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working paper
1713

In Vaccines We Trust? The Effects of the CIA's Vaccine Ruse on Immunization in Pakistan

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September 2017

Revised July 2018

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CEMFI Working Paper No. 1713
September 2017
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Abstract

In July 2011, the Pakistani public unexpectedly learnt that the CIA had used a vaccination campaign as cover during the operations to locate and capture Osama Bin Laden. This episode lent credibility to conspiracy theories against vaccines that had been spread by the Taliban. We evaluate the effects of these events on immunization by implementing a Difference-in-Differences strategy across cohorts and regions. We find that vaccination rates declined 9 to 13% per standard deviation in Islamist parties' support. These results suggest that the disclosure of information discrediting vaccination campaigns can negatively affect trust in health services and demand for immunization.

JEL Codes: I15, D74, D83.

Keywords: Vaccines, demand, propaganda, trust, Pakistan.

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Acknowledgement

We would like to thank Manuel Arellano, Diego Puga, Nancy Qian, Pascaline Dupas, Nathan Nunn, Guillermo Caruana, Paula Bustos, Jishnu Das, Michael Callen, Pamela Campa, Joachim Voth, Brian Knight, David Yanagizawa-Drott, and Lorenzo Casaburi for valuable suggestions. We also thank seminar participants at NEUDC-2016, CEMFI PhD workshop, Oxford University, Political Economy of Development Workshop at Warwick University, and the University of Zurich. We also thank the National Emergency Operation Centre and the Expanded Program of Immunization for kindly sharing the administrative data on immunization campaigns, as well as the Center for Economic Research in Pakistan for their logistical support during our visit to Pakistan. The present draft is a revised version of the Master's Thesis presented by Andreas Stegmann in partial fulfillment of the 2013-2015 Master in Economics and Finance at CEMFI. We gratefully acknowledge financial support from Ramón y Cajal Grant (RYC-2013-14307) and from the Spanish Ministry of Economics and Competitiveness (ECO2016-80411-P).

1 Introduction

Trust in the medical sector and in medical products is a key determinant of the demand for health care. This is specially relevant for the use of vaccines. Because of herd immunity, it is difficult - if not impossible - to learn about the effectiveness of vaccines based on own experience. Hence, events that discredit the effectiveness of vaccines or the reputation of the medical sector, can have dramatic consequences on immunization rates. A commonly discussed example of such dynamics was the publication of an article in the medical journal *The Lancet* in 1998, which linked autism to the MMR (measles, mumps, and rubella) vaccine. Media reports have associated this publication with the emergence of the anti-vaccines movement and with the recent rise in the number of unvaccinated children in several countries. The declines in vaccination rates have contributed to the reemergence of previously eradicated diseases in several countries.[1]

These issues are even more relevant in developing countries, where citizens have lower levels of education and the low quality of remedial medicine can exacerbate the negative consequences of infections. In spite of the importance of these issues, we have only limited empirical evidence on the causal effect of the disclosure of information that damages the reputation of vaccines on immunization rates and on health outcomes.

In this paper, we exploit a sequence of events that took place in the recent history of Pakistan and that severely affected the degree to which citizens trusted formal medicine and vaccines, in particular. As part of the operations to capture Osama Bin Laden in 2011, the CIA launched a fake vaccination campaign in the city of Abbottabad, Pakistan. The objective of this operation was to obtain DNA samples of children living in a compound in Abbottabad where Bin Laden was suspected to hide. This would have allowed the CIA to obtain definite proof that Bin Laden was hiding there. In July 2011, two months after the actual capture of Bin Laden, the British newspaper *The Guardian* published an article reporting on the vaccine ruse and describing the collaboration of a Pakistani doctor with the CIA.[2]

The disclosure of this information caused uproar in Pakistan. The Pakistani Taliban used this information to intensify their discrediting campaign against formal medicine and vaccines, in particular. They issued a number of *fatwas* - religious edicts - in which they

[1] Alazraki, Melly. 2011. "The Autism Vaccine Fraud: Dr. Wakefield's Costly Lie to Society." *aol.com*, January 12. *http://www.aol.com/article/2011/01/12/autism-vaccine-fraud-wakefield-cost-money-deaths/19793484/* (last accessed 06.09.2017).

[2] Shah, Saeed. 2011. "CIA organized fake vaccination drive to get Osama bin Laden's family DNA". *The Guardian*, July 11. *http://www.theguardian.com/world/2011/jul/11/cia-fake-vaccinations-osama-bin-ladens-dna* (last accessed 06.09.2017).

accused health workers of regularly conducting espionage activities for the US[3] and related polio vaccination campaigns to attempts to sterilize Muslim girls.[4] While the Taliban's campaign to discredit vaccinations can be traced back to the early 2000s, the disclosure of the vaccination ruse and the actual involvements of Pakistani doctors in espionage activities lent credibility to the Taliban's arguments.

