Sacred Cows: The Impact of Slaughter Bans on Neonatal Mortality in India*

Min Kyong Kim†
Iowa State University

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Abstract

Nutritional intake during pregnancy, especially protein and iron found abundantly in beef, strongly affects babies' birth outcomes and survival. While most upper-caste Hindus in India traditionally eschew beef consumption, minority groups such as Muslims, Christians, and Dalits, also often poor, do not. Recently, many Indian states in secular India, especially those governed by the Hindu-nationalist BJP party, have passed laws promoting the protection of cows, effectively making beef unavailable. In this paper, I study the impact of such laws on neonatal mortality using cattle-slaughter and beef bans as a natural experiment. Using a difference-in-differences design, I find neonatal mortality increases by five per 1,000 live births among beef consumers suggesting India's cattle-slaughter bans intended to promote bovine welfare have deleterious collateral consequences on humans.

Key words: Neonatal mortality, Cattle slaughter ban, Caste, Nutrition, India
JEL Classification: O15, I15

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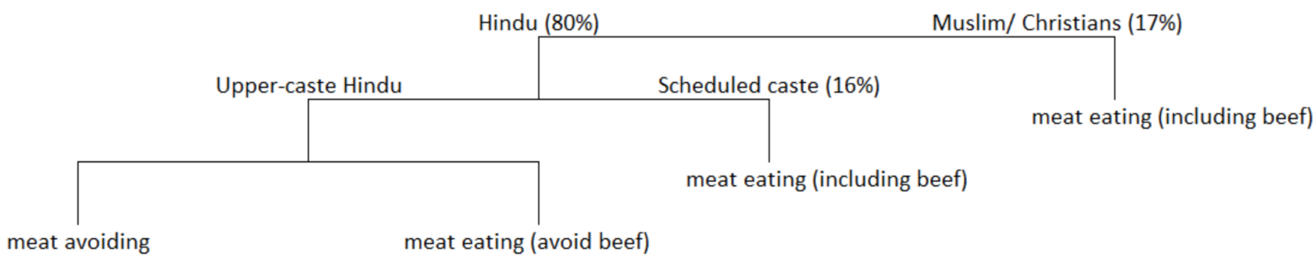
†Department of Economics, Iowa State University, Ames IA 50011-1054, USA. E-mail: mkkim@iastate.edu

1 Introduction

The end of Britain's colonial rule in India, in 1947, was accompanied by the separation of Hindu-majority India from Muslim-majority Pakistan. Since 1950, India has been a secular country where the freedom of religion is constitutionally guaranteed. According to the 2011 census, the vast majority (80%) of its population practices Hinduism, roughly 15% (170 million people) practice Islam, and 2.5% (28 million people) are Christians. Around 30% of Indians identify themselves as members of the General Category castes, a broad grouping at the top of India's caste system. The rest (68%) are outside this General Category group, including 34% who are members of either Scheduled Castes (SCs) or Scheduled Tribes (STs) and 35% who are members of Other Backward Classes (OBCs). Religion and caste have strong influences on diet in India – see Figure 1. About 40% of Indian adults say they are vegetarian. Less than 10% of Muslims and Christians are vegetarians (Sahgal et al., 2021)[1]. Non-vegetarians restrict meat in their diet in some way, either by abstaining from eating certain meats, by abstaining from eating meat on certain days, or both. Most upper-caste Hindus (castes other than Scheduled Castes) are vegetarians or avoid eating beef but some do consume chicken or goat. Dalits (members of Scheduled Castes, formerly known as untouchables) and minority religious groups consume beef in their regular diet presumably because it is the least expensive meat (Parikh and Miller, 2019; Sathyamala, 2019)[2].

Figure 1: Population composition in India



Since Independence, and assuredly so in recent years, the unfettered access to beef for consumption has been under attack in many Indian states. The trade and consumption of beef have become a particularly contentious issue ever since the Hindu-nationalist BJP party came into power in 2014. BJP-led governments have repeatedly pushed the idea that cows are sacred and therefore need to be protected; they have used this idea to try and prohibit the slaughter of cattle across the country. Following the Directive Principles of State Policy under the Indian Constitution, each state can protect bovine animals by legislating prohibition of cattle slaughter and restrictions on beef sales or possession[3]. Currently, there

[1]Because of the hegemony of vegetarianism and the stigmatization of beef, Natrajan and Jacob (2018) show that surveys tend to overestimate vegetarianism and underestimate beef consumption.

[2]In 2011-2012, the average price of buffalo meat was Rs 130-150/kg, compared to Rs 380/kg for mutton, Rs 200-500/kg for fish, and Rs 180/kg for chicken in the Indian domestic market (Federation of Indian Chamber of Commerce and Industry, 2014). Despite a minor increase in 2009, the overall trend in beef prices has been downward in inflation-adjusted terms since mid-2000 (Landes, Melton, and Edwards, 2016).

[3]The laws relevant to cattle slaughter in each state widely vary, in terms of when they were enacted, to what extent they protect (cow, bull, bullock, buffalo), and the penalties they charge. For example, some states like Meghalaya do not have any restrictions on cattle slaughter while other states like West Bengal allows cow slaughter with a "fit-for-slaughter" certificate when

are active bans in over eighteen states. Such bans do not directly affect upper-caste Hindus since they do not consume beef anyway. However, it clearly affects Muslims and other beef-eating minorities: the size of the affected population is over 200 million.

Importance of beef in gestational nutritional intake As discussed above, beef-eating communities in India are minorities and often poor and therefore more likely to be malnourished anyway. Cattle-slaughter bans act as negative nutritional shocks by severely curtailing beef availability and thereby reducing beef consumption. Because the nutritional intake of a pregnant woman is linked to her baby's birth outcome (Rasmussen and Yaktine, 2009), inadequate maternal nutrition contributes to poor fetal development, low birth weight (Ramakrishnan, 2004; Ludwig and Currie, 2010) and increased risk of preterm birth (Rutstein, 2005). Low birth-weight babies are less likely to survive early infancy (Almond, Chay, and Lee, 2005). Low gestational weight gain, typically used as a proxy for poor nutritional intake during pregnancy, is associated with increased infant mortality; the risk increases even more when the mother is underweight before pregnancy. Beef is an excellent source of inexpensive protein; it is also an easily accessible source of iron[4], which is essential during physical growth more so during pregnancy[5]. Iron is crucial in pregnancy for maternal health and fetal growth and development (Chang et al., 2013). Previous studies document that maternal iron deficiency is a risk factor of preterm delivery, subsequent low birth weight, and inferior neonatal health (Allen, 2000; Juul, Derman, and Auerbach, 2019; Quezadaâpinedo et al., 2021). The upshot is that cattle-slaughter bans, by limiting access to beef, may cause adverse birth outcomes due to reduced protein and iron intake by pregnant women from beef-consuming communities.

Conceptual framework In this paper, I study the impact of these cattle slaughter bans on a measure of health: neonatal mortality, or death in the first month of life. The main channel of causality is as follows.

$$\text{Ban} \rightarrow \text{Beef consumption} \downarrow \rightarrow \text{Nutritional intake of beef-eating pregnant women} \downarrow \rightarrow \quad \text{Neonatal mortality} \uparrow$$

I develop a simple conceptual framework to help discipline the exercise and predict the differential birth outcomes of upper-caste Hindus and beef-eating pregnant women. The framework is based on a pregnant woman's utility function that values the source of her protein intake and its effect on her health which, in turn, is assumed to influence the expected health of her baby. To capture differential preferences over the source of protein (many upper-caste Hindu women do not want to get their protein from animal sources, much less beef), I allow for religious identity-based preferences. A woman choose her optimal protein consumption, noting the price and her natural likes and dislikes for a type of protein, and knowing her preferred protein may not be the cheapest or the best for the fetus. My partial equilib-

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the cow is unproductive. In Gujarat, protection applies to cows, bulls, and bullocks, but it does not extend to buffaloes, whereas Chhattisgarh prohibits the slaughter of all kind of bovine animals Punishment for cow slaughter also varies significantly across states ranging from Rs 1,000 (USD 13) to Rs 50,000 (USD 670) (Sarkar and Sarkar, 2016). In addition to animal slaughter, some states ban sales or possession of beef. For example, the Gujarat animal preservation act enacted in 2011 prohibits selling, keeping, or storing beef, and the penalties extended to three years of imprisonment or twenty-five thousand rupees of fine.

[4] Heme-iron, which is abundant in beef and found in animal flesh, is better absorbed by the body than non-heme iron, found mostly in plants. Lombardi-Boccia, Martinez-Dominguez, and Aguzzi (2002) documented that 100g of cooked beef contains, on average, 3.39 mg of iron while chicken contains 1.01mg of iron. However, cooked heme-iron in chicken and beef is 0.28mg, 2.63mg per 100g of meat, respectively.

[5] Adult women need 18mg, pregnant women 27mg, men and old women over 51 years 8mg of iron daily.

rium model assumes a cattle-slaughter ban whose impact is assumed to show up in a higher price for beef. I show that ceteris paribus, beef-eating women reduce their beef consumption following the ban, negatively impacting their newborn's projected health. There is no such direct effect for those who do not eat beef.

Data I use individual-level data from four rounds of India's National Family Health Survey (NFHS), a nationally representative survey that collects data from women aged 15-49 focusing on fertility, maternal and child health, and mortality. Respondents report their religion and whether they belong to a scheduled caste. Since the data does not include information on whether the respondent eats beef, I classify all Muslims, Christians, and Scheduled Caste Hindus as beef consumers.

Identification strategy I employ a difference-in-differences approach to provide evidence of a causal link between cattle slaughter bans and neonatal mortality. The cattle slaughter ban is an ideal exogenous policy shock because it was enacted to protect cows and yet, unintentionally, it affects human health.[6] Disciplined by my conceptual framework, I assign beef-eaters (Muslims, Christians, and Scheduled Caste) to the treatment group and upper-caste Hindus, those who do not consume beef, to a control group. I establish a parallel trend in neonatal mortality between Hindus and beef-eaters near the time of treatment and exploit the difference in neonatal mortality of the two groups *living in the same state* after the ban was enacted. This allows me to control for confounding variables, such as health care availability or endemic diseases, common to all women residing in the same state. To take care of generally declining downward trends in child mortality due to, say, improved sanitation facilities or better public health, I introduce a fixed effect for the year of birth.Given India's massive size (28 states and 8 union territories), there is a possibility that the innate heterogeneity across states (language, culture, food, climate, and so on) invalidates my identification strategy. To that end, I document similarity in the mortality trends in never-treated and always-treated states. Due to the staggered timing of the treatment, my estimate may be biased (Callaway and Sant'Anna, 2020; Goodman-Bacon, 2021; Sun and Abraham, 2020). To establish the reliability of my findings, I use an event-study design to demonstrate that my conclusion remains valid. I also control for many demographic and socioeconomic covariates, such as maternal years of education, the month of birth, sex of the child, possession of latrine, and the share of households that openly defecate in the primary sampling unit.

Main results My paper provides evidence that India's cattle slaughter bans causally raised neonatal mortality among its beef-eating communities (relative to those in the control group) by five per 1,000 live births. It bears emphasis that my result does not speak to the effect of these bans on the *level* of neonatal mortality among beef-eaters. Rather, I show that the differential mortality between the treatment and control groups went up by five per 1,000 births because the bans were instituted.

Institutional delivery is frequently recommended by medical professionals as a way to reduce the likelihood of newborn death. By the same token, pregnant women are often urged to take iron supplements. My result will be invalidated if health care access and utilization or advice about iron supplements in India varies according to religion or socioeconomic status. My data allows me to estab-

[6] Pawan Pandit, the founder of the Bhartiya Gau Raksha Dal (BGRD), a vigilante group of cow protectors said in a 2016 interview: "We are not anti-Muslim or anti-Dalit. We are a fraternity which wants to save the cow, because she is our mother... because that is what my religion, my parents, my holy book, taught me."

lish parallel trends in institutional birth, prenatal care visits, and iron supplement consumption among upper-caste Hindus and beef eaters implying these factors are not tainting my result.

In India, religious minorities such as Muslims or Christians, often lead very different, sometime segregated, lives from those of upper-caste Hindus. This means there is the concern that some fundamental, omitted difference between the groups is driving the effects. To check for that, I employ a difference-in-difference estimation to compare the change of neonatal mortality in states which implemented a cattle-slaughter ban to states that did not using only the data from beef-eaters. I find neonatal mortality was higher by four per 1,000 live births in states with the ban. I also run a placebo test and find that the bans increased neonatal mortality of upper-caste Hindus by 1.6 per 1,000 live births. Although the impact on upper-caste Hindus is smaller than that of beef-eating communities, the ban unintentionally harmed non-beef-eaters as well.

The plan for the remainder of the paper is as follows. Section 2 provides literature review. Section 3 presents the conceptual framework exploring how cattle slaughter ban affects health differently based on the identity. Section 4 explains data, the legislation of cattle slaughter ban by state and the National Family Health Survey (NFHS). Section 5 presents the identification strategy, difference-in-differences and event study design. Section 6, I present regression results while Section 7 includes robustness check including placebo test. Section 8 concludes.

2 Literature

My paper touches on three strands of the literature. First, it adds to our understanding of puzzling differences within India in health or nutrition among demographic groups (Deaton and Drèze, 2009; Tarozzi, 2008; Jayachandran and Pande, 2017). Bhalotra, Valente, and Soest (2010) coined the term "Indian Puzzle" for the phenomenon that Muslim children in India are more likely (17%, 19%) to survive to their first birthday (first month) than Hindu children despite their inferior socioeconomic status. The authors found more than two-thirds of the Muslims' survival advantage shows up in neonatal mortality. The first month of birth is also the period that makes a noticeable difference in this paper. My results suggest that the Muslim survival advantage may be fast eroding, now that the bans have become entrenched.

More broadly, this paper contributes to the literature on early life shocks and interventions (Almond and Currie, 2011b; Almond and Currie, 2011a; Bharadwaj, Løken, and Neilson, 2013; Chay and Greenstone, 2003). The fetal origin hypothesis argues that adverse shocks such as nutrient deprivation experienced in utero can significantly impact health outcomes. Royer (2009) uses birth weight as a proxy for fetal nutrient intake, and finds that lower birth weight increases the probability of infant mortality and decreases educational attainment. His study suggests that nutritional shocks experienced in utero have a long-lasting effect on an individual's health and economic outcome. Lindeboom, Portrait, and Berg (2010) document exposure to a nutritional shock at birth reduces the probability of survival at older ages. They find that people who experienced the Dutch Potato famine at birth had a lower life expectancy.

Scholte, Berg, and Lindeboom (2015) further analyze the same event to find that in-utero exposure to famine affects labor market outcomes.

Since the cattle slaughter ban affects neonatal mortality through maternal nutritional intake, the current study adds to the literature on the association of maternal nutrition and children's health. In India, a later-born sibling has a steep survival advantage, the opposite of the pattern observed in developed countries. Coffey and Spears (2021) attribute this unique pattern to maternal undernutrition. While being underweight is common among young Indian women, they are less likely to be underweight as they gain social status over their childbearing careers. This implies that the mother had better nutritional intake while bearing the later-born sibling, which is connected to better survival in the first month of life. Lee et al. (2016) argue that rising food prices compromise maternal and child nutrition by reducing dietary quality thereby increasing infant and child mortality in developing countries. Their study emphasizes that food insecurity – lack of access to a sufficient amount of nutritious food for normal growth and development – may lead to a rise in infant mortality.

Despite the significant impact of cattle slaughter bans on health, most of the prior literature discusses only the economic impact side of the ban (Khan, 2016). This is the first paper to assess the impact of these bans on mortality outcomes. To the best of my knowledge, Majid, Hakim, and Aparajita (2019) is the sole paper studying health impacts of bans. They find that women who lived through cow-slaughter bans in utero face a higher likelihood of being anemic as adults.

