

Table A3: Effect of IPW on aggregate birth outcomes of children with lower educated mothers

Birth Outcome	Low Birth Weight	Overweight	Low Apgar Score	Premature
IPW_{ct}	-0.0037***	-0.0003	-0.0145	-0.0020
	(0.0012)	(0.0005)	(0.0315)	(0.0024)
IPW_{ct}	0.0007***	-0.0002	-0.0089	0.0004
	(0.0003)	(0.0001)	(0.0105)	(0.0005)
First-stage F-test (p-value)	0.0093	0.0008	0.0005	0.7186
Test of Endogeneity (p-value)	0.0000	0.0000	0.0399	0.0000

Note: Same as Table A1.

Appendix B

Effect of IPW of Industries with Different Pollution Intensity

Table B1: Effect of IPW of Dirty Industries

Birth Outcome	Low Birth Weight	Overweight	Low Apgar Score	Premature	Mortality
IPW_{ct}	-.0045***	0.00004	0.0123	-0.0036*	-0.0001
	(0.0009)	(0.0004)	(0.0094)	(0.0019)	(0.0002)
IPW_{ct}^2	0.0006***	0.00005	-0.0008	0.0005	0.0000
	(0.0002)	(0.0001)	(0.0029)	(0.0004)	(0.0000)
Joint Significance	0.0000	0.2065	0.0149	0.0696	0.3092
First-stage F-test	0.0000	0.0000	0.0000	0.0000	0.0000
Test of Endogeneity	0.0000	0.0000	0.0148	0.1862	0.0000

Note: The control set includes county level average mother's age at birth; percentage of mothers with less than high school, high school and college education; percentage of married mothers; percentage of mothers who are white, back and other race; ratio of male newborns by county.
The US trade exposure variable IPW_{ct} is instrumented by the exposure to Chinese import competition of eight other high-income countries.
The table presents test results in p-value.
The regression is also weighted by the inverse of county population squared.
*** Indicates significant at the 1% level.
** Indicates significant at the 5% level.
* Indicates significant at the 10% level.

Table B2: Effect of IPW of Clean Industries

Birth Outcome	Low Birth Weight	Overweight	Low Apgar Score	Premature	Mortality
IPW_{ct}	0.3841***	0.0933*	0.5906	-0.3909*	0.0603***
	(0.1101)	(0.0490)	(0.9390)	(0.2337)	(0.0219)
IPW_{ct}^2	-3.9141***	-0.6555	-3.3591	3.4543*	-0.4220**
	(0.9785)	(0.4363)	(0.0028)	(2.0769)	(0.1948)
Joint Significance	0.0002	0.1013	6987	0.2401	0.0080
First-stage F-test	0.0000	0.0000	0.0000	0.0000	0.0000
Test of Endogeneity	0.0511	0.0002	0.9902	0.8806	0.3761

Note: Same as Table B1.