We estimate the impact of these events on immunization rates using household-level data from the Pakistani Social Living Standards Measurement (PSLM) survey. We implement a *Difference-in-Differences* strategy where we compare immunization rates of children born before and after the vaccine ruse was disclosed and, across districts with different levels of support for Islamist political groups. Our underlying hypothesis is that, on average, parents in districts with higher support for political Islamist groups will be more likely to change their beliefs about vaccines according to the messages spread by the Taliban. As a measure of support for Islamist groups we use district-level measures of electoral support for *Muttahida Majlis-e-Amal* (MMA), which was a coalition of Islamist parties that ran under a single banner in the 2008 general election.[5]

Our estimates suggest that the disclosure of the vaccine ruse had substantial effects on vaccination rates: a one standard deviation increase in the support for Islamist groups leads to a 9 to 13% larger decline in the likelihood that children have received the first dose of a number of different vaccines. The results are highly statistically significant and robust to the inclusion of a host of controls, including district and month-of-birth fixed effects. Furthermore, we document the absence of pre-existing trends preceding the disclosure of the vaccination ruse.

These results are consistent with the hypothesis that the disclosure of the vaccine ruse damaged the reputation of vaccines and of formal medicine, more generally. The increase in vaccine skepticism may have led some parents to refuse to vaccinate their children. We provide additional evidence consistent with this channel. First, we show that other forms of health seeking behavior also experienced important declines. In particular, parents were less likely to consult formal health workers when their children got sick. Second, using data from the South Asia Barometer, we document that there were larger declines in levels of trust in regions with high support for Islamist groups. Third, we show that the negative effect of the disclosure of the vaccine ruse on vaccination rates is larger for girls than for

[3]Walsh, Decan. 2012. "Taliban Block Vaccinations in Pakistan". *The New York Times*, June 18. *http://www.nytimes.com/2012/06/19/world/asia/taliban-block-vaccinations-in-pakistan.html* (last accessed 06.09.2017).

[4]Roul (2014).

[5]The parties that form the MMA coalition have strong ideological and financial connections to the Pakistani Taliban. See section 2 for further details.

boys. This is consistent with parents believing the rumors spread by Islamist groups that suggested vaccination campaigns were intended to sterilize Muslim girls.

We also examine the empirical relevance of alternative channels. In particular, we explore whether the supply of medical services changed in response to the disclosure of the vaccine ruse.[6] We obtained administrative data on the number and scope of the vaccination drives that took place during the period of our study. We provide evidence that the number of vaccination campaigns and the number of children targeted during those campaigns did not differentially change across districts with different levels of support for Islamist groups. Furthermore, we show that the availability of health facilities did not experience differential changes. Finally, we show that our main results are fully robust to controlling for measures of supply of health services.

This paper is related to a number of different literatures. First, the paper relates to the recent literature that has investigated the determinants of demand for health care in developing countries. See Dupas (2011), Banerjee and Duflo (2012), and Dupas and Miguel (2017) for literature reviews. These studies document that, oftentimes, the poor exhibit low levels of demand for highly effective preventive care, such as vaccines. While the reasons are varied, in some cases the poor seem to have incorrect beliefs about the effectiveness of preventive treatments. Misconceptions about the effectiveness of vaccines and the concerns over potential side effects are also prevalent in developed countries. However, the problem is exacerbated in developing countries due to a lack of well-established organizations that certify treatments and enjoy a respectable reputation, such as the Food and Drugs Administration in the US or the European Medicines Agency.

Despite the prominent role of trust in shaping the demand for vaccination, there is limited empirical evidence on the causal effect of events that damage the reputation of vaccines on immunization rates. Das and Das (2003) examine the determinants of the demand for vaccination in a case study from one Indian village. In this village, vaccination rates sharply declined after two mothers died while in labor. The authors argue that the deaths of these two mothers led to a decrease in the level of trust in the local midwife. Since the local midwife was also in charge of delivering vaccines, the authors argue that it is likely that parents started distrusting the midwife's recommendation to vaccinate their children, after

[6] Starting in mid-2012 the Taliban carried out attacks and intimidation acts against health workers. This could have hindered the operations of immunization drives or may have discouraged effort from health workers. While the areas subject to the most intense intimidation campaigns against health workers are not in our sample, this remains an important alternative channel for our results.
The Express Tribune. 2012. "Six polio workers shot dead in Pakistan: Police". *The Express Tribune*, December 18. *https://tribune.com.pk/story/481168/five-polio-workers-shot-dead-in-pakistan/* (last accessed 06.09.2017).

the two mothers passed away.[7]