3 Conceptual Framework

Model is based on a maternal utility function $U(\cdot)$ during pregnancy. I assume mothers derive utility from an anticipated child's health (H) and food they consume, beef (b), goat or chicken (g), and vegetables (v). The mother with j dietary habit and income Y_i faces the utility maximization problem

$$\begin{aligned} &max\, U\left(H_{ij}, b_{ij}, g_{ij}, v_{ij}\right), \quad j \in \{B, NV, VH\} \\ &s.t.\; H_{ij} = \alpha_1 b_{ij} + \alpha_2 g_{ij} + v_{ij} \\ &\quad Y_{ij} = p_b b_{ij} + p_g g_{ij} + p_v v_{ij} \\ &\quad \alpha_1 > \alpha_2 > 1 \end{aligned}$$

Anticipated child health (H) is a function of the protein the mother consumes, and each source of protein has a different contribution to health. This question is interesting because women care about the children's health and the inputs of the health function based on their identity. There are three types of women: 1) beef-eaters (B) who do not constrain their diet, so they derive utility from all sources of protein -Muslims, Christians, and Scheduled Caste (Dalits) belong to this group-, 2) non-vegetarian Hindus (NV) do not consume beef but consume goat, chicken, and vegetables, 3) vegetarian Hindus (VH) consume only vegetables. I normalize the contribution of vegetables as one and assume the contribution of beef and goat/chicken is α_1 and α_2 , respectively. Further, I assume the contribution of beef on health (α_1) is greater than that of goat/chicken (α_2), i.e. $\alpha_1 > \alpha_2 > 1$, reflecting the contribution of other micronutrients that are richly found in beef. All women are subject to the budget constraint, and income is exogenously given. The sum of expense on beef, goat, and vegetables equals the income Y_{ij}. If each food has the same effect on health and mothers do not care about the source of protein, consuming only the cheapest food is optimal. Assume the utility function is separable and quasi-linear in H, therefore, $u''(H) = 0$.

I will describe the utility maximization problem in the following order: vegetarian Hindu, non-vegetarian Hindu, and beef consumers.

Vegetarian Hindu

Vegetarian Hindus do not derive utility from eating beef (b) and goat $\left(g\right)$, so they consume only vegetables (v) and the anticipated health (H) is a function of vegetables (v).

$$\begin{aligned}
max\, U(H_{iVH}, v_{iVH}) &= u(H_{iVH}) + u(v_{iVH}) \\
s.t.\, H_{iVH} &= v_{iVH} \\
Y_{iVH} &= p_v v_{iVH} \\
v^*_{iVH} &= \frac{Y_{iVH}}{p_v}
\end{aligned}$$

Since they do not consume beer or goat, their optimal consumption is to spend all their income on vegetables, and their reduced-form anticipated health function is

$$H^*_{iVH} = H^*_{VH}\left(p_v, Y_{iVH}\right)$$

It shows vegetarian Hindus choose invest in the anticipated health conditional on vegetable price and exogenous income.

Non-vegetarian Hindu

Non-vegetarian Hindus eat goat $\left(g\right)$ and vegetables (v), so the anticipated child's health comes from these two foods.

$$\begin{aligned}
max\, U\left(H_{iNV}, g_{iNV}, v_{iNV}\right) &= u(H_{iNV}) + u\left(g_{iNV}\right) + u(v_{iNV}) \\
s.t.\, H_{iNV} &= \alpha_2 g_{iNV} + v_{iNV} \\
Y_{iNV} &= p_g g_{iNV} + p_v v_{iNV} \\
\alpha_2 &> 1
\end{aligned}$$

From the above utility maximization problem, I can yield the following first order condition

$$u'\left(g_{iNV}^{*}\right)+\alpha_{2}u'\left(H_{iNV}^{*}\right)=u'\left(v_{iNV}^{*}\right)\frac{p_{g}}{p_{v}}+u'\left(H_{iNV}^{*}\right)\frac{p_{g}}{p_{v}}$$

The marginal benefit from consuming an additional unit of goat comes through two channels: 1) direct utility that comes from consuming goat $\left(u'\left(g_{iNV}^{*}\right)\right)$, 2) additional protein intake increases the anticipated health of the newborn and the mother derives utility from it $\left(\alpha_{2}u'\left(H_{iNV}^{*}\right)\right)$. The marginal cost also comes through two channels, the utility forgone from the vegetables that she gave up to consume an additional unit of goat $\left(u'\left(v_{iNV}^{*}\right)\frac{p_{g}}{p_{v}}\right)$ and its contribution to health $\left(u'\left(H_{iNV}^{*}\right)\frac{p_{g}}{p_{v}}\right)$. The reduced-form anticipated health function is

$$H_{iNV}^{*}=H_{NV}^{*}\left(p_{g},p_{v},Y_{iNV},\alpha_{2}\right)$$

Non-vegetarian Hindus choose the anticipated health based on price of goat, vegetables, income.

Beef consumers

Beef-eaters do not have any restrictions on their diet, so they derive utility from consuming beef (b), goat (g), and vegetables (v). The utility maximization problem of beef consumers is

$$\begin{aligned}
&max\,U\left(H_{iB},b_{iB},g_{iB},v_{iB}\right)\\
&s.t.\;H_{iB}=\alpha_{1}b_{iB}+\alpha_{2}g_{iB}+v_{iB}\\
&\quad Y_{iB}=p_{b}b_{iB}+p_{g}g_{iB}+p_{v}v_{iB}\\
&\quad \alpha_{1}>\alpha_{2}>1
\end{aligned}$$

Replacing the constraints into the utility function yields the following form

$$\begin{aligned}
U\left(H_{iB},b_{iB},g_{iB},v_{iB}\right)=&u\left(H_{iB}\right)+u\left(b_{iB}\right)+u\left(g_{iB}\right)+u\left(v_{iB}\right)\\
=&u\left(\alpha_{1}b_{iB}+\alpha_{2}g_{iB}+\frac{Y_{iB}-p_{b}b_{iB}-p_{g}g_{iB}}{p_{v}}\right)\\
&+u\left(b_{iB}\right)+u\left(g_{iB}\right)+u\left(\frac{Y_{iB}-p_{b}b_{iB}-p_{g}g_{iB}}{p_{v}}\right)
\end{aligned}$$

and the following first order conditions

$$\frac{\partial U}{\partial b}=u'\left(H_{iB}^{*}\right)\left(\alpha_{1}-\frac{p_{b}}{p_{v}}\right)+u'\left(b_{iB}^{*}\right)+u'\left(v_{iB}^{*}\right)\left(-\frac{p_{b}}{p_{v}}\right)=0$$
$$\frac{\partial U}{\partial g}=u'\left(H_{iB}^{*}\right)\left(\alpha_{2}-\frac{p_{g}}{p_{v}}\right)+u'\left(g_{iB}^{*}\right)+u'\left(v_{iB}^{*}\right)\left(-\frac{p_{g}}{p_{v}}\right)=0$$

The implication of the first order conditions is similar to the previous case. The marginal benefit of consuming an additional unit of beef comes from taste based marginal utility $\left(u'\left(b_{iB}^{*}\right)\right)$ and from marginal utility coming from the increase of the anticipated health of the baby $\left(\alpha_1 u'\left(H^*_{iB}\right)\right)$. The marginal cost of consuming an additional unit of beef comes from the forgone utility from food that had to be given up because of the budget constraint $\left(u'\left(v^*_{iB}\right)\frac{p_b}{p_v}\right)$ and the change in anticipated health caused by reduced vegetable consumption $\left(u'\left(H^*_{iB}\right)\frac{p_b}{p_v}\right)$. The optimal consumption of beef is determined when the marginal benefit equals the marginal cost. It applies similarly to the goat consumption. The reduced-form anticipated health function is

$$H^*_{iB} = H^*_B\left(p_b, p_g, p_v, Y_{iB}, \alpha_1, \alpha_2\right)$$

Their optimal anticipated health relies on the price of beef, goat, vegetables, and income.

Cattle slaughter ban

In this framework p_b increases when the cattle slaughter ban is enacted. The descriptions above show that Hindus' optimal investment on anticipated health, both for vegetarians and non-vegetarians, is not affected by the change in beef price $\left(p_b\right)$. However, it affects beef consumers to change their optimal consumption of food and consequently the anticipated health changes.

$$\begin{aligned}
\frac{\partial H^*_{NH}}{\partial p_b} &= 0 \\
\frac{\partial H^*_{VH}}{\partial p_b} &= 0 \\
\frac{\partial H^*_{B}}{\partial p_b} &= \frac{\partial H_B}{\partial b_B}\frac{\partial b_B}{\partial p_b} + \frac{\partial H_B}{\partial g_b}\frac{\partial g_b}{\partial p_b} + \frac{\partial H_B}{\partial v_B}\frac{\partial v_B}{\partial p_b} \\
&= \alpha_1 \frac{\partial b_{B},}{\partial p_b} + \alpha_2 \frac{\partial g_b}{\partial p_b} + \frac{\partial v_B}{\partial p_b}
\end{aligned}$$

4 Data

4.1 Cattle slaughter ban and beef ban legislation

The animal slaughter ban and beef ban[7] data were collected based on the legislation of India. The main source was the Department of animal husbandry and dairying of India[8]. I review the related Act between 1950 and 2015 of each State and fill in the details. The date it came into force is the date published in Government Gazette.

In this paper, I will consider the cow, bull, bullock slaughter ban and beef sales or possession ban. Hereafter, bull ban includes ban on bullock and bull slaughter because they are always imposed together. Beef ban means either beef sales ban or beef possession ban. The ban is coded to be effective from the month it became effective. If the State allows animal slaughter with a fit-for-slaughter certificate, it is treated as having no ban since it allows to supply the animal's flesh. Figure 3 plots the changes in the

[7] Beef ban includes ban on beef sales and beef possession.

[8] https://dahd.nic.in/hi/related-links/annex-ii-8-gist-state-legislations-cow-slaughter

cattle slaughter ban and beef ban by the State in 1980, 2000, 2010, and 2015[9][10]. It is noticeable that there is substantial variation across states and times.

The National Family Health Survey (NFHS) survey asks where they are residing at the time of the survey, but does not track the past places of residence. I assume respondents gave birth in the State they were living at the time of the survey[11]. In November 2000, three new states were created: Jharkhand split from Bihar on Nov 15, 2000, Chhattisgarh split from Madhya Pradesh on Nov 1, 2000, and Uttarakhand split from Uttar Pradesh on Nov 9, 2000. Households living in newly formed states at the time of the survey but who gave birth before 2000 were treated to have been born in the original State.

4.2 National Family Health Survey

I use data from four rounds of India's National Family Health Survey (NFHS) (Indian Demographic and Health Survey): 1992-93, 1998-99, 2005-06, and 2015-16. The NFHS is a nationally representative survey that collects data from women aged 15 to 49 focusing on fertility, reproductive health, maternal and child health, and mortality. Respondents self-report all birth histories, including the month and year of each birth. If the child is dead, they report the date of death. Using this information, I calculate the neonatal, infant, and child mortality rates. Respondents report their religion and whether they belong to a scheduled caste. Based on this information, I can classify a group of beef consumers; Muslims, Christians, and Scheduled Caste Hindus.[12](Sathyamala, 2019).

I exclude samples from states that had the cow, bull slaughter ban and beef ban before 1984[13], which is a year before my sample started. Table 2 presents the summary statistics for selected variables. Throughout the paper, the analysis is conducted at the level of live birth, constructing mortality rates from birth history information on around nine hundred thousand births in India over the four survey rounds. Due to the data availability, analysis related to anemia uses information on 165,961 alive children.

My outcome variables are neonatal mortality rate (NNM), infant mortality rate (IMR), and child mortality rate (CMR), defined as the number of deaths among children less than a month, one-year-old, five-year-old scaled per 1,000 live births, respectively. I also look at the postneonatal mortality rate (PNM), the number of newborns dying between 28 and 364 days of age. To test how the beef ban affects health, I add an analysis using child anemia status. This information is available only for children aged 6-59 months at the survey time and survey round on 2005-06 and 2015-16. The anemia status was measured by the level of hemoglobin concentration from a drop of blood obtained from by finger prick. Children were coded to be anemic if they belong to one of the following statuses: mild (10.0–10.9 g/dl), moderate (7.0–9.9 g/dl) and severe (<7.0 g/dl). It is an indicator of both nutrition and health that affects the

[9] During the 1980s only the state of Jammu and Kashmir legislated a new law on 1989, which is the only difference between the map of 1980 and 1990.

[10] The full list of the change is provided in the Appendix.

[11] Munshi and Rosenzweig (2009) documents spatial mobility in India is very low.

[12] To clean the data, I dropped households whose religion is Jewish, not specified, or no religion.

[13] The State of Chandigarh, Himachal Pradesh, Punjab are always treated. Analysis based on all samples without exclusion yields similar results except cow slaughter ban.

brain and physical growth of children. Anemia indicator is also scaled per 1,000 alive children aged 6-59 months.

On average, over the four survey rounds, neonatal mortality rate is slightly lower in the beef consumer group despite the lower socioeconomic status of Muslims, Christians, Scheduled Caste in India. This reflects the Indian puzzle that Muslims have a higher probability of surviving to their first birthday than Hindu infants, and it is related to open defecation (Bhalotra, Valente, and Soest, 2010; Geruso and Spears, 2018). Therefore, I control the latrine ownership and the share of people who openly defecate in their neighborhood using the primary sampling unit (PSU). Other socioeconomic variables such as maternal years of education, wealth[14], and the likelihood of residing in a rural area are higher in non-beef consumers.

5 Identification Strategy

The objective of this study is to estimate the impact of cattle slaughter ban on the neonatal mortality. I rely on two empirical models.

5.1 Difference-in-differences

In my main empirical analysis, I implement a difference-in-differences (DD) research design by comparing the neonatal mortality rate of babies from households who do not traditionally consume beef and children from beef-consumer groups residing in different states with varying degrees of beef ban policies. My main specification is

$$\begin{aligned} y_{ibst} &= \alpha + \delta Beef\,Consumer_{ib} + \beta Beef\,Ban_{st} \\ &\quad + \gamma Beef\,Ban_{st} \times Beef\,Consumer_{ib} + X'_{ibst}\psi + \lambda_t + \mu_s + \varepsilon_{ibst} \end{aligned} \tag{1}$$

where y_{ibst} is an individual-level mortality indicator for neonatal death. It is scaled to 1,000 so that coefficients reflect impacts on deaths per thousand. y_{ibst} is 0 if a child i from group b in state s born in year t survives to the relevant age of the indicator or 1,000 if dies before reaching that age. By inflating the binary indicator, the coefficient matches the standard expression rates per 1,000. $Beef\,Consumer_{ib}$ is equal to one if a child is from a family that belongs to a beef consumer group. $Beef\,Ban_{st}$ is a dummy variable that equals one if the child born in state s, year t experienced beef sales ban or possession ban in utero. Thus, it is equal to one for children who were born nine months later after the ban became effective. My coefficient of interest γ is the effect of the beef ban on mortality on the beef consumer group[15]. X' is a vector that includes a set of covariates including demographic and socioeconomic characteristics. The X vector consists of maternal years of education, month of birth, birth order, sex of the child,

[14]The wealth index is calculated using easy-to-collect data on a household's ownership of selected assets, such as televisions and bicycles, materials used for housing construction, and types of water access and sanitation facilities. These standardized scores are then used to create the breakpoints that define wealth quantiles as Lowest, Second, Middle, Fourth, and Highest.

[15]This estimation is a lower bound since the data contains live birth only. The ban could increase the probability of miscarriages through the low nutritional intake of the mother. In such case, the health cost of the ban is higher.

whether the child is a twin, urban indicator, possession of latrine, and share of households that openly defecate in the primary sampling unit. λ_t and μ_s is the year of birth fixed effect and state fixed effect, respectively.