Our study is most closely related to a recent set of papers that have studied the effects of medical malpractice on subsequent demand of health services. Alsan and Wanamaker (2018) study the implications of the Tuskegee experiment, in which a number of black males, infected with syphilis, were intentionally denied medical treatment in order to study the long-term effects of the disease. The paper documents that the disclosure of the Tuskegee study in 1972 was associated with a decline in utilization of medical services and with negative health outcomes for black males living in states close to Tuskegee. The authors argue that the effects are driven by the fact that black males identified more closely with the subjects of the Tuskegee experiment and, consequently, developed lower levels of trust in healthcare institutions. Lowes and Montero (2018) study the long-run effects of the French colonial campaigns against the sleeping sickness in West Africa. These campaigns involved forcefully treating the native population with ineffective medical treatments that had serious side-effects.

Our paper makes several contribution to this nascent research agenda. First, we focus on a shock to the reputation of vaccines and examine immunization rates as the main outcome of interest. Given the inherent difficulties in inferring the effectiveness of vaccines based on own-experience, shocks to the reputation of vaccines can be especially damaging. Second, we examine events that were detrimental to the reputation of vaccines in the context of the recent history of Pakistan. Hence, this illustrates that preserving the reputation of vaccines and the health sector more generally is a current pressing issue for developing countries. Third, we differ from previous studies in exploiting ideological proximity to the Taliban, as opposed to distance to the onset of the event or demographic characteristics. By the time at which the vaccine ruse was disclosed, the Taliban had established an on-going defamation campaign against vaccination efforts. Hence, it is likely that the cross sectional variation that we exploit is closely connected to exposure to information discrediting vaccination campaigns and to the likelihood that individuals updated their beliefs based on the new information.

This paper is also related to the literature that examines the effect of persuasive communication on behavior. See Della Vigna and Gentzkow (2010) for a literature review. While a large literature has documented the effect of advertising campaigns and media exposure on consumer and voting behavior, to the best of our knowledge, no study has documented the causal effect of propaganda campaigns against vaccines—or of information lending credibility to such campaigns—on immunization rates. Furthermore, the presence of an active

[7]The medical literature has examined the correlates to vaccine hesitation and has tested a number of interventions to reduce it. See Sadaf et al. (2013) for a literature review. Also, Oster (2017) provides evidence of that outbreaks of diseases in the USA are followed by higher vaccination rates.

political group trying to discredit the reputation of vaccines by means of spreading rumors and wrongful information connects the paper with the recent literature on the effects of fake news and the consequences of conspiracy theories.[8] A way of conceptualizing the natural experiment described in this paper is as follows: the disclosure of the vaccine ruse constituted a piece of information that lent credibility to a set of rumors and conspiracy theories related to vaccinations that were circulating in the Pakistani population. As a result, the diffusion of these rumors and misinformation increased. It is the combination of these two factors, we argue, that led to the discrediting of vaccines and to the effects that we estimate in this paper.

In order to compare our results to the literature on persuasive communication we compute persuasion rates as defined by Della Vigna and Gentzkow (2010). We estimate that the events described in this paper led to persuasion rates of 27% for polio vaccination, 24% for DPT vaccination, and 26% for measles vaccination. See section 11 in the Online Appendix for details. These persuasion rates are among the highest rates reported in Della Vigna and Gentzkow (2010), which range between 0.7% and 29.7%, with the median persuasion rate being 8%.[9]

The remainder of the paper is organized as follows. Section 2 provides background information on the political and administrative context of Pakistan. Section 3 presents the data used in the analysis. Sections 4 presents the empirical strategy. Section 5 discusses the main results. Section 6 presents the robustness checks. Section 7 discusses evidence on the mechanism. Section 8 concludes.

2 Background

2.1 The Vaccine Ruse

In the summer of 2010, the CIA obtained intelligence that Bin Laden could be hiding in a compound located in the city of Abbottabad, Pakistan. During the following months, the CIA surveilled the compound in a number of different ways, such as via satellite images and from a nearby safe house. Yet, prior to launching an operation that would entail invading the territory of Pakistan, a critical ally of the US in the region, the CIA wanted to obtain definite proof that Bin Laden was hiding in the suspected compound. To this end, the CIA organized a fake vaccination campaign. The main objective of this vaccination ruse was to

[8]See Alcott and Gentzkow (2017) for a literature review.