I also estimate Eq.(1) replacing the beef ban with cow and bull slaughter ban. Cow or bull slaughter ban does not directly prohibit beef consumption but will affect newborns' health through price effect as shown in Section 3. I exclude always treated states, where the relevant ban existed before my sample's earliest year of birth. [16]

My identification assumption is that the trend of neonatal, infant, and child mortality of beef consumers and non-beef consumers is parallel, conditional on controls[17] in the absence of the beef ban or cattle slaughter ban. The parallel trend assumption is visually demonstrated in Figure 4, which plots the mortality rates by birth cohort and beef consumption group of treated and untreated states. In addition, Figure 2 plots the trend of neonatal and infant mortality near the treatment year in treated states. Time to treat, the horizontal axis, indicates the relative time to the treatment year. Before the ban enactment, the trend of neonatal and infant mortality is parallel, but after the ban enactment, mortality of the treatment group increases substantially. Furthermore, the existence of always treated states[18] and never treated states allows to do test additionally the parallel trend assumption. Figure 5 outlines the mortality trend of always treated and never treated states that follow a parallel trend.

Institutional delivery is typically suggested as a solution for neonatal death in developing countries. Health care utilization may be different by religion or socioeconomic status, or their perception may keep them away from visiting the health facilities before birth. In such cases, it will invalidate the parallel trend assumption. However, Figure A.1 and Figure A.2 suggest that institutional delivery and antenatal care visits increased in a parallel trend in both treatment and control groups[19]. In addition, Figure A.3 plots the trend of the likelihood of taking iron supplements during pregnancy of the beef consuming group and non-beef consuming group.

[16] Including all samples yields significant results except the cow slaughter ban. 20 states already had the cow slaughter ban before the 1980s and only three States have newly imposed cow slaughter ban within the sample period. Hence, pooling all groups compares the average change in mortality of the newly treated group to the average change in the untreated and already treated states.

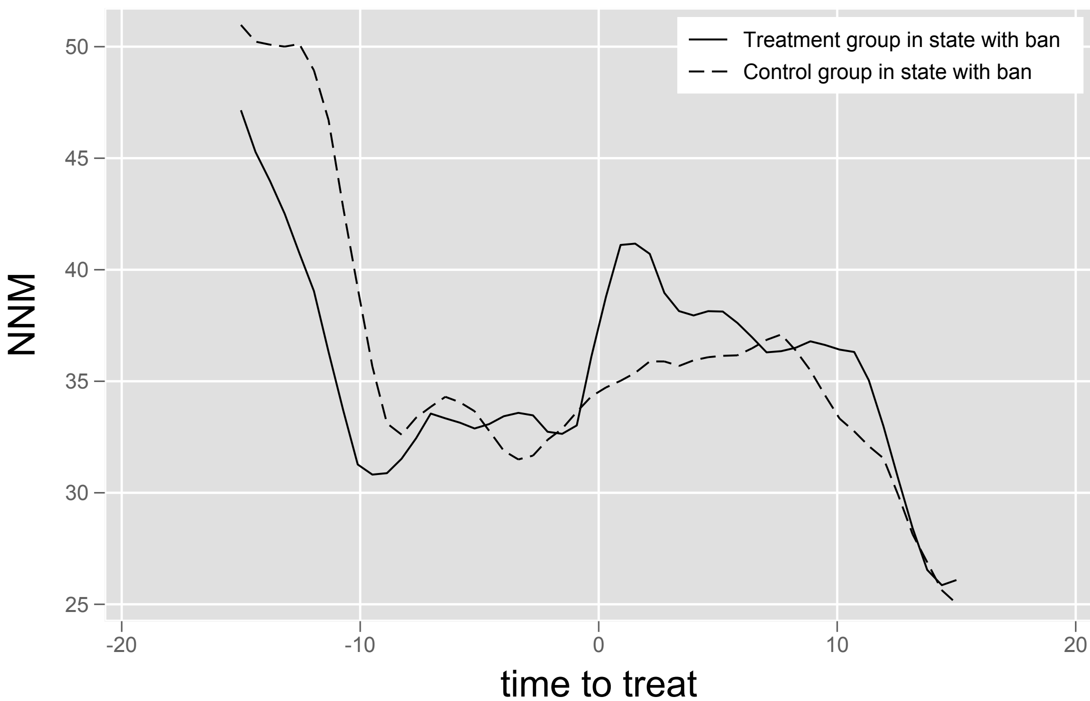
[17] It includes X vectors described in the previous paragraph. Maternal years of education, month of birth, birth order, sex of the child, whether the child is a twin, urban indicator, possession of latrine, and share of households that openly defecate in the primary sampling unit.

[18] States that had the cow, bull slaughter ban and beef ban before 1984.

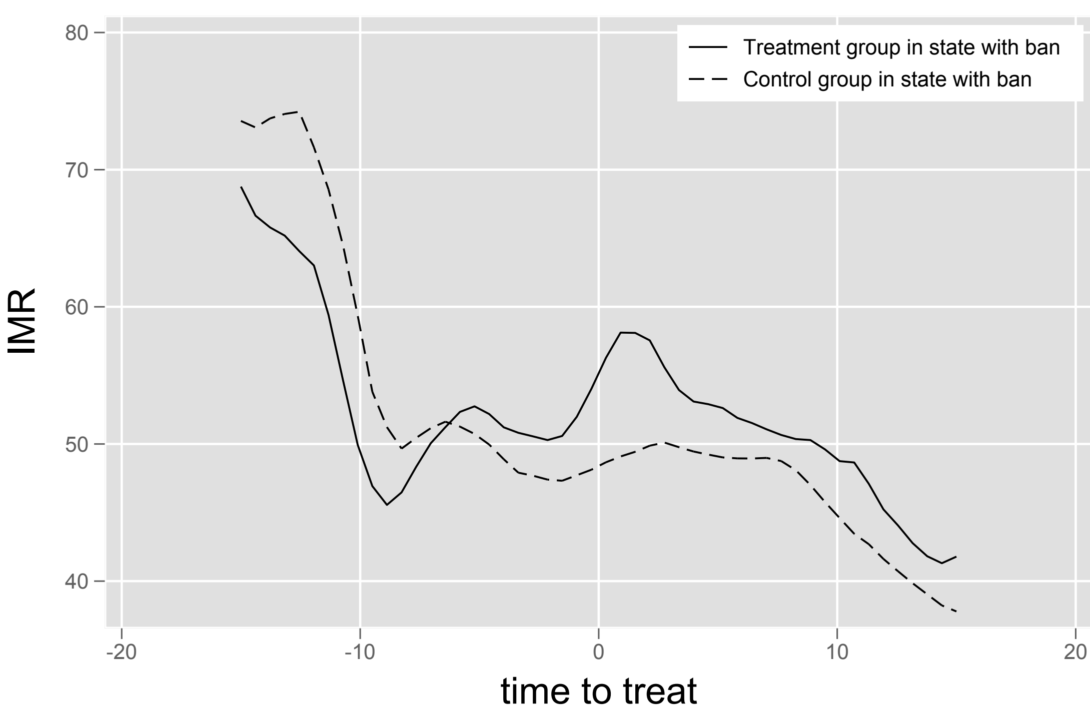
[19] The relevant information is available only for birth prior five years to the survey. The kink between 2006-2010 is because of lack of observable data.

Figure 2: Mortality trend of beef-consumers and non-beef-consumers in treaded states around the treatment time

(a) Neonatal mortality



(b) Infant mortality



The existence of different combinations of bans makes the evaluation of the policy challenging. An ideal setting would be that all states impose the same ban. However, there are three cases of the ban imposing sequence: 1) states that legislated cow, bull slaughter ban and beef ban simultaneously, 2) states had a cow slaughter ban and later imposed an additional ban on bull slaughter and beef sales or possession, 3) states had a cow slaughter ban and beef ban and then additionally imposed a bull slaughter ban. Thus, I analyze the increase when all possible bans are imposed from no ban or cow slaughter ban only[20]. All possible bans are defined to be a combination of cow, bull slaughter ban and beef ban, and henceforth referred to as the complete ban. States that had non-standard combinations were excluded[21] together with the always treated states.

5.2 Event study design

The canonical difference-in-differences (DD) takes 2×2 format; there are two time periods and two groups. No one is treated in the first period, and some units are treated while others are not in the second period. With the assumption that the average outcomes for treated and control groups would have followed a parallel trend over time in the absence of treatment, one can estimate the average treatment effect on the treated (ATT) by comparing the average change in outcomes experienced by the treated group to the average change in outcomes experienced by the comparison group. A variant of the canonical DD with multiple time periods and groups is the two-way fixed effect DD, the linear model with time fixed effect and unit fixed effect. However, there is a potential that the two-way fixed effect DD may be biased with multiple time periods and differential timing of treatment.

Recent econometric literature finds that the difference-in-differences estimator is an weighted average of all possible two-way fixed effect DD (TWFEDD) when treatment timing varies. Goodman-Bacon (2021) point out that common trends tend to absorb part of the effect of interest with staggered treatment, thus leading to attenuation bias. He also finds that units treated near the beginning of the end have more weights as controls than treatments, adding another source of bias.

When different states impose the ban at different times, there is variation in treatment timing. Denote G_t the group treated at time t and G_0 the never treated group. Possible comparisons are; 1) the treatment group is G_{t_1} and the control group is G_0, 2) the treatment group is G_{t_2} and control group is G_{t_3}, $t_2 < t_3$; compare the early treated group and not yet treated, 3) the treatment group is G_{t_3} and the control group is G_{t_1}, $t_1 < t_3$. The first two are fair comparisons but the last one has an additional source of bias because the early treated group is working as a control group. The weights of TWFEDD are proportional to group size at each time and the variance of the treatment dummy in each pair. To fix this problem, I estimate event studies using the method proposed by Sun and Abraham (2020). The specification is

$$y_{ibst} = \delta Beef\,Consumer_{ib} + \sum_{l} \beta_l \mathbf{1}\{t - E_s = l\} \times Beef\,Ban_{st} + X'_{ibst}\psi + \lambda_t + \mu_s + \varepsilon_{ibst} \tag{2}$$

where E_s is an year when state s imposes a complete ban as described above. Fixed effects and covariates

[20] States that had beef sales or possession ban prohibiting only cow flesh were considered not having beef ban before.

[21] The state of Bihar does not have a beef ban, but cow, bull, buffalo slaughter is prohibited; the State of Puducherry and Uttar Pradesh allow bull slaughter but bans beef sales, including the flesh of bulls and bullocks.

are defined in Eq.(1). The coefficients of interest are the β_l. First, they use the never-treated units as controls and estimate the group average treatment effect on the treated. Then, it re-weights the linear combination of treatment effects using the distribution of treatment groups and relative time indicators, l. The treatment group is the units sharing the same treatment year.

6 Results

6.1 Difference-in-differences

Table 3 presents OLS estimates for the effect of a beef ban on four different mortality rates. The beef ban includes a beef sales ban and a beef possession ban. Each Column includes different fixed effects on Eq.(1). Column (1) only includes a year of birth fixed effect, Column (2) adds State fixed effect, Column (3) adds other covariates as described in the previous Section, and finally Column (4) also includes wealth quantile information. Survey fixed effects were included in all estimates and standard errors were clustered by the primary sampling unit.

The OLS results suggest that beef ban increases neonatal death by 3.6 out of 1,000 live births of beef consumer groups. infant mortality and child mortality increase by 5.2 and 4.7, respectively. Post neonatal mortality increases by 1.6 - the difference between the estimates of IMR and NNM. Since PNM is the difference between IMR and NNM, the estimated effect also reflects this fact. These results imply that deaths due to the beef ban occur mostly within the first month of birth. This suggests that neonatal mortality increases due to the consequence of low intrauterine growth. Existing evidence suggests that fetal growth is most vulnerable to maternal dietary deficiencies in nutrients such as protein and micronutrients, both rich in beef, during pregnancy (Wu et al., 2004). Considering that mortality is an extreme outcome measure, it is possible that children who survived suffer from other health problems.

Table 4 reports the estimation result using bull and bullock slaughter ban. The bull slaughter ban increases the NNM by six in the beef-consuming communities and IMR and CMR increased by 7.7-7.8. Deaths caused by the bull slaughter ban are concentrated on the neonates. The bull slaughter ban[22] has a substantial effect because it restricts the supply of all kinds of cattle.

The details of the beef sales or possession ban vary by time and state. Most beef sales or possession ban co-enforced with cow slaughter ban but not with bull slaughter ban prohibits the sales or possession of cow flesh only. In other words, a beef ban without a bull slaughter ban allows the sales or possession of the flesh of bull or bullock. Under such circumstances, women have access to beef. The beef ban in the state of Puducherry and Uttar Pradesh is the only exception to this rule; it allows bull slaughter but prohibits sales of the flesh of cow, bull, and bullock. On the other hand, a beef ban accompanied by both cow and bull[23] slaughter ban prohibits the sales or possession of flesh of cow and bull, effectively making beef unavailable on the market. To make a clear comparison, I exclude the state of Chandigarh, Himachal Pradesh, and Punjab because they had the cow, bull slaughter ban, and beef ban before 1984. I also exclude the state of Bihar which does not restrict beef sales and possession but prohibits the slaughter of

[22] It includes bullock slaughter ban and it is always on top of cow slaughter ban.

[23] Includes bullock slaughter ban.

all bovine animals constraining the actual supply of beef.

Table 1: Effect of cattle slaughter ban and beef ban on mortality

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A	Neonatal mortality (NNM)				Infant mortality(IMR)			
Complete Ban	6.991***	-1.208	-1.664	-1.481	8.683***	-5.393***	-6.103***	-5.813***
	(0.742)	(1.187)	(1.160)	(1.160)	(0.895)	(1.506)	(1.458)	(1.457)
Beef Consumer	-4.600***	0.532	-0.307	-0.674	-3.565***	1.810**	-0.336	-0.934
	(0.603)	(0.669)	(0.661)	(0.662)	(0.758)	(0.815)	(0.798)	(0.798)
Complete Ban	4.951***	4.836***	5.539***	5.437***	4.652***	6.188***	7.238***	7.083***
x Beef Consumer	(1.152)	(1.239)	(1.226)	(1.226)	(1.380)	(1.469)	(1.447)	(1.446)
R-squared	0.002	0.005	0.020	0.020	0.004	0.008	0.024	0.024
Panel B	Child mortality (CMR)				Post neonatal mortality (PNM)			
Complete Ban	11.235***	-9.964***	-11.015***	-10.663***	1.691***	-4.185***	-4.438***	-4.332***
	(0.992)	(1.728)	(1.646)	(1.640)	(0.460)	(0.836)	(0.824)	(0.824)
Beef Consumer	-3.149***	3.037***	-0.124	-0.923	1.035**	1.278***	-0.029	-0.260
	(0.870)	(0.917)	(0.888)	(0.886)	(0.426)	(0.450)	(0.451)	(0.452)
Complete Ban	3.156**	6.326***	7.930***	7.811***	-0.300	1.352*	1.699**	1.646**
x Beef Consumer	(1.531)	(1.620)	(1.587)	(1.584)	(0.724)	(0.769)	(0.765)	(0.764)
R-squared	0.003	0.004	0.007	0.007	0.003	0.004	0.007	0.007
Observations	639,448	639,448	639,446	639,446	639,448	639,448	639,446	639,446
State Fe	N	Y	Y	Y	N	Y	Y	Y
Year of Birth FE	Y	Y	Y	Y	Y	Y	Y	Y
Controls	N	N	Y	Y	N	N	Y	Y
Wealth quantile	N	N	N	Y	N	N	N	Y

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

The results presented in this table test: "Does a complete ban generate worse mortality outcome for babies from beef consumer groups?" A complete ban indicates a combination of cow, bull slaughter ban and beef ban. The estimates colored in red indicates the change on mortality in beef consuming communities after the ban compared to non beef consumers.