[9]This study is also related to a recent set of papers that explore the determinants of anti-Americanism ideology and trust in the state in the Pakistani context (Bursztyn et al. 2017, Acemoglu et al. 2018). It also relates to the literature on the delivery of health services in Pakistan (Andreoni et al. 2016).

obtain DNA samples of children living in the compound and compare them to the DNA of Bin Laden's sister, who died in Boston in 2010. Obtaining proof that the children were related to Bin Laden would have been telling evidence that Bin Laden was hiding in the compound.[10]

To conduct the fake vaccination campaign, the CIA recruited a senior Pakistani doctor, Dr. Shakil Afridi. The doctor, in turn, hired low-ranked health workers, who were unaware of the motives behind the vaccination campaign and of the CIA involvement in the operation. Bypassing the official Pakistani health services, in March 2011, Dr. Afridi began a vaccination campaign for hepatitis B in a poor neighborhood of the city. In April 2011, the team moved to Bilal Town, a rich suburb of the city, where the suspected compound was located. Allegedly, one of the nurses gained access to the compound. However, whether the operation succeeded in obtaining DNA samples of children in the compound is still unclear.

On the 2nd of May 2011, U.S. special forces carried out a targeted attack on the compound resulting in the killing of Osama Bin Laden.

A few months later, on July 11th of 2011, the British newspaper *The Guardian* published an article describing the vaccine ruse.[11] The article described the collaboration of Dr. Afridi with the CIA and the attempts of health workers to obtain DNA samples from children living in the suspected compound during the vaccine ruse.[12]

The involvement of health personnel in the operations to capture Osama Bin Laden was intensely criticized, both in the US as well as in other countries.[13] In January 2013, the deans of twelve leading public health schools sent an open letter to President Obama protesting against the use of vaccination programs in espionage activities.[14] In response to

[10] Shah, Saeed. 2011. Op. cit.

[11] Ibid.

[12] In January 2012, the U.S. Defense Secretary at that time, Leon E. Panetta, publicly confirmed that the Pakistani doctor Shakil Afridi had collaborated with the CIA to gather intelligence in the city of Abbottabad. Shakil Afridi was arrested shortly after the operation to kill Bin Laden had been concluded. He was accused of conspiracy against the state and sentenced to serve 33 years in jail on the 23rd of May 2012.
Mazetti, Mark. 2012. "Panetta Credits Pakistani Doctor in Bin Laden Raid". *The New York Times*, January 28. *http://www.nytimes.com/2012/01/29/world/asia/panetta-credits-pakistani-doctor-in-bin-laden-raid.html?_r=0* (last accessed 06.09.2017).
Boone, Jon. 2012. "Doctor who helped US in search for Osama Bin Laden jailed for 33 years". *The Guardian*, May 23. *http://www.theguardian.com/world/2012/may/23/doctor-bin-laden-cia-jail* (last accessed 06.09.2017).

[13] Some of these reactions were described in an article published in 2013 in the Scientific American Magazine. For instance, Leslie F. Roberts, Professor of Columbia University's Mailman School of Public Health argued *"Forevermore, people would say this disease, this crippled child is because the U.S. was so crazy to get Osama bin Laden."*
Scientific American. 2013. "How the CIA's Fake Vaccination Campaign Endangers Us All". *Scientific American*, May 1. *https://www.scientificamerican.com/article/how-cia-fake-vaccination-campaign-endangers-us-all/* (last accessed 06.09.2017).

[14] Johns Hopkins Bloomberg School of Public Health. 2013. "CIA Vaccination Cover in Pak-

these critiques, on May 2014, the White House announced that the CIA had pledged not to use vaccination programs as a cover to gather intelligence or genetic material.

2.2 Political Context in Pakistan

Pakistan is divided into four provinces, three territories, and the capital city of Islamabad. Our study focuses on the four provinces of Balochistan, Khyber Pakhtunkhwa, Punjab, and Sindh.[15] Provinces are divided in districts. In the year 2013, the four provinces of Pakistan had 114 districts in total.

Pakistan is a federal parliamentary democracy which had held regular election since the end of the Musharraf regime in 2008. Legislative elections take place every five years. Since 2008, two main political forces have been alternating in power: first, the Pakistan Peoples Party (PPP) a center-left political party founded by Zufilkar Ali Bhutto and currently led by Yousaf Gillani; second, the Pakistan Muslim League (N) (PML (N)) a right-wing nationalistic party led by Nawaz Sharif, the current prime minister of Pakistan.

A number of smaller political parties have also contested elections in Pakistan. Foremost among them is an alliance of six Islamist parties known as *Muttahida Majlis-e-Amal* (MMA).[16] This alliance was established in 2002 in direct opposition to Pakistan's support to the US-led invasion of Afghanistan. All of the parties organized within the MMA are Islamist in nature. The three largest and most influential parties[17] strongly emphasize Islamist moral and principles in every day life. They preach a hard-line and traditional Islamic ideology that is shared by many Pashtuns living along the Pakistani-Afghan border. These political groups all have historical and ethnic links with the Afghan Taliban, as they are all Pashtun, which is Afghanistan's largest and Pakistan's second largest ethnic group.[18]

Several authors have documented the close connections between some of the parties that form MMA and the Pakistani-Taliban. Norell (2007) documents a vast amount of political,

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istan". *Johns Hopkins Bloomberg School of Public Health*, January 8. *https://www.jhsph.edu/news/news-releases/2013/klag-CIA-vaccination-cover-pakistan.html* (last accessed 23.04.2018).