Notes : The table reports results from OLS regression. The dependent variable in columns 1 through 4 in panel A is neonatal mortality (1 month). The dependent variable in columns 5 through 8 in panel A is infant mortality (1 year). The dependent variable in columns 1 through 4 in panel B is child mortality (5 years). The dependent variable in columns 5 through 8 in panel B is post neonatal mortality (1 month – 1 year). Mortality variables are scaled as described in the text to generate coefficients that indicate impacts on rates × 1,000 (deaths per 1,000 children). All regressions include survey round fixed effects. Controls include birth order indicators, indicators for child's birth month and birth year, an indicator for the child being a multiple birth, an urban indicator, sex of child, mother's education in years, indicator of ownership of latrine, as well as PSU-level means of open defecation. Observations are children (live births). Standard errors are clustered at the PSU level.
States that had cow, bull slaughter ban and beef sales or possession ban are excluded. Bihar, Puducherry and Uttar Pradesh are also excluded.

To evaluate the effect of beef availability, I compare neonatal mortality before and after a complete ban. The list of possible cases for ban legislation of untreated or not yet treated states is 1) no ban, 2) cow slaughter ban only, 3) cow slaughter ban and beef ban that limits cow flesh only. Table 1 presents the results. The enactment of a complete ban increases the NNM of beef consumers by 5.4 per every 1,000 live births. IMR and CMR increase by 7-7.8. Most deaths occur within the first month of birth where low intrauterine growth is a high-risk factor. It is noticeable that a complete ban has a lower effect than a bull slaughter ban. This is because the state of Uttar Pradesh and Puducherry are included in the control group in the analysis of the bull slaughter ban. Although these states only have a cow slaughter ban and beef ban, the law prohibits the sales of the flesh of bulls and bullocks.

Table 5 presents the results using the cow slaughter ban. The sample size reduces substantially because most states have the cow slaughter ban enacted before the 1980s, and I exclude the always-treated states. The size of the effect is relatively big because four states that newly implemented the ban within the sample period imposed a bull ban and beef ban at the same time. Including states treated before 1984 makes the result insignificant because these states act as control biasing the results (Chaisemartin and D'Haultfœuille, 2020; Goodman-Bacon, 2021).

6.2 Event study

Figure 6 - 9 presents the results of Eq.(2) for each outcome variable. All estimates include state, year of birth, wealth fixed effects, and maternal years of education, the share of households that openly defecate in the primary sampling unit, month of birth, birth order, sex of the child, whether the child is a twin, living in an urban area, and possession of latrine with standard error clustered at PSU. The dot indicates the coefficient estimate and the bars indicates the 95% confidence interval. The horizontal axis indicates the relative time from the treatment expressed as $\mathbf{1}\{t - E_s = l\}$ in Eq.(2). The first lead $\mathbf{1}\{t - E_s = 1\}$ is omitted to avoid multicollinearity . Therefore, the estimate of each coefficient is relative to the year before the treatment. The result indicates that the estimated coefficients of the leads of the treatments, i.e. β_l for $l \leq -2$, are statistically indifferent from zero. In other words, in the pre-treatment years, NNM, IMR and CMR are not statistically different from the year before the treatment. However, after a year of ban enactment, the mortality statistics increase substantially[24], but it returns to the previous level after two years. It is possible that people found other substitutes for beef and adjusted their diets after several years. Another plausible scenario is that the law had practical effect only around the time it came into force and then became loosely enforced afterwards.

7 Robustness check

7.1 The impact of cattle slaughter ban on beef consumers vs upper-caste Hindus

The difference-in-differences estimation in Section 5 compares the neonatal mortality of beef consumers and non-beef consumers living in the same state. However, the existence of treated states and not treated

[24]The estimated coefficients of PNM are not different from zero after the treatment. This shows that most of the deaths increased due to the ban occurs during the first month of birth.

states allows comparing the mortality change within a more homogeneous group. Comparing the mortality of beef consumers living in treated states to those living in untreated states also estimates the treatment effect. I can apply this similarly to the sample of upper-caste Hindus as a placebo. The specification is

$$y_{ibst} = \alpha + \delta TreatedState_s + \gamma CompleteBan_{st} \times TreatedState_s + X'_{ibst}\psi + \lambda_t + \varepsilon_{ibst} \tag{3}$$

where y_{ibst} is an individual-level mortality indicator for neonatal death similar to the previous section. $TreatedState_s$ is a dummy variable that equals one if the state enacts a complete ban and $CompleteBan_{st}$ equals one if the child born in state s, year t experienced a complete ban in utero. My coefficient of interest γ is the effect of the beef ban on mortality on those living in a treated state. The X vector is similar to the previous section[25]. λ_t is the year of birth fixed effect. Table 6 presents the result estimating Eq.(3). Panel A and B present the results for the beef-eating and upper-caste Hindu, respectively. Neonatal mortality of beef-eating communities increases by 3.9 per 1,000 live births and is statistically significant at 1%. In comparison, the mortality of upper-caste Hindus increases by 1.6 and is statistically significant at 10%. The increase of Hindus could be because of the general equilibrium effect that increases the price of chicken or goat. If beef-eating communities substitute goat or chicken for beef, the increased demand will increase the price of chicken and goat. When the price of meat other than beef increases after the ban, upper-caste Hindus' mortality will also change. The fact that upper-caste Hindus were adversely affected by the ban may bias my main results toward zero.

7.2 Placebo test

Table 7 contains the results of the placebo test using Eq.(1) assigning random treatment time. I randomly assigned the treatment date of the treated state. Thus, each treated state is assigned with a treatment date of another treated state. Since the treatment date is not the actual date beef consumers faced the nutritional shock, the treatment effect should not be significant. In fact, I see that the estimated effects are not significantly different from zero and are unaffected by including or excluding controls and state, year, wealth fixed effects. Other random assignments also yield statistically insignificant results.

7.3 Children Anemia

Beef is rich in iron, and it is easily absorbed in the human body than plant-based iron. Thus, cutting beef consumption can cause anemia, a disease mainly caused by low iron intake. Although anemia has other risk factors, iron deficiency anemia is the top cause of anemia. Through this exercise, I can confirm that the cattle slaughter ban reduces the nutritional intake of traditional beef consumers, and it adversely affects health. From the results of Section 6.2, the beef ban has significant health impacts during the first two years after it becomes enacted and then households adjust their diets. Hemoglobin levels could be easily improved in a short time if children have sufficient iron intake. Thus, I analyzed the risk of iron

[25] It includes maternal years of education, month of birth, birth order, sex of the child, whether the child is a twin, urban indicator, possession of latrine, and share of households that openly defecate in the primary sampling unit.

deficiency anemia in children aged 6-59 months within the first two years of the ban. I estimate

$$
\begin{aligned}
y_{ibst} = \alpha + \delta Beef\,Consumer_{ib} + \beta Ban_{st} \\
+ \gamma Ban_{st} \times Beef\,Consumer_{ib} + X'_{ibst}\psi + \lambda_t + \mu_s + \varepsilon_{ibst}
\end{aligned}
\tag{4}
$$

where y_{ibst} takes 1,000 if the child is anemic and 0 otherwise. It is scaled per 1,000 alive children to match the interpretation with the mortality measurement. Ban_{st} is 1 if the child lives in a state that enacted a law that limits access to beef within two years before the survey is taken. Fixed effects are added similarly with the mortality estimation, but the relevant control variables are different. They are taken from the literature and includes maternal years of education, month of birth, birth order, sex of the child, whether the child is a twin, living in an urban area, indicator whether a child is taking iron pills or sprinkles, indicator whether the child is still breastfeeding, and indicator if the child had fever or diarrhea recently with standard error clustered at PSU. Results presented in Table 8 suggest that 34 per 1,000 children from beef-consuming communities are more likely to be anemic after the beef ban. Thus, this result suggests that the beef ban actually reduces the iron intake of children and this alludes that mothers would experience similar nutritional shocks.

7.4 Ban imposed under the BJP Chief Minister

Cow protection has a long history in India that goes far before its colonial period, but it was not exceedingly popular until Hindu nationalism surged[26]. Recently Hindu nationalist political party Bharatiya Janata Party (BJP) made it their political agenda. It is possible that the law was administrated in the past when cow protection was actively debated but only enforced for a short amount of time. Thus, I run a separate test of beef bans using legislation or amended laws after the 2000s under a BJP chief minister who is likely to strictly enforce the ban. Six states[27] legislated or amended the act after 2000 under the BJP chief minister. I estimated Eq.(1) replacing the beef ban by the bans administrated under BJP chief minister and the result is presented in Table 9. Four neonates per 1,000 live birth died after a new ban on beef-eating communities, statistically significant at the 5% level. Death was concentrated in the neonates and had no significant effect on post-neonates.

7.5 Impact by wealth

If the increased neonatal death comes from nutritional intake, its impact would be smaller on rich people than on the poor because they have access to more substitutes and less likely to be in the state of malnutrition before the ban. The NFHS survey provides the wealth quantile of each household based on the amount of asset they possess. I divide the sample into rich, the top two quantiles, and poor, the lower two quantiles, and compare the change in neonatal mortality. This assumes that the neonatal mortality

[26] Cow protection movement accompanied by communal violence was observed in the 1960s when the first round of cow slaughter ban legislation was instituted across states. But the next few decades, such violence didn't happen until the recent national rise of the BJP party (Tejani, 2019).

[27] The states and years that correspond to this criteria are as follows: Chhattisgarh in 2006 and 2012, Gujarat in 2011, Himachal Pradesh in 2010, Madhya Pradesh in 2004 and 2011, Punjab in 2011, and Uttarakhand in 2007 and 2015.

trend of the rich (poor) Hindus and rich (poor) Muslims, Christians, and Scheduled Caste have a parallel trend. Table 10 presents the results for upper and lower wealth quantiles. As expected, the increase in neonatal death from rich families is smaller then the increase from the poor.

8 Conclusion

Legislation rooted in the diverse religious background of India have unintended social consequences, and India becomes a natural breeding ground for social experiments. The beef ban based on the political support from Hindus is such example, but the prior literature gave little attention. I fill important knowledge gaps by emphasizing the health impact of the beef ban by using a difference-in-difference method to estimate its causal effect on neonatal mortality. I differentiate between neonatal, infant, and child mortality rate. The concentration on the neonatal mortality implies that nutritional intake affects the health of the fetus. I also conduct event study analysis that estimates the impact of each year after the enactment.

I find an increase of 5.4 neonatal deaths after cattle ban and beef ban in beef-eating communities. The magnitude of the increase alone is greater than the neonatal mortality of the United States in 2015 which was 4 per 1,000 live births. The increased deaths among infants are concentrated in the first month of birth, suggesting that the fetal exposure to nutritional shock during pregnancy is the pathway. The event study analysis suggests that the impact was greater during the first two years after the enactment, which is natural considering the dietary adjustments and substitutions that beef eating communities can make after the ban.

The cattle slaughter ban and beef ban call for special attention because they pose a disproportionately higher threat towards pregnant women and children of beef-eating minorities. Nutrition during pregnancy is important to the fetal development, and limiting access to an affordable source of protein hampers the intrauterine growth causing adverse birth outcomes. Furthermore, as mortality is an extreme outcome, the increase in mortality suggests surviving children could also be suffering from detrimental health conditions. Future research focusing on the beef ban's effect on long-run outcomes would help evaluate the actual cost of the cattle slaughter ban and beef ban. Early life health conditions have enduring importance for later economic and health outcome (Almond and Currie, 2011b), so the welfare consequences of the beef ban can only grow larger.

This paper provides one of the first attempts to estimate the health cost of the cattle slaughter ban. Estimating the overall cost of the ban leaves room for future research as it will involve studying the long-run outcomes such as cognitive development and labor market outcomes. Furthermore, a general equilibrium approach will help assess the impact on the whole population of India.

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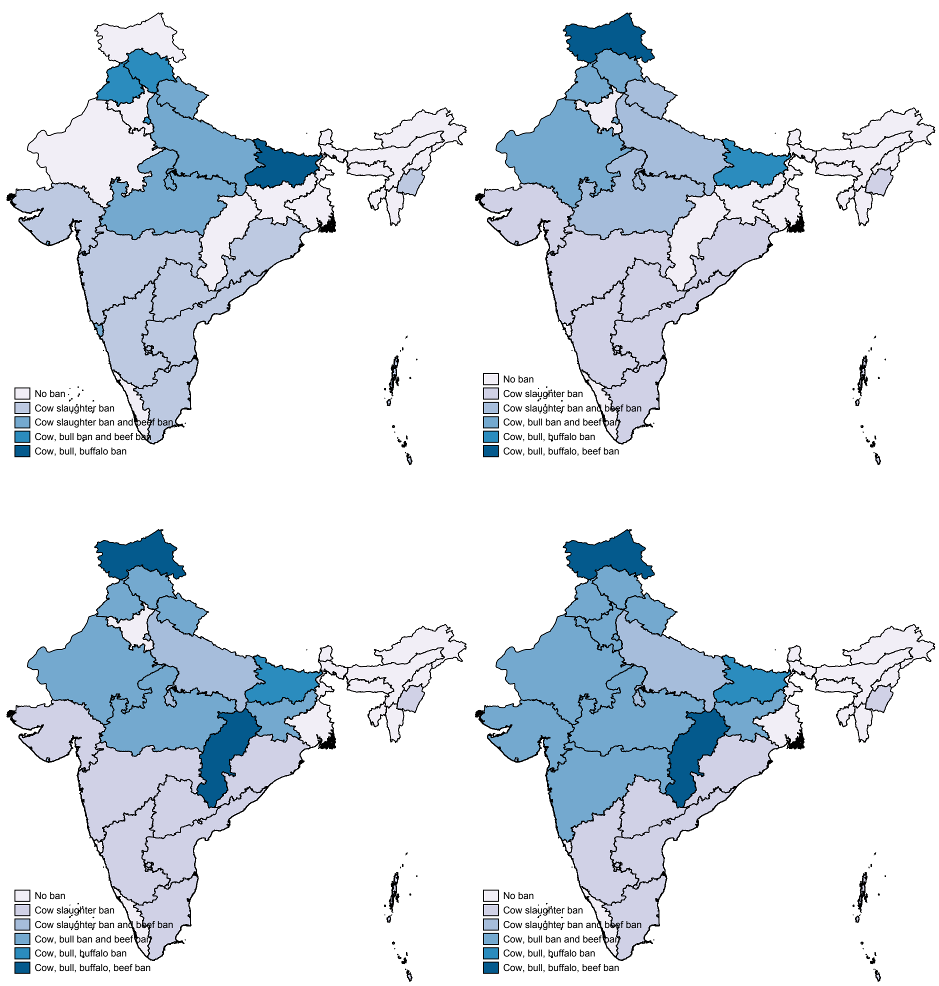
Figures

Figure 3: Animal Slaughter ban and Beef ban

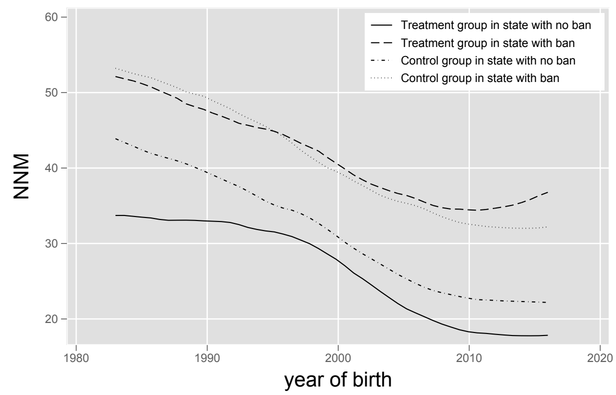
(a) 1980 (b) 2000

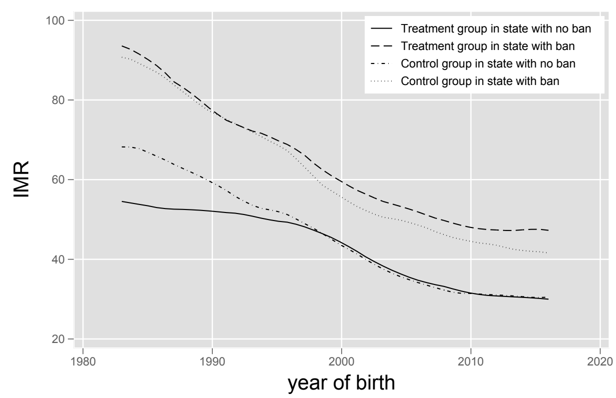


(c) 2010 (d) 2015

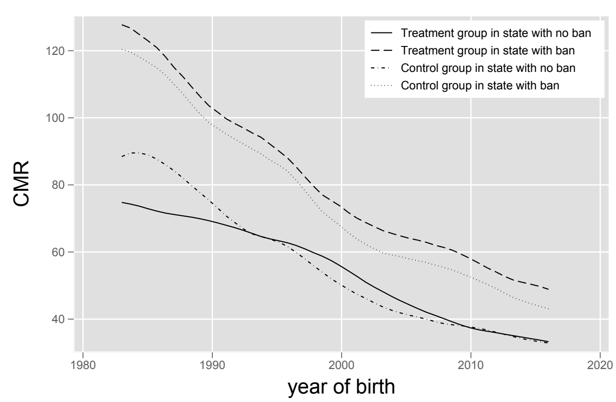
Figure 4: Trends of mortality rates

(a) Neonatal mortality rates





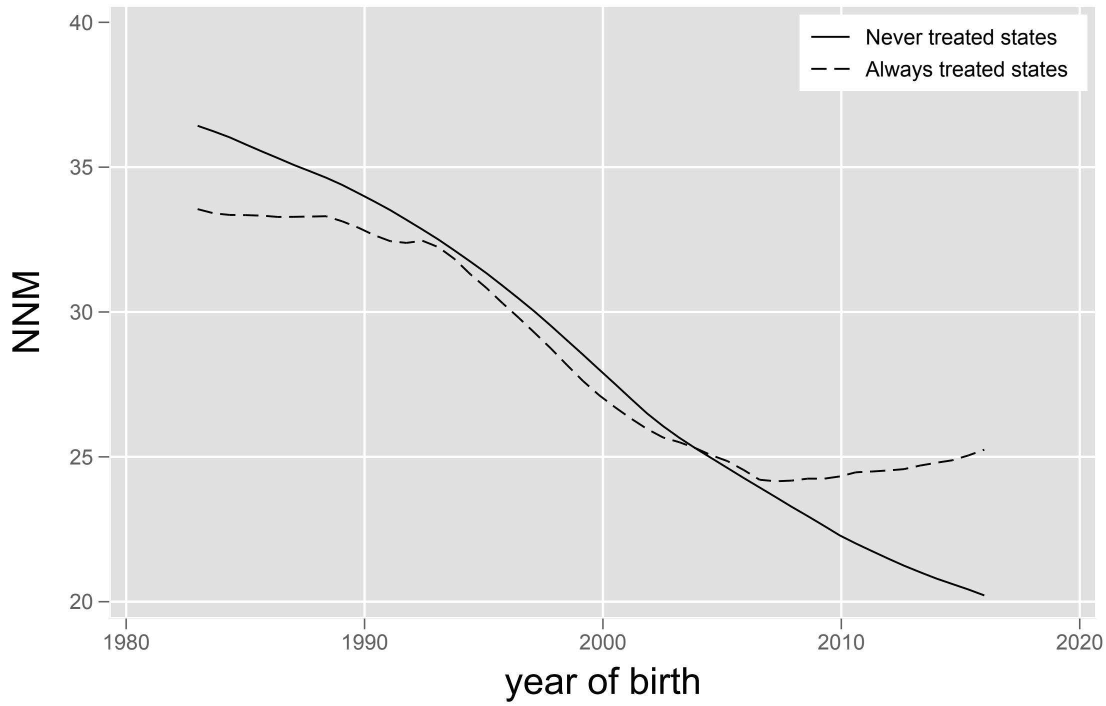
(b) Infant mortality rates



(c) Child mortality rates

Figure 5: Mortality trend in never treated states vs always treated states

(a) Neonatal mortality



(b) Infant mortality

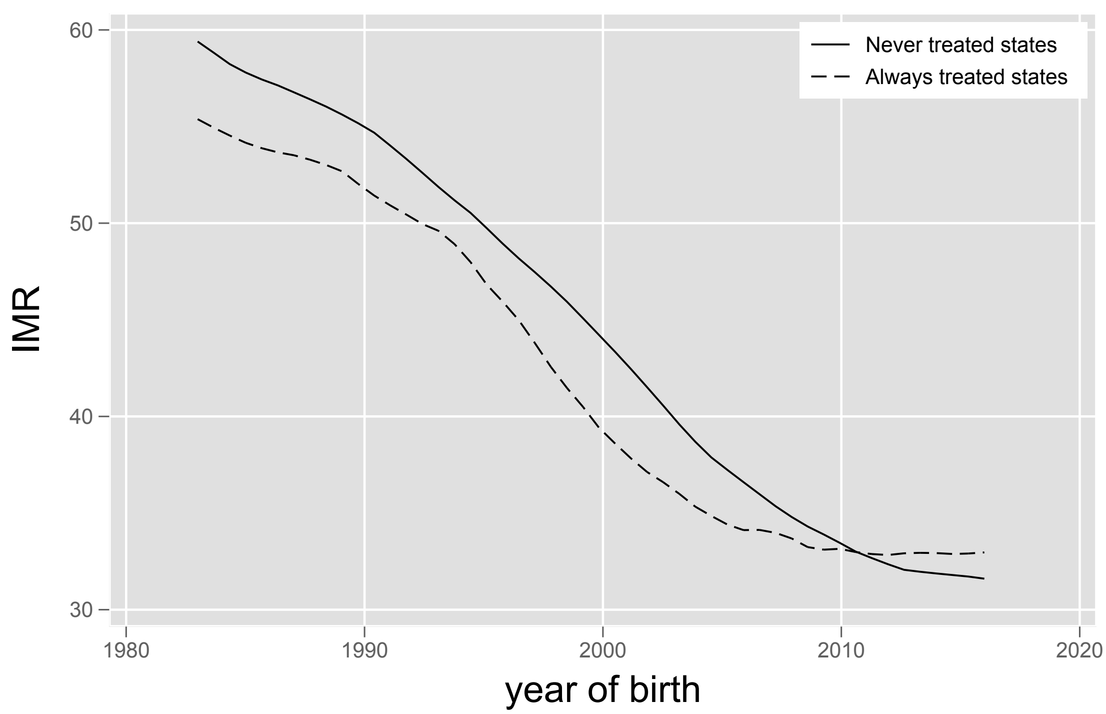


Figure 6: Event study, effect of complete cattle slaughter ban in NNM

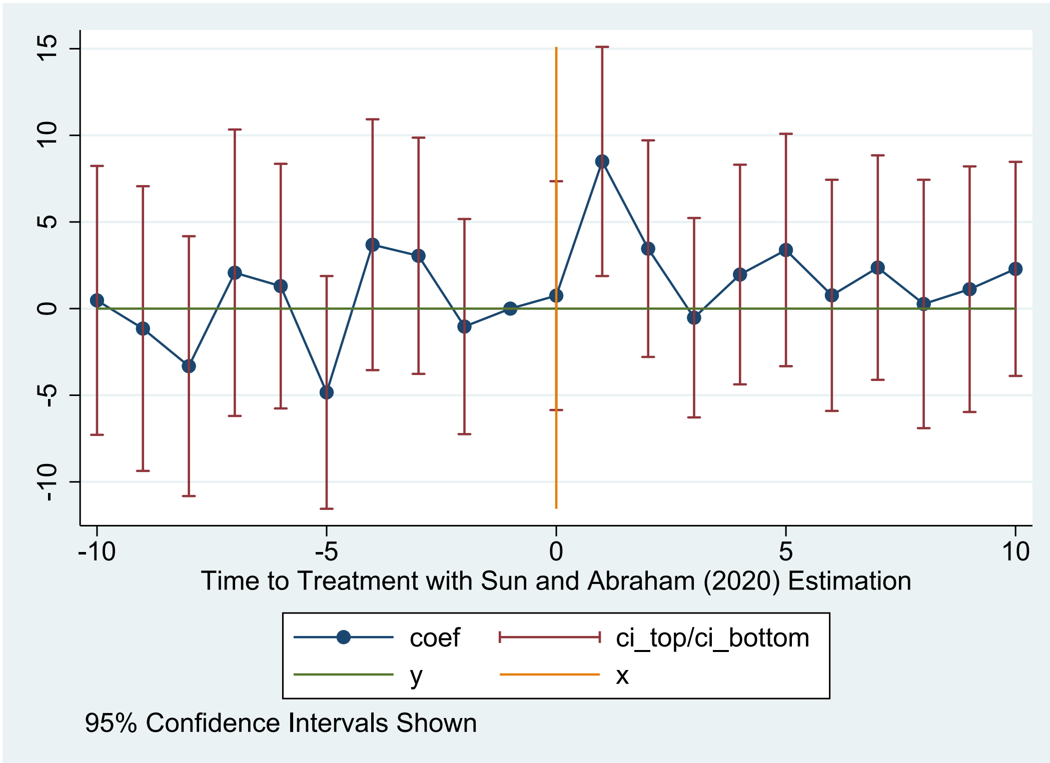


Figure 7: Event study, effect of complete cattle slaughter ban in IMR

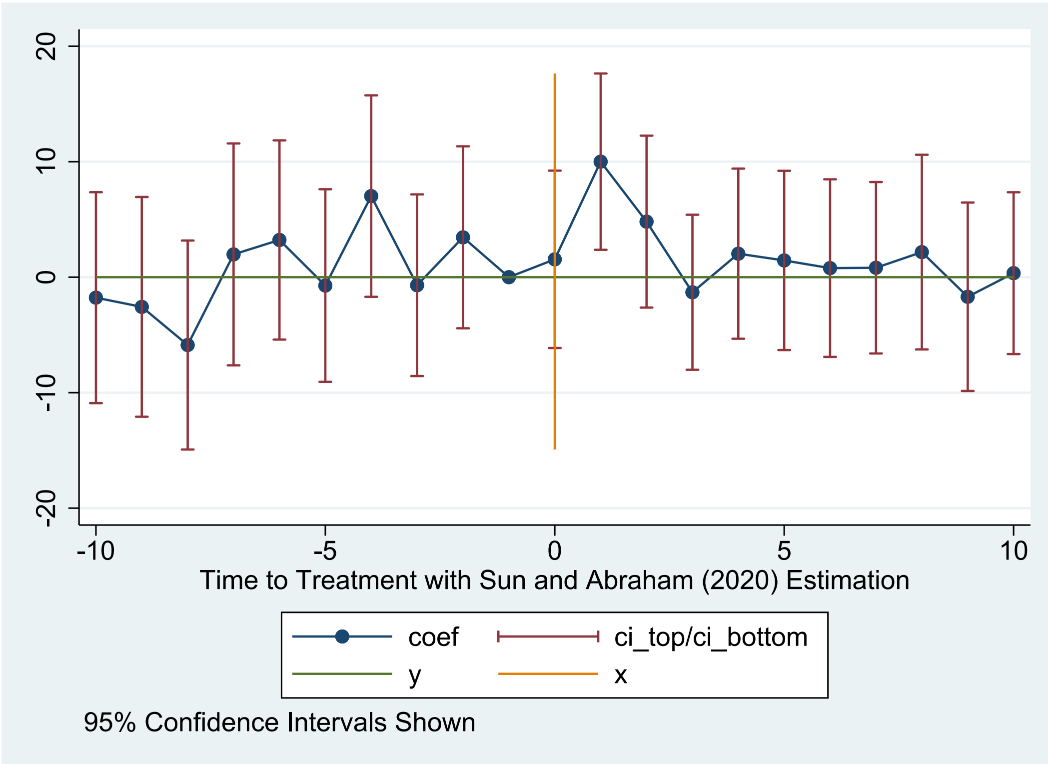


Figure 8: Event study, effect of complete cattle slaughter ban in CMR

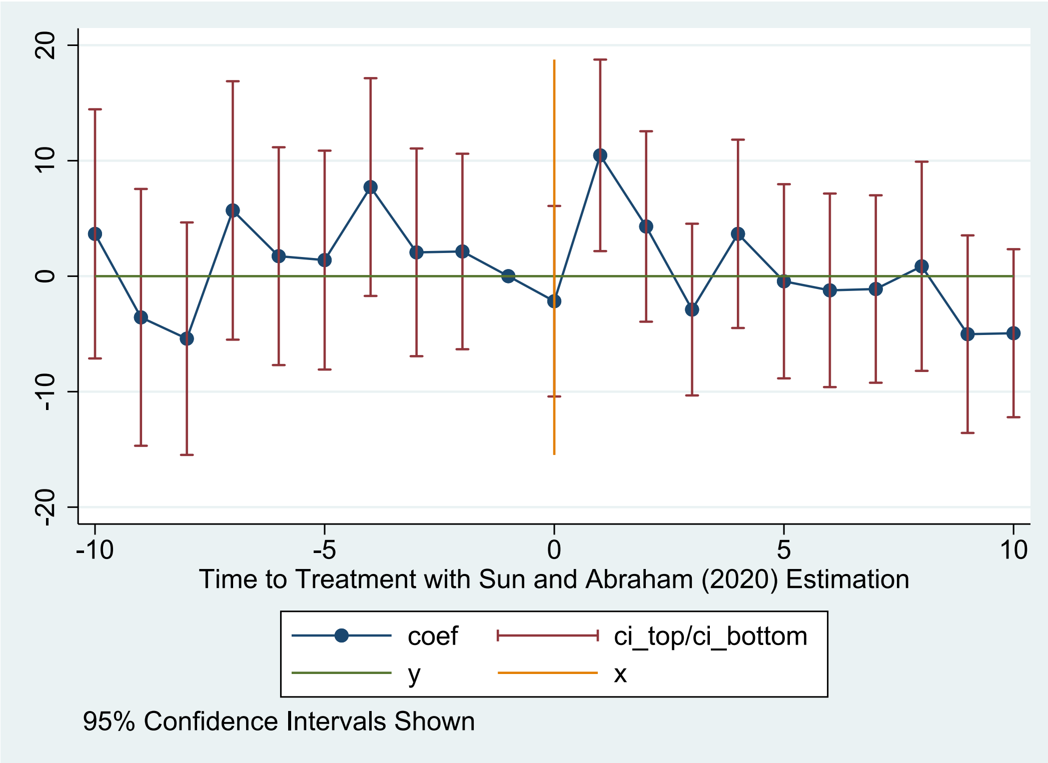
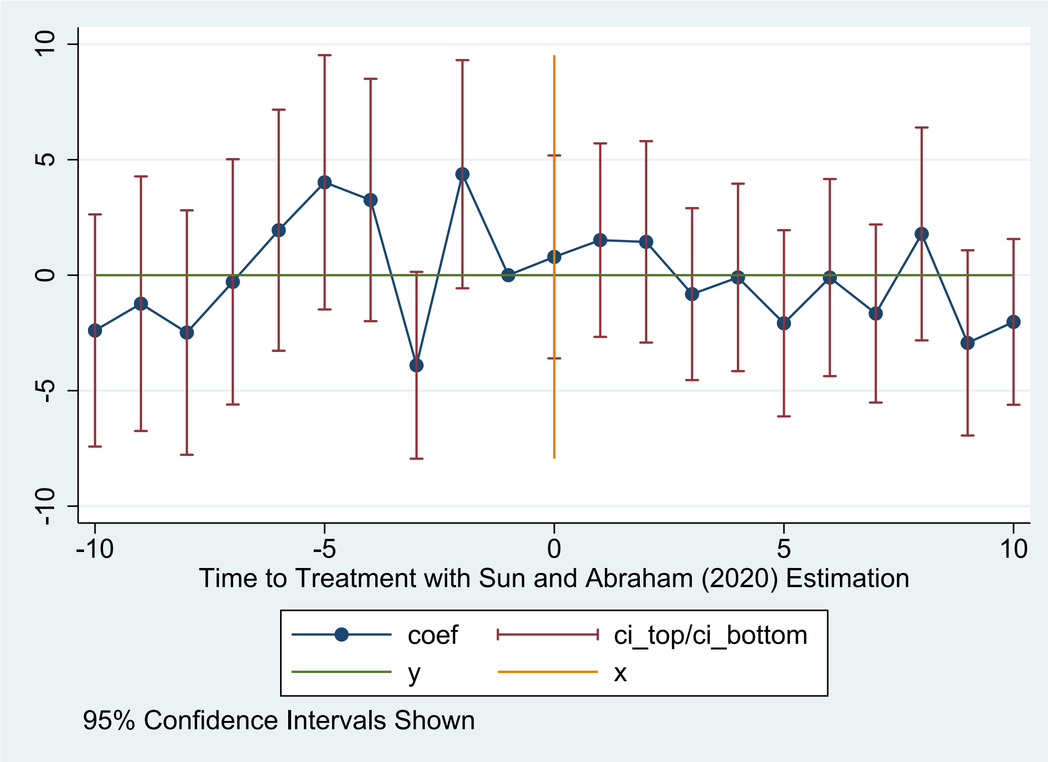