[15] We exclude from the study the Federally Administered Tribal Areas, also known as FATA. This region is semi-autonomous and has never been under the full control of the Pakistani government. We also exclude from the sample the semi-autonomous territories of Gilgit-Baltistan and Azad Kashmir because they experience the long-standing conflict with India for the overall Kashmir region. No data on vaccinations are available for these regions. Finally we exclude the capital city of Islamabad because it constitutes a large city and operates very differently from the rest of the country. The four provinces in our sample cover 96.47% of the current undisputed territory of Pakistan and contain 97.35% of its population. See section 10 in the Online Appendix for further details on the data.

[16] The six parties are: Jamiat Ulema-e-Pakistan (JUP), Jamiat Ulema-e-Islam-Fazl (JUI-F), Jamiat Ulema-e-Islam (JUI-S), Jamiat-e-Ahle Hadith, Pakistan Isami Tehrik (ITP) (formerly Tehriq-e-Jafaria (TeJ)) and Jamaat-e-Islami (JI).

[17] JUI-F, JUI-S, and JI.

[18] See Norell (2007).

financial, and ideological connections between members of the individual parties contained in the MMA and the Taliban. For instance, many of the Taliban leaders have been educated in the madrassas run by some of the Islamist parties that form MMA. Also, MMA leaders have been observed attending the funerals of Taliban fighters. Both Taliban and JUI-F flags were displayed during these funerals (Norell (2007), page 75). While the support of MMA to the Taliban is not official, the electoral support of MMA predominantly consists of individuals that are sympathetic to the Taliban and support their fight in Afghanistan (Norell (2007), page 71).

2.3 The Pakistani Taliban's Anti-Vaccine Propaganda

Islamist extremist groups have tried to discredit formal medicine and vaccines on multiple occasions. In Pakistan, the Taliban have recurrently engaged in propaganda campaigns, which questioned the effectiveness and safety of vaccines. For instance, starting in 2006, the Taliban leader Maulana Fazlullah criticized Western lifestyles and polio vaccination drives during illegal radio shows and Friday prayers in local mosques. He claimed that the polio eradication campaign was part of a "conspiracy of Jews and Christians to make Muslims impotent and stunt the growth of Muslims" (Roul (2014), page 18).

Islamist groups have also spread a variety of other rumors and misconceptions about vaccines. For instance, they have argued that vaccines should be avoided because they were made out of pig fat—and hence forbidden for Muslims—and because it is un-Islamic to "take a medicine before the disease [is contracted.]"[19] The concern that vaccines are a conspiracy to sterilize Muslim children, girls in particular, has been recurrent.[20]

In this context, the disclosure of the CIA vaccination sham had a large impact because it lent credibility to many of the Taliban's arguments against vaccines. Several scholars and journalists have made this observation.[21] For instance,

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[19] Nishtar (2009).
Saleem, Sana. 2011. "Muslim scholars fight to dispel polio vaccination myths in Pakistan". *The Guardian*, November 4. *https://www.theguardian.com/commentisfree/belief/2011/nov/04/polio-vaccination-pakistan*, (last accessed 25.04.2018).
Siddiqui, Taha. 2014. "The naysayers' propaganda machinery". *Dawn*, February 23. *https://www.dawn.com/news/print/1088811* (last accessed 25.04.2018).

[20] Scientific American. 2013. Op. cit.

[21] Saleem, Sana. 2011. "Muslim scholars figth to dispel polio vaccination myths in Pakistan". *The Guardian*, November 4. *https://www.theguardian.com/commentisfree/belief/2011/nov/04/polio-vaccination-pakistan*, (last accessed 25.04.2018).
Shah, Saeed. 2012. "CIA tactics to trap Bin Laden linked with polio crisis, say aid groups". *The Guardian*, March 2. *https://www.theguardian.com/world/2012/mar/02/aid-groups-cia-osama-bin-laden-polio-crisis* (last accessed 25.04.2018).
Roul (2014).

"However the ruse has provided seeming proof for a widely held belief in Pakistan, fuelled by religious extremists, that polio drops are a western conspiracy to sterilise the population."[22]

The Taliban reacted to the disclosure of the vaccination ruse by intensifying their propaganda campaign against vaccines. They levered on the renewed credibility of their claims and issued a number of religious edicts (*fatwas*), directly linking the on-going vaccination campaigns to espionage activities by the CIA.

"The CIA's actions likely made the Taliban leadership in Pakistan all the more suspicious about the vaccination programs, and it contributed to a renewed armed backlash against polio immunization workers in the country.