Figure 9: Event study, effect of complete cattle slaughter ban in PNM



Tables

Table 2: Summary Statistics

	Non-beef consumers		Beef consumers		Difference	
	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.
Neonatal mortality rate (NMR), month 1	36.25	186.90	33.49	179.93	2.752	0.394
Infant mortality rate (IMR), year 1	52.49	223.02	50.40	218.77	2.092	0.474
Child mortality rate (CMR), year 5	63.55	243.96	62.00	241.16	1.550	0.520
Anemia	604.28	489.01	582.84	493.09	21.431	1.944
Birth order	2.40	1.59	2.77	1.86	-0.369	0.004
Sex of child	0.52	0.50	0.52	0.50	0.007	0.001
Rural	0.75	0.43	0.71	0.45	0.035	0.001
Twin	0.02	0.12	0.01	0.12	0.000	0.000
Month of birth	6.52	3.43	6.39	3.44	0.134	0.007
Year of birth	2003.26	9.33	2004.52	8.62	-1.257	0.019
Mother's education	5.14	5.19	4.20	4.64	0.934	0.011
Open defecation	0.54	0.50	0.41	0.49	0.124	0.001
Local open defecation	0.55	0.38	0.40	0.38	0.149	0.001
Wealth	2.86	1.44	2.73	1.34	0.129	0.003
Observations	536,984		367,070		-	

Table 3: Effect of beef ban on mortality

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A	Neonatal mortality (NNM)				Infant mortality(IMR)			
Beef Ban	4.091***	-0.216	-0.376	-0.306	4.831***	-3.111*	-3.360*	-3.259*
	(0.837)	(1.415)	(1.393)	(1.393)	(0.993)	(1.791)	(1.749)	(1.746)
Beef Consumer	-3.590***	1.201*	0.129	-0.229	-2.103***	2.714***	0.235	-0.350
	(0.581)	(0.639)	(0.635)	(0.635)	(0.720)	(0.771)	(0.760)	(0.760)
Beef Ban x Beef Consumer	2.920**	3.442**	3.819***	3.649***	2.553*	5.099***	5.539***	5.236***
	(1.268)	(1.369)	(1.358)	(1.358)	(1.504)	(1.612)	(1.597)	(1.597)
R-squared	0.002	0.004	0.019	0.019	0.004	0.007	0.023	0.024
Panel B	Child mortality (CMR)				Post neonatal mortality (PNM)			
Beef Ban	6.651***	-4.209**	-4.501**	-4.312**	0.740	-2.895***	-2.984***	-2.953***
	(1.091)	(2.045)	(1.978)	(1.969)	(0.497)	(0.989)	(0.979)	(0.977)
Beef Consumer	-0.349	5.123***	1.441*	0.601	1.487***	1.513***	0.107	-0.121
	(0.823)	(0.870)	(0.850)	(0.849)	(0.400)	(0.420)	(0.422)	(0.423)
Beef Ban x Beef Consumer	-0.031	4.263**	5.051***	4.727***	-0.367	1.657**	1.720**	1.588*
	(1.660)	(1.771)	(1.751)	(1.749)	(0.784)	(0.843)	(0.841)	(0.841)
R-squared	0.003	0.004	0.007	0.007	0.003	0.004	0.007	0.007
Observations	619,086	619,086	619,085	619,085	619,086	619,086	619,085	619,085
State Fe	N	Y	Y	Y	N	Y	Y	Y
Year of Birth FE	Y	Y	Y	Y	Y	Y	Y	Y
Controls	N	N	Y	Y	N	N	Y	Y
Wealth quantile	N	N	N	Y	N	N	N	Y

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

The results presented in this table test: "Does a beef ban generate worse mortality outcome for babies from beef consumer groups?" The estimates colored in red indicates the change on mortality in beef consuming communities after the ban compared to non beef consumers.

Notes : (applies to Table 3-5, 7, and 9) The table reports results from OLS regression. The dependent variable in columns 1 through 4 in panel A is neonatal mortality (1 month). The dependent variable in columns 5 through 8 in panel A is infant mortality (1 year). The dependent variable in columns 1 through 4 in panel B is child mortality (5 years). The dependent variable in columns 5 through 8 in panel B is post neonatal mortality (1 month – 1 year). Mortality variables are scaled as described in the text to generate coefficients that indicate impacts on rates × 1,000 (deaths per 1,000 children). All regressions include survey round fixed effects. Controls include birth order indicators, indicators for child's birth month and birth year, an indicator for the child being a multiple birth, an urban indicator, sex of child, mother's education in years, indicator of ownership of latrine, as well as PSU-level means of open defecation. Observations are children (live births). Standard errors are clustered at the PSU level.
States that had beef sales ban or beef possission ban before 1984 are excluded.

Table 4: Effect of bull ban on mortality

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A	Neonatal mortality (NNM)				Infant mortality(IMR)			
Bull Ban	-0.699	-1.507	-2.099*	-2.038*	-1.362	-4.833***	-5.726***	-5.638***
	(0.735)	(1.233)	(1.201)	(1.200)	(0.887)	(1.586)	(1.529)	(1.526)
Beef Consumer	-3.837***	0.502	-0.199	-0.595	-2.432***	2.131***	-0.060	-0.702
	(0.560)	(0.605)	(0.602)	(0.603)	(0.696)	(0.733)	(0.722)	(0.723)
Bull Ban x Beef Consume	5.716***	5.582***	6.263***	6.092***	5.418***	7.088***	8.127***	7.865***
	(1.153)	(1.234)	(1.219)	(1.219)	(1.379)	(1.463)	(1.439)	(1.439)
R-squared	0.002	0.005	0.021	0.021	0.004	0.009	0.026	0.027
Panel B	Child mortality (CMR)				Post neonatal mortality (PNM)			
Bull Ban	-0.119	-8.362***	-9.631***	-9.569***	-0.664	-3.325***	-3.627***	-3.599***
	(0.982)	(1.834)	(1.737)	(1.729)	(0.452)	(0.885)	(0.872)	(0.871)
Beef Consumer	-1.041	4.263***	0.928	0.030	1.405***	1.629***	0.139	-0.107
	(0.793)	(0.820)	(0.799)	(0.798)	(0.384)	(0.403)	(0.406)	(0.407)
Bull Ban x Beef Consume	2.911*	6.455***	7.976***	7.726***	-0.299	1.506**	1.864**	1.773**
	(1.522)	(1.608)	(1.574)	(1.571)	(0.719)	(0.764)	(0.760)	(0.759)
R-squared	0.003	0.005	0.008	0.008	0.003	0.005	0.008	0.008
Observations	785,925	785,925	785,924	785,924	785,925	785,925	785,924	785,924
State Fe	N	Y	Y	Y	N	Y	Y	Y
Year of Birth FE	Y	Y	Y	Y	Y	Y	Y	Y
Controls	N	N	Y	Y	N	N	Y	Y
Wealth quantile	N	N	N	Y	N	N	N	Y

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

The results presented in this table test: "Does a bull slaughter ban generate worse mortality outcome for babies from beef consumer groups?"

States that had bull slaughter ban before 1984 are excluded.

Table 5: Effect of cow slaughter ban on mortality

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A	Neonatal mortality (NNM)				Infant mortality(IMR)			
Cow Ban	0.978	-2.769	-3.156	-2.792	0.312	-8.865***	-9.613***	-9.079***
	(1.082)	(1.990)	(1.951)	(1.948)	(1.290)	(2.583)	(2.512)	(2.506)
Beef Consumer	-7.014***	1.281	-0.029	-0.348	-5.206***	3.158**	0.103	-0.465
	(0.862)	(1.004)	(0.996)	(0.997)	(1.081)	(1.227)	(1.210)	(1.211)
Cow Ban x Beef Consumer	8.858***	4.707***	4.958***	4.727***	8.645***	6.777***	7.376***	7.009***
	(1.514)	(1.688)	(1.679)	(1.679)	(1.818)	(2.010)	(1.994)	(1.993)
R-squared	0.002	0.005	0.018	0.018	0.003	0.006	0.021	0.021
Panel B	Child mortality (CMR)				Post neonatal mortality (PNM)			
Cow Ban	1.374	-12.643***	-13.681***	-12.819***	-0.666	-6.096***	-6.457***	-6.288***
	(1.430)	(3.018)	(2.907)	(2.887)	(0.663)	(1.471)	(1.452)	(1.450)
Beef Consumer	-4.108***	5.821***	1.301	0.581	1.808***	1.877***	0.132	-0.117
	(1.242)	(1.397)	(1.363)	(1.361)	(0.604)	(0.673)	(0.676)	(0.677)
Cow Ban x Beef Consumer	6.437***	5.660**	6.851***	6.305***	-0.212	2.070*	2.418**	2.282**
	(2.024)	(2.236)	(2.210)	(2.206)	(0.974)	(1.077)	(1.075)	(1.074)
R-squared	0.005	0.010	0.024	0.025	0.002	0.004	0.006	0.007
Observations	318,512	318,512	318,512	318,512	318,512	318,512	318,512	318,512
State Fe	N	Y	Y	Y	N	Y	Y	Y
Year of Birth FE	Y	Y	Y	Y	Y	Y	Y	Y
Controls	N	N	Y	Y	N	N	Y	Y
Wealth quantile	N	N	N	Y	N	N	N	Y

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

The results presented in this table test: "Does a cow slaughter ban generate worse mortality outcome for babies from beef consumer groups?"

States that had cow slaughter ban before 1984 are excluded.

Table 6: Effect of complete ban on beef consumers vs upper caste Hindus

	(1)	(2)	(3)
Panel A		Beef consumers	
Treated States	4.984***	3.128***	4.959***
	(1.136)	(1.136)	(1.154)
Treated States x Complete Ban	4.865***	4.141***	3.919***
	(1.313)	(1.291)	(1.290)
Observations	260,615	260,613	260,613
R-squared	0.003	0.018	0.019
Panel B		Upper caste Hindus	
Treated States	2.337***	2.206**	3.747***
	(0.866)	(0.861)	(0.875)
Treated States x Complete Ban	2.932***	1.902**	1.660*
	(0.947)	(0.943)	(0.943)
Observations	378,833	378,833	378,833
R-squared	0.004	0.019	0.020
Year of Birth FE	Y	Y	Y
Controls	N	Y	Y
Wealth quantile	N	N	Y

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

The results presented in this table test: "Does a complete ban generate worse neonatal mortality outcome?" For beef eating communities and upper caste Hindu groups separately

Notes: The table reports results from OLS regression. Panel A presents the results for beef-consumers subsample while Panel B presents the results for upper caste Hindu subsample. The dependent variable is neonatal mortality (1 month). Mortality variables are scaled as described in the text to generate coefficients that indicate impacts on rates × 1,000 (deaths per 1,000 children). All regressions include survey round fixed effects. Controls include birth order indicators, indicators for child's birth month and birth year, an indicator for the child being a multiple birth, an urban indicator, sex of child, mother's education in years, indicator of ownership of latrine, as well as PSU-level means of open defecation. Observations are children (live births). Standard errors are clustered at the PSU level.

States that had cow, bull slaughter ban and beef sales or possession ban are excluded. Bihar, Puducherry and Uttar Pradesh are also excluded.

Table 7: Placebo test using random treatment time

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A	Neonatal mortality (NNM)				Infant mortality(IMR)			
Placebo Ban	1.601*	0.493	1.019	0.771	0.561	0.879	1.705	1.297
	(0.837)	(1.286)	(1.259)	(1.259)	(0.996)	(1.564)	(1.511)	(1.510)
Beef Consumer	-4.619***	1.405**	0.988	0.632	-3.945***	2.901***	1.439*	0.857
	(0.577)	(0.643)	(0.639)	(0.640)	(0.717)	(0.776)	(0.765)	(0.766)
Placebo Ban x	4.305***	2.660**	1.478	1.272	4.985***	3.563**	1.561	1.231
Beef Consumer	(1.278)	(1.318)	(1.294)	(1.294)	(1.529)	(1.568)	(1.532)	(1.530)
R-squared	0.002	0.005	0.020	0.020	0.004	0.008	0.024	0.024
Panel B	Child mortality (CMR)				Post neonatal mortality (PNM)			
Placebo Ban	-0.431	3.750**	4.900***	4.275***	-1.040**	0.386	0.686	0.526
	(1.088)	(1.720)	(1.649)	(1.646)	(0.482)	(0.835)	(0.820)	(0.820)
Beef Consumer	-4.402***	3.881***	1.689**	0.929	0.674*	1.496***	0.450	0.225
	(0.819)	(0.868)	(0.846)	(0.846)	(0.399)	(0.422)	(0.424)	(0.424)
Placebo Ban x	6.532***	5.019***	2.404	2.013	0.679	0.903	0.084	-0.041
Beef Consumer	(1.678)	(1.706)	(1.654)	(1.651)	(0.779)	(0.800)	(0.793)	(0.792)
R-squared	0.007	0.012	0.028	0.029	0.003	0.004	0.007	0.007
Observations	639,448	639,448	639,446	639,446	639,448	639,448	639,446	639,446
State Fe	N	Y	Y	Y	N	Y	Y	Y
Year of Birth FE	Y	Y	Y	Y	Y	Y	Y	Y
Controls	N	N	Y	Y	N	N	Y	Y
Wealth quantile	N	N	N	Y	N	N	N	Y

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

Placebo test using random treatment time. The change of mortality of beef consumer compared to non beef consumers is not statistically different after the ban.

States that had cow, bull slaughter ban and beef sales or possession ban are excluded. Bihar, Punducherry and Uttar Pradesh are also excluded.

Table 8: The effect of cattle slaughter ban on children anemia

	(1)	(2)	(3)	(4)
	Anemia			
Ban	-3.810	-122.913***	-102.378***	-106.213***
	(9.998)	(11.449)	(10.441)	(10.336)
Beef Consumer	-57.611***	7.358**	-1.139	-2.155
	(3.534)	(3.196)	(3.128)	(3.122)
Ban x Beef Consumer	105.789***	40.968**	33.025**	34.723**
	(16.054)	(16.047)	(15.038)	(14.925)
Observations	168,841	168,841	165,961	165,961
R-squared	0.035	0.105	0.132	0.133
State Fe	N	Y	Y	Y
Year of Birth FE	Y	Y	Y	Y
Controls	N	N	Y	Y
Wealth quantile	N	N	N	Y

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

This table tests whether the likelihood of being anemic for children from beef consuming households increases after the ban enactment in the short run.

Notes : The table reports results from OLS regression. The dependent is indicator of being anemic, scaled as described in the text to generate coefficients that indicate impacts on rates × 1,000. All regressions include survey round fixed effects. Controls include maternal years of education, month of birth, birth order, sex of the child, whether the child is a twin, urban indicator, indicator whether a child is taking iron pills or sprinkles, indicator whether the child is still breastfeeding, and indicator if the child had fever or diarrhea recently. Observations are alive children age 6-59 months. Standard errors are clustered at the PSU level.

Table 9: Effect of cattle slaughter ban and beef possession/ sales ban imposed under a BJP chief minister

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A	Neonatal mortality (NNM)				Infant mortality(IMR)			
BJP Ban	5.284***	-2.277	-2.889**	-2.917**	6.377***	-4.212**	-5.062***	-5.105***
	(0.857)	(1.392)	(1.351)	(1.351)	(1.018)	(1.730)	(1.664)	(1.662)
Beef Consumer	-2.281***	1.533***	0.698	0.227	-0.640	3.687***	1.281**	0.516
	(0.500)	(0.538)	(0.540)	(0.541)	(0.616)	(0.648)	(0.645)	(0.646)
BJP Ban x	4.601***	2.113	3.643**	3.962**	3.375*	0.666	3.390*	3.909**
Beef Consumer	(1.570)	(1.581)	(1.551)	(1.552)	(1.835)	(1.840)	(1.804)	(1.803)
R-squared	0.002	0.005	0.021	0.021	0.004	0.009	0.026	0.026
Panel B	Child mortality (CMR)				Post neonatal mortality (PNM)			
BJP Ban	9.115***	-7.061***	-8.245***	-8.415***	1.093**	-1.935**	-2.173**	-2.188**
	(1.121)	(1.989)	(1.872)	(1.865)	(0.508)	(0.939)	(0.925)	(0.924)
Beef Consumer	0.902	6.253***	2.595***	1.503**	1.641***	2.154***	0.583	0.289
	(0.701)	(0.727)	(0.715)	(0.714)	(0.338)	(0.354)	(0.359)	(0.360)
BJP Ban x	1.708	-1.521	2.401	3.287*	-1.226	-1.447	-0.252	-0.053
Beef Consumer	(1.998)	(2.001)	(1.950)	(1.946)	(0.894)	(0.900)	(0.897)	(0.896)
R-squared	0.007	0.014	0.031	0.032	0.003	0.005	0.008	0.008
Observations	864,540	864,540	864,540	864,540	864,540	864,540	864,540	864,540
State Fe	N	Y	Y	Y	N	Y	Y	Y
Year of Birth FE	Y	Y	Y	Y	Y	Y	Y	Y
Controls	N	N	Y	Y	N	N	Y	Y
Wealth quantile	N	N	N	Y	N	N	N	Y

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

Table 10: Effect of cattle slaughter ban and beef possession/ sales ban by wealth

	(1)	(2)	(3)	(4)
Panel A: top two wealth quantiles	Neonatal mortality (NNM)			
Complete Ban	6.530***	0.339	0.502	0.517
	(1.024)	(1.638)	(1.613)	(1.612)
Beef Consumer	-3.470***	-0.451	-2.039**	-2.164**
	(0.787)	(0.898)	(0.908)	(0.909)
Complete Ban x Beef Consumer	5.738***	5.021***	4.767***	4.691***
	(1.700)	(1.831)	(1.818)	(1.817)
Observations	233,209	233,209	233,208	233,208
R-squared	0.002	0.004	0.012	0.012
Panel B: lower two wealth quantiles	Neonatal mortality (NNM)			
Complete Ban	4.591***	-1.325	-1.379	-1.380
	(1.222)	(1.939)	(1.913)	(1.913)
Beef Consumer	-7.319***	-1.187	-1.097	-1.105
	(1.077)	(1.217)	(1.192)	(1.191)
Complete Ban x Beef Consumer	7.355***	6.514***	6.552***	6.613***
	(1.863)	(2.022)	(2.003)	(2.003)
Observations	269,729	269,729	269,727	269,727
R-squared	0.003	0.005	0.026	0.026
State Fe	N	Y	Y	Y
Year of Birth FE	Y	Y	Y	Y
Controls	N	N	Y	Y
Wealth quantile	N	N	N	Y

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

This table tests whether the impact on the poor, who have less available substitutes, is bigger than that on the rich.

Notes: The table reports results from OLS regression. The dependent variable is neonatal mortality (1 month). Mortality variable is scaled as described in the text to generate coefficients that indicate impacts on rates × 1,000 (deaths per 1,000 children). All regressions include survey round fixed effects. Controls include birth order indicators, indicators for child's birth month and birth year, an indicator for the child being a multiple birth, an urban indicator, sex of child, mother's education in years, indicator of ownership of latrine, as well as PSU-level means of open defecation. Observations are children (live births). Standard errors are clustered at the PSU

States that had cow, bull slaughter ban and beef sales or possession ban are excluded. Bihar, Puducherry and Uttar Pradesh are also excluded.

Appendix Figures

Figure A.1: Trend of home delivery

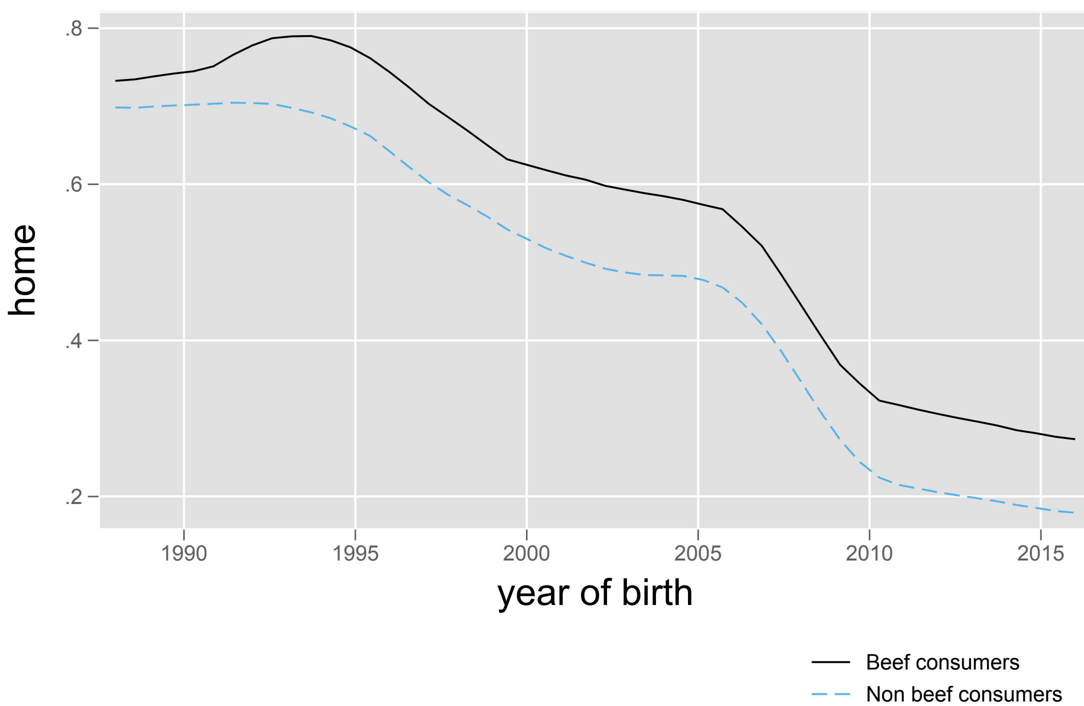


Figure A.2: Trend of likelihood to receive antenatal care

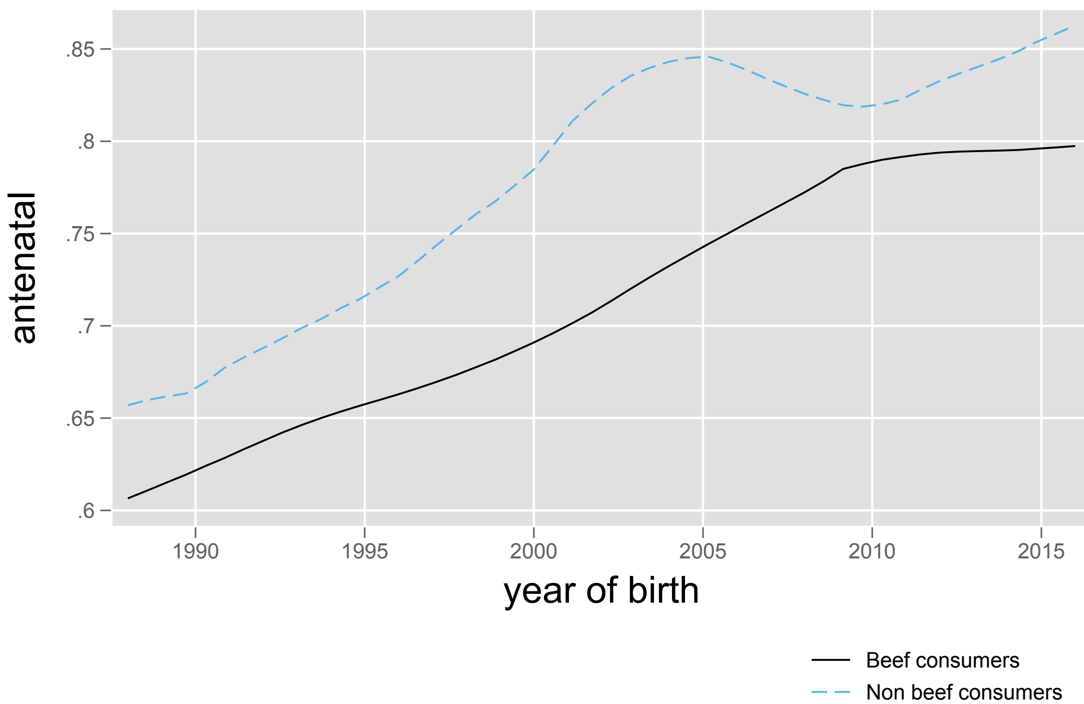
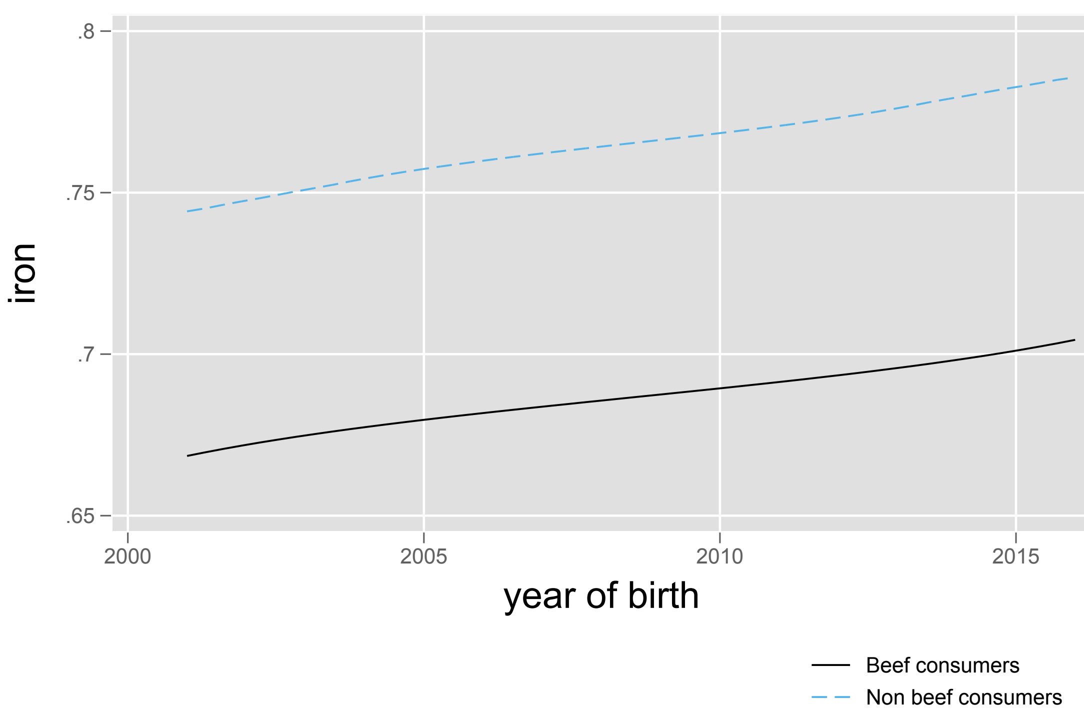


Figure A.3: Trend of likelihood to take iron supplement



Appendix Table

Using nine rounds[28] of the National Sample Survey (NSS), I employ the following difference-in-differences estimation

$$y_{ibst} = \alpha + \delta Beef\ Consumer_{ib} + \beta Ban_{st} + \gamma Beef\ Consumer_{ib} \times Ban_{st} + \lambda_t + \mu_s + \varepsilon_{ibst}$$

where y_{ibst} is the amount of beef consumed in kilograms by each household in the last 30 days, $Beef\ Consumer_{ib}$ is 1 if the respondent is a beef-eater and 0 otherwise, and Ban_{st} is a dummy variable that equals 1 if the survey was conducted after the ban (ban on cow, bull slaughter and beef sales/ possession) was enacted. The estimation includes year, month, state fixed effect and size of household. γ measures the change of beef consumption among the beef-eaters after the ban. The estimates is a lower bound because the beef consumption on NSS does not include eating outside in restaurants.

Table A.1: Change in beef consumption after cattle slaughter ban

	Beef consumption
Ban	-0.055
	(0.035)
Beef consumer	0.533***
	(0.016)
Ban x Beef consumer	-0.118*
	(0.062)
Observations	494,258
R-squared	0.079

Standard errors clustered in district level
*** p<0.01, ** p<0.05, * p<0.1
Data: NSS. Always treated states are excluded. The dependent variable is the quantity of consumption of beef during the last 30 days. Ban is a dummy variable that equals one if the survey was conducted after cow, bull slaughter ban and beef ban was enacted. The regression includes year, month, state fixed effect and size of household.

[28] I relied on surveys that asked about beef consumption in the previous 30 days. Round 56, 57, 58, 60, 61, 62, 64, 66, and 68 are included.