According to a Taliban fatwa issued in June 2012, "polio agents could also be spies as we have found in the case of Dr. Shakil Afridi [Pakistani doctor involved in the CIA vaccination ruse] *has surfaced. Keeping these things in mind we announce to stop the polio dosage.""*[23]

The renewed propaganda campaign was spread through illegal radio shows, extremist religious leaders, and through right-wing newspapers.[24]

"Many parents still resist the vaccine, as they believe in many conspiracies. Some think it's a Western conspiracy to sterilise the next generation, while others think that this campaign is a cover for some kind of spy programme. Many Urdu newspapers and magazines publish material to the effect that polio drops are not good for children, and then religious clerics use these articles to prove their conspiracy theories." (Siddiqui (2014), quoting a campaigner in the Karachi polio vaccination team.)[25]

The Taliban have also exerted violence against vaccination workers. Seventy health workers had been killed during this campaign of violence, which started in July 2012.[26] Taliban leaders also boycotted immunization campaigns by banning immunization drives.

[22] Shah, Saeed. 2012. Op. cit.

[23] Roul (2014), page 18.

[24] Siddiqui, Taha. 2014. Op. cit.

[25] Ibid.

[26] The first attack happened in July 2012 in the city of Karachi, the capital of Sindh province. In December 2012, coordinated attacks took place in several districts during a national vaccination drive.
Roul (2014).
BBC. 2015. "Four kidnapped polio workers are found dead in Pakistan". *BBC*, February 17. *www.bbc.com/news/world-asia-31507217* (last accessed 25.04.2018).

These boycotts and most of the attacks to health workers took place in the FATA region, which is not included in our study sample. Nevertheless, we discuss later in the paper how intimidation to health workers could affect our empirical strategy.

In April 2013, the Pakistani Taliban issued a statement declaring that they will not interfere with the polio vaccination drives as long as the drives were not used by the United States as a cover for espionage and as long as the vaccine was manufactured in accordance with Islamic laws.[27] However, the conflict between the Taliban, the Pakistani government, and the United States has continued affecting the immunization campaigns, predominantly in the FATA region (Ahmad et al. (2015)).

Since 2013, vaccination campaigns have also aimed at addressing misconceptions about vaccines by engaging local community and religious leaders during vaccination drives. Vaccinators have been equipped with fatawa (religious) books and videos on their mobile phones that describe vaccines as being safe and in accordance with Islamic precepts. Vaccine workers show these materials to parents that hesitate to vaccinate their children because of religious concerns.[28]

2.4 Immunization in Pakistan

Children in Pakistan typically receive three main vaccines at young age through routine immunization activities: vaccine against poliomyelitis (or polio vaccine), DPT (vaccine against diphtheria, pertussis, and tetanus); and measles vaccine. Pakistan follows the recommended vaccination calendar of the World Health Organization and the first dose of most of these vaccines is supposed to be administered shortly after birth. See Appendix Table 1 for details on the immunization calendar.[29]

The health workers responsible for immunization of children are Lady Health Workers. These workers are assigned to a local health facility and each of them is responsible for, approximately, 1,000 people or 150 homes. They regularly visit households to provide information on family planning and to immunize children according to the vaccination schedule.[30]

The Expanded Program on Immunization of Pakistan (EPI, henceforth) coordinates the

[27] Roul (2014).

[28] Khan, Taimur. 2017. "How Pakistan got to near zero on polio". *www.devex.com*, November 14. *https://www.devex.com/news/how-pakistan-got-to-near-zero-on-polio-91521* (last accessed 23.04.2018).

[29] The official immunization schedule of Pakistan is published by the Expanded Program on Immunization (EPI), Pakistan.
Expanded Program on Immunization (EPI), Pakistan. 2017. "Immunization Schedule". *http://epi.gov.pk/?page_id=139* (last accessed 06.09.2017).

[30] The Lady Health Worker program was established in 1994 by the federal government. Since 2010, the provision of health public goods is a provincial responsibility. In 2014, there were, approximately, 110,000 Lady Health Workers in Pakistan.

procurement and supply of vaccines, syringes, safety boxes and other vaccination-related logistical needs of health providers. These EPI activities are financed by the federal government of Pakistan. Nevertheless, the provinces through respective EPI programme units are themselves responsible to manage the operational cost of the immunization activities at the provincial and district levels.

The supply of polio vaccine plays a special role in the EPI activities. Pakistan is one of the only two countries in the world in which the poliomyelitis virus is still endemic.[31] Immunization against polio is supported by the Global Polio Eradication Initiative. In conjunction with staff from the World Health Organization, EPI coordinates national as well as subnational immunization days during which vaccinators (typically lady health workers joined by other volunteers recruited from different branches of local government, e.g. the education department) provide the polio vaccine at households' doorstep. These immunization campaigns take place every month in most districts. They typically last for 3 days and target all children up to age 5 in the respective district.

3 Data

Our main data source is the Pakistan Social and Living Standards Measurement (PSLM) provided by Pakistan's Bureau of Statistics. These data contain individual-level data on the vaccination status of each child living in the household. For our main results we focus on waves 2010/11 and 2012/13, which cover the events of interest. In some of the robustness checks we also use the 2008/9 wave.

Our main outcomes correspond to whether a child has received the first dose of the polio, DPT, or measles vaccine, respectively. Focusing on the first dosages provides a tighter prediction of how the events described in this paper affected children's vaccination status. However, we also present results for full immunization rates — i.e., receiving all dosages of each vaccine. We record a successful vaccination if the immunization was reported in the vaccine card. In order to minimize the scope for misreporting we do not rely on recall measures of vaccinations.[32]

Our baseline sample records the vaccination status of 22,346 children born between 2010 and 2012 that were up to 24 months old at the time of the interview. These children are distributed through the 114 districts that conform the four provinces that are part of our study. See Appendix Table 2 for descriptive statistics and Appendix Table 3 for a tabulation

[31] The other country where polio is still endemic is Afghanistan.

[32] Vaccination status based on recall has been shown to be subject to a large extent of measurement error (Research and Development Solutions (2012); Sheikh et al (2011)). See section 10 of the Appendix for further details on the construction of our main outcome variables.

of the cohorts included in our baseline sample.

We complement this analysis with data from the Demographic Health Survey (NIPS, 2008, 2013). We use the two waves closest in time to the disclosure of the vaccine ruse: 2006 and 2012. Using these data, we replicate our main results on immunization and conduct some additional analysis. However, the sample size is more limited—about 6,500 children—and the study waves are more distant to the time of the vaccine ruse, relative to the PSLM data. Hence, our preferred specifications are estimated using the PSLM survey.

As a measure of support for political Islamist groups, we collect electoral data from the legislative elections of 2008 provided by the Election Commission of Pakistan. In particular, we obtain constituency-level electoral results for the provincial assembly. Electoral constituencies are smaller than districts. Hence, we aggregate the results at the district level. Our main measure of support for Islamists groups is the population-weighted share of votes obtained by the alliance of Islamist parties, *Muttahida Majlis-e-Amal* (MMA), across all constituencies within a given district. See section 10 in the Online Appendix for further details. Figure 1 represents the geographic distribution of the district-level vote shares for MMA in the 2008 election.

For the purpose of this project, we also collected administrative data on the polio vaccination campaigns that were conducted between 2008 and 2013 throughout Pakistan.[33] These data contain district-month measures of whether a polio vaccination campaign was conducted, the type of campaign—national or subnational immunization days—, and the number of children targeted.

We also use some additional datasets that we describe as they become relevant. For an exhaustive description of the data used in this paper see section 10 of the Online Appendix.

4 Empirical Strategy and Basic Results

Our objective is to evaluate the effect of the disclosure of information about the vaccine ruse and the subsequent intensification of anti-vaccine propaganda on immunization rates. Our main outcomes of interest are binary variables that take value 1 if a particular child has received the first dose of polio, DPT, or measles vaccine, 0 otherwise. Our working assumption is that the date of birth and the district of residence jointly determine children's exposure to the shock induced by the disclosure of the vaccine ruse.

Children born after July 2011 were fully exposed to the disclosure of the vaccine ruse, since their entire childhood took place after the information had been disclosed. Children

[33] These data was kindly provided by the internal monitoring and surveillance unit at the National Emergency Operations Centre within the Expanded Program on Immunization in Pakistan.

born *much earlier* were not exposed to the disclosure of information, since they reached older ages before the information about the vaccine ruse was available. Children born *shortly before* July 2011, were partially exposed, since part of their early months of life took place under the new information scenario.

In order to identify the partially exposed children and the non-exposed children, we empirically examine the age profiles of the three vaccines. The official immunization schedule—presented in Appendix Table 1—is not perfectly enforced. Hence, it is important to empirically examine how the likelihood of obtaining each vaccine changes as children get older.

Figure 2 presents the monthly age profiles of the main vaccines. These figures show the fraction of children that received the first dose of each vaccine as a function of their age at the time of interview. We restrict the sample to the pre-treatment period, so that the age profiles are not confounded by the effects of the disclosure of information on the vaccine ruse.[34] As we can see, the likelihood of obtaining the first dose of the polio and DPT vaccines increases during the first three months of life and remains constant thereafter. This is consistent with the first dose of these vaccines being received during regular visits of Lady Health Workers or during vaccination drives in the first months of life. This evidence also illustrates the imperfect compliance with the official calendar: the first dose of polio is supposed to be received at birth and the first dose of DPT in the 6th week of life. The last panel of the figure shows the age profile of the measles vaccine, which is supposed to be administered in the 9th month of life. As we can see, the probability of receiving the first dose of the measles vaccine rapidly increases after the 9th month of life and reaches a plateau after the first year of life.