Appendix

Beef-consumers utility maximization problem

$$
\begin{aligned}
& max\, U\left(H_{iB}, b_{iB}, g_{iB}, v_{iB}\right) \\
& s.t.\; H_{iB} = \alpha_1 b_{iB} + \alpha_2 g_{iB} + v_{iB} \\
& \quad Y_{iB} = p_b b_{iB} + p_g g_{iB} + p_v v_{iB} \\
& \quad \alpha_1 > \alpha_2 > 1
\end{aligned}
$$

Assume

$$
\begin{aligned}
& u'(x) > 0, u''(x) < 0, x \in \{b, g, v\} \\
& u'(H) > 0, u''(H) = 0
\end{aligned}
$$

Rewrite the problem

$$
\begin{aligned}
U\left(H_{iB}, b_{iB}, g_{iB}, v_{iB}\right) &= u\left(H_{iB}\right) + u\left(b_{iB}\right) + u\left(g_{iB}\right) + u\left(v_{iB}\right) \\
&= u\left(\alpha_1 b_{iB} + \alpha_2 g_{iB} + \frac{Y_{iB} - p_b b - p_g g}{p_v}\right) + u\left(b_{iB}\right) + u\left(g_{iB}\right) + u\left(\frac{Y_{iB} - p_b b_{iB} - p_g g_{iB}}{p_v}\right)
\end{aligned}
$$

First order conditions are

$$
\begin{aligned}
\frac{\partial U}{\partial b} &= u'\left(H_{iB}\right)\left(\alpha_1 - \frac{p_b}{p_v}\right) + u'\left(b_{iB}\right) - u'\left(v_{iB}\right)\frac{p_b}{p_v} = 0 \\
\frac{\partial U}{\partial g} &= u'\left(H_{iB}\right)\left(\alpha_2 - \frac{p_g}{p_v}\right) + u'\left(g_{iB}\right) - u'\left(v_{iB}\right)\frac{p_g}{p_v} = 0
\end{aligned}
$$

Comparative Statics

1. Taking derivative on the first order conditions with respect to p_b, yields the following system of equations

$$
\begin{bmatrix}
+u''(b^*) + u''(v^*)\left(\frac{p_b}{p_v}\right)^2 & u''(v^*)\left(\frac{p_b p_g}{p_v^2}\right) \\
u''(v^*)\left(\frac{p_b p_g}{p_v^2}\right) & +u''(g^*) + u''(v^*)\left(\frac{p_g}{p_v}\right)^2
\end{bmatrix}
\begin{bmatrix}
\frac{\partial b^*}{\partial p_b} \\
\frac{\partial g^*}{\partial p_b}
\end{bmatrix}
=
\begin{bmatrix}
\left\{u'(H^*) + u'(v^*)\right\}\frac{1}{p_v} - u''(v^*)\left(\frac{b^* p_b}{p_v^2}\right) \\
-u''(v^*)\left(\frac{p_g b^*}{p_v^2}\right)
\end{bmatrix}
$$

by the second order condition,

$$det(A) \equiv det \begin{bmatrix} u''(b^*) + u''(v^*)\left(\frac{p_b}{p_v}\right)^2 & u''(v^*)\left(\frac{p_b p_g}{p_v^2}\right) \\ u''(v^*)\left(\frac{p_b p_g}{p_v^2}\right) & u''\left(g^*\right) + u''(v^*)\left(\frac{p_g}{p_v}\right)^2 \end{bmatrix} > 0$$

Using Cramer's rule

$$\frac{\partial b^*}{\partial p_b} = \frac{\begin{vmatrix} \left\{u'(H^*) + u'(v^*)\right\}\frac{1}{p_v} - u''(v^*)\left(\frac{b^* p_b}{p_v^2}\right) & u''(v^*)\left(\frac{p_b p_g}{p_v^2}\right) \\ -u''(v^*)\left(\frac{p_g b^*}{p_v^2}\right) & u''\left(g^*\right) + u''(v^*)\left(\frac{p_g}{p_v}\right)^2 \end{vmatrix}}{det(A)}$$

$$= \frac{\left[\left\{u'(H^*) + u'(v^*)\right\}\frac{1}{p_v} - u''(v^*)\left(\frac{b^* p_b}{p_v^2}\right)\right] \times \left[u''\left(g^*\right) + u''(v^*)\left(\frac{p_g}{p_v}\right)^2\right] + \left[u''(v^*)\left(\frac{p_b p_g}{p_v^2}\right) \times u''(v^*)\left(\frac{p_g b^*}{p_v^2}\right)\right]}{det(A)}$$

Thus, the numerator decides the sign of $\frac{\partial b^*}{\partial p_b}$

$$\text{numerator} = \left\{u'\left(H^*\right) + u'\left(v^*\right)\right\} u''\left(g^*\right)\frac{1}{p_v} + \left\{u'\left(H^*\right) + u'\left(v^*\right)\right\} u''\left(v^*\right)\left(\frac{p_g}{p_v}\right)^2 \frac{1}{p_v} - u''\left(v^*\right) u''\left(g^*\right)\left(\frac{b^* p_b}{p_v^2}\right) < 0$$

$\frac{\partial b^*}{\partial p_b} < 0$

2. Take derivatives with respect to Y, the system of equations become

$$\begin{bmatrix} u''(b^*) + u''(v^*)\left(\frac{p_b}{p_v}\right)^2 & u''(v^*)\left(\frac{p_b p_g}{p_v^2}\right) \\ u''(v^*)\left(\frac{p_b p_g}{p_v^2}\right) & u''\left(g^*\right) + u''(v^*)\left(\frac{p_g}{p_v}\right)^2 \end{bmatrix} \begin{bmatrix} \frac{\partial b^*}{\partial y} \\ \frac{\partial g^*}{\partial y} \end{bmatrix} = \begin{bmatrix} u''(v^*)\left(\frac{p_b}{p_v^2}\right) \\ u''(v^*)\left(\frac{p_g}{p_v^2}\right) \end{bmatrix}$$

Using Cramer's rule

$$\frac{\partial b^*}{\partial y} = \frac{det \begin{bmatrix} u''(v^*)\left(\frac{p_b}{p_v^2}\right) & u''(v^*)\left(\frac{p_b p_g}{p_v^2}\right) \\ u''(v^*)\left(\frac{p_g}{p_v^2}\right) & u''\left(g^*\right) + u''(v^*)\left(\frac{p_g}{p_v}\right)^2 \end{bmatrix}}{det(A)}$$

$$\begin{aligned} \text{numerator} &= \left[u''\left(v^*\right)\left(\frac{p_b}{p_v^2}\right) u''\left(g^*\right) + \left(u''\left(v^*\right)\right)^2\left(\frac{p_b}{p_v^2}\right)\left(\frac{p_g}{p_v}\right)^2\right] - \left(u''\left(v^*\right)\right)^2\left(\frac{p_b p_g}{p_v^2}\right)\left(\frac{p_g}{p_v^2}\right) \\ &= u''\left(v^*\right) u''\left(g^*\right)\left(\frac{p_b}{p_v^2}\right) > 0 \end{aligned}$$

$\frac{\partial b}{\partial y} > 0$ thus beef is normal good.

3. Change in anticipated health

$$
\begin{aligned}
H &= \alpha_1 b + \alpha_2 g + v \\
\frac{\partial H^*}{\partial p_b} &= \alpha_1 \frac{\partial b^*}{\partial p_b} + \alpha_2 \frac{\partial g^*}{\partial p_b} + \frac{\partial v^*}{\partial p_b} \\
\frac{\partial H^*}{\partial p_b} &= \alpha_1 \frac{\partial b^*}{\partial p_b} + \alpha_2 \frac{\partial g^*}{\partial p_b} - \frac{1}{p_v}\left(b^* + p_b \frac{\partial b^*}{\partial p_b} + p_g \frac{\partial g^*}{\partial p_b}\right) \\
\frac{\partial H}{\partial p_b} &= \left(\alpha_1 - \frac{p_b}{p_v}\right)\frac{\partial b^*}{\partial p_b} + \left(\alpha_2 - \frac{p_g}{p_v}\right)\frac{\partial g^*}{\partial p_b} - \frac{b^*}{p_v}
\end{aligned}
$$

$$
\begin{aligned}
&\frac{\partial H}{\partial p_b} \times det(A) \\
&= \left[\left(\alpha_1 - \frac{p_b}{p_v}\right)\frac{\partial b}{\partial p_b} + \left(\alpha_2 - \frac{p_g}{p_v}\right)\frac{\partial g}{\partial p_b}\right] \times det(A) - \frac{b^*}{p_v} \times det(A) \\
&= \left(\alpha_1 - \frac{p_b}{p_v}\right)\left\{u'\left(H^*\right) + u'\left(v^*\right)\right\} u''\left(g^*\right)\frac{1}{p_v} + \left(\alpha_1 - \frac{p_b}{p_v}\right)\left\{u'\left(H^*\right) + u'\left(v^*\right)\right\} u''\left(v^*\right)\left(\frac{p_g}{p_v}\right)^2 \frac{1}{p_v} \\
&\quad - \left(\alpha_1 - \frac{p_b}{p_v}\right) u''\left(v^*\right) u''\left(g^*\right)\left(\frac{b^* p_b}{p_v^2}\right) - \left(\alpha_2 - \frac{p_g}{p_v}\right) u''\left(v^*\right) u''\left(b^*\right)\left(\frac{p_g b^*}{p_v^2}\right) \\
&\quad - \left(\alpha_2 - \frac{p_g}{p_v}\right) u''\left(v^*\right)\left(\frac{p_b p_g}{p_v^3}\right)\left\{u'\left(H^*\right) + u'\left(v^*\right)\right\} - \frac{b^*}{p_v} u''\left(b^*\right) u''\left(g^*\right) - \frac{b^*}{p_v} u''\left(g^*\right) u''\left(v^*\right)\left(\frac{p_b}{p_v}\right)^2 \\
&\quad - \frac{b^*}{p_v} u''\left(b^*\right) u''\left(v^*\right)\left(\frac{p_g}{p_v}\right)^2 \\
&= \left\{u'\left(H^*\right) + u'\left(v^*\right)\right\}\left[\left(\alpha_1 - \frac{p_b}{p_v}\right) u''\left(g^*\right)\frac{1}{p_v} + \left(\alpha_1 - \frac{p_b}{p_v}\right) u''\left(v^*\right)\left(\frac{p_g}{p_v}\right)^2 \frac{1}{p_v} - \left(\alpha_2 - \frac{p_g}{p_v}\right) u''\left(v^*\right)\left(\frac{p_b p_g}{p_v^3}\right)\right] \\
&\quad - u''\left(b^*\right) u''\left(v^*\right)\left[\left(\alpha_2 - \frac{p_g}{p_v}\right)\left(\frac{p_g b^*}{p_v^2}\right) + \frac{b^*}{p_v}\left(\frac{p_g}{p_v}\right)^2\right] - u''\left(v^*\right) u''\left(g^*\right)\left[\left(\alpha_1 - \frac{p_b}{p_v}\right)\left(\frac{b^* p_b}{p_v^2}\right) + \frac{b^*}{p_v}\left(\frac{p_b}{p_v}\right)^2\right] \\
&\quad - \frac{b^*}{p_v} u''\left(b^*\right) u''\left(g^*\right) \\
&= \left\{u'\left(H^*\right) + u'\left(v^*\right)\right\}\left[\left(\alpha_1 - \frac{p_b}{p_v}\right) u''\left(g^*\right)\frac{1}{p_v} + u''\left(v^*\right)\left\{\alpha_1 \frac{p_g^2}{p_v^3} - \alpha_2 \frac{p_b p_g}{p_v^3}\right\}\right] \\
&\quad - \alpha_2 \frac{p_g b^*}{p_v^2} u''\left(b^*\right) u''\left(v^*\right) - \alpha_1 \frac{b^* p_b}{p_v^2} u''\left(v^*\right) u''\left(g^*\right) - \frac{b}{p_v} u''\left(b^*\right) u''\left(g^*\right) \\
&= \left\{u'\left(H^*\right) + u'\left(v^*\right)\right\}\frac{1}{p_v}\left[\left(\alpha_1 - \frac{p_b}{p_v}\right) u''\left(g^*\right) + u''\left(v^*\right)\frac{p_g}{p_v^2}\left\{\alpha_1 p_g - \alpha_2 p_b\right\}\right] \\
&\quad - \alpha_2 \frac{p_g b^*}{p_v^2} u''\left(b^*\right) u''\left(v^*\right) - \alpha_1 \frac{b^* p_b}{p_v^2} u''\left(v^*\right) u''\left(g^*\right) - \frac{b}{p_v} u''\left(b^*\right) u''\left(g^*\right)
\end{aligned}
$$

The sufficient condition of $\frac{\partial H}{\partial p_b} < 0$ is $\left(\alpha_1 - \frac{p_b}{p_v}\right) > 0$

Cattle slaughter ban

	date come into force	cow slaughter ban	bullock slaughter bans	bull slaughter ban	buffalo slaughter bans	beef possession bans	beef sales ban
Andaman and Nicobar Islands	1/25/1967	Y	N	N	N	N	N
Andhra Pradesh	12/19/1976	Y	N	N	N	N	N
Arunachal Pradesh	na	N	N	N	N	N	N
Assam	1962	N	N	N	N	N	N
Bihar	1/11/1956	Y	Y	Y	Y	N	N
Chandigarh	6/27/1956	Y	Y	Y	N	N	Y
Chhattisgarh	9/11/2006	Y	Y	Y	Y	Y	N
Chhattisgarh	9/1/2012	Y	Y	Y	Y	Y	N
Dadra and Nagar Haveli	6/21/1978	Y	N	N	N	N	Y
Daman and Diu	6/21/1978	Y	N	N	N	N	Y
Delhi	1994	Y	Y	Y	N	Y	N
Goa	6/21/1978	Y	N	N	N	N	Y
Goa	7/11/1996	N	N	N	N	N	N
Goa	8/29/2003	N	N	N	N	N	N
Goa	6/3/2010	N	N	N	N	N	N
Gujarat	12/14/1954	N	N	N	N	N	N
Gujarat	5/6/1961	Y	N	N	N	N	N
Gujarat	11/28/1978	Y	N	N	N	N	N
Gujarat	9/23/1993	Y	N	N	N	N	N
Gujarat	10/12/2011	Y	Y	Y	N	Y	Y
Haryana	11/19/2015	Y	Y	Y	N	Y	Y
Himachal Pradesh	6/16/1979	Y	Y	Y	N	N	Y
Himachal Pradesh	9/14/2010	Y	Y	Y	N	N	Y
Jammu and Kashmir	10/8/1989	Y	Y	Y	Y	Y	N
Jharkhand	11/22/2005	Y	Y	Y	N	Y	Y
Karnataka	8/14/1964	Y	N	N	N	N	N
Kerala	na	N	N	N	N	N	N
Lakshadweep	na	N	N	N	N	N	N
Madhya Pradesh	1/15/1960	Y	N	N	N	Y	N
Madhya Pradesh	3/29/2004	Y	Y	Y	N	Y	N
Madhya Pradesh	12/31/2011	Y	Y	Y	N	Y	N
Maharashtra	2/16/1977	Y	N	N	N	N	N
Maharashtra	3/4/2015	Y	Y	Y	N	Y	N
Manipur	1939	Y	N	N	N	N	N
Meghalaya	na	N	N	N	N	N	N
Mizoram	na	N	N	N	N	N	N
Nagaland	na	N	N	N	N	N	N
Odisha	2/28/1961	Y	N	N	N	N	N
Puducherry	7/1/1969	Y	N	N	N	N	Y
Punjab	6/27/1956	Y	Y	Y	N	N	Y
Punjab	12/12/1980	Y	Y	Y	N	N	Y
Punjab	11/11/2011	Y	Y	Y	N	N	Y
Rajasthan	8/24/1995	Y	Y	Y	N	Y	Y
Sikkim	2017	N	N	N	N	N	N
Tamil Nadu	7/1/1959	N	N	N	N	N	N
Tamil Nadu	8/30/1976	Y	N	N	N	N	N

Telangana	12/19/1976	Y	N	N	N	N	N
Tripura	na	N	N	N	N	N	N
Uttar Pradesh	6/1/1956	Y	N	N	N	N	Y
Uttar Pradesh	6/26/1979	Y	N	N	N	N	Y
Uttar Pradesh	9/12/2002	Y	N	N	N	N	Y
Uttarakhand	6/1/1956	Y	N	N	N	N	Y
Uttarakhand	7/19/2007	Y	Y	Y	N	Y	Y
Uttarakhand	3/31/2015	Y	Y	Y	N	Y	Y
West Bengal	1950	N	N	N	N	N	N
West Bengal	1979	N	N	N	N	N	N

Note: fit-for-slaughter is marked in N. If the date is na, it means the corresponding state does not have a animal protection Act that restricts animal slaughter.