When considering immunization status of polio and DPT, we will regard children born in the three months prior to July 2011 as partially treated: the information on the vaccine ruse is disclosed at a time when their likelihood of receiving the vaccine was rapidly increasing. Similarly, when considering the measles vaccine, we will consider children born in the year prior to July 2011 as partially treated.

Note that the probability of receiving the first dose of these vaccines tends to increase during the first months of life. However, in each of the three cases, it reaches a plateau suggesting that a substantial fraction of children remains unvaccinated. This is consistent with certain families being isolated from vaccination (either because of lack of demand or supply) and inconsistent with erratic or irregular supply of vaccines. In the latter case, we would expect a continuous increase in the probability of the receiving the vaccines as children get older.

[34] In particular, we restrict the sample to PSLM waves 2008/09 and 2010/11. The latter wave was fielded before June 2011.

Our main empirical strategy consists of comparing vaccination rates across cohorts of children with different levels of exposure to information on the vaccine ruse, and across regions that have different levels of support for Islamist parties. The underlying hypothesis is that parents in districts, in which higher support for political Islamist groups prevails, were more likely to change their beliefs about vaccines according to the messages spread by the Taliban.

In order to provide a visual representation of the variation used in this empirical design, Figure 3 presents the age profiles of children observed before and after the disclosure of information and across regions with different levels of support for Islamist parties.[35] The figures on the left panel restrict the sample to districts in the first quartile of the distribution of support for Islamist parties. The figures on the right show the age profiles for districts in the top quartile of the distribution of support for Islamist parties.

The left-hand side figures show that, in regions with low support for Islamist parties, the immunization age profiles are similar before and after the disclosure of information on the vaccine ruse. In contrast, the right-hand side figures show that, in regions with high support for Islamist groups, vaccination rates experienced a substantial decline after the disclosure of information on the vaccination ruse. This result is consistent with the hypothesis that, in regions with high levels of support for Islamist groups, a larger proportion of parents were influenced by the anti-vaccine propaganda spread by the Taliban, became more skeptical about vaccination, and decided not to vaccinate their children.[36]

In Appendix Figures 1 and 2, we examine the age profiles for complete immunization. The PSLM survey only records the first three doses of polio and DPT, as well as the first dose of measles. Hence, we consider a child completely immunized against each disease if she received all dosages recorded in the survey. Similarly, we consider children "completely immunized" once they have received all dosages documented in the survey for the vaccines. See section 10 in the Online Appendix for further details.

The first two panels of Appendix Figure 1 show the age profiles for full immunization of polio and DPT. The last panel shows the age profile of full immunization for the three vaccines.[37] The figures show a steady increase in the likelihood that children are fully

[35]The age profiles labeled as "pre-period" use information from children observed in the 2008/09 and 2010/11 waves of the PSLM. All of them are born before June 2011. The age profiles labeled as "post-period" use information from children observed in the 2012/13 wave of the PSLM that are born after July 2011. Hence, all these children are *fully-exposed* to the information treatment.

[36]Note that the decline in vaccination rates seems to be higher for older children. The reason is that the old children in the post-treatment age profile are born at a time closer to the disclosure event—July 2011. (The post-treatment survey was conducted towards the end of 2012.) As we show later in the paper, the effects are the largest for the children born shortly after the disclosure of the vaccine ruse. See Appendix Figure 6 for the distribution of dates of interview in the different waves of the PSLM survey.

[37]Note that we only have information on one dose of the measles vaccine. Hence, the "full immunization"

immunized during the first 14 months of life. Hence, when the outcome is full immunization, we will consider children born between May 2010 and July 2011 as partially treated.

Appendix Figure 2 presents the age profiles for full immunization, before and after the disclosure of information, and across regions with different levels of support for Islamist parties. The results are similar to the ones documented for the first doses of each vaccine. In regions with low support for Islamist groups there are no differences in the age profiles before and after the treatment. In contrast, regions with high support for Islamist parties experience a decline of full immunization rates after the information on the vaccine ruse was disclosed.

Regression Framework

The previous results provide suggestive evidence on the effects of the disclosure of information of the vaccine ruse on immunization rates. However, the results could be subject to district- or cohort-level confounders. Next, we estimate a more demanding econometric specification that allows for the inclusion of controls:

$$Y_{ikaj} = \sum_k \beta_k D_k I_j + \gamma_k + \gamma_j + \gamma_a + \delta c_i + \epsilon_{ikaj} \tag{1}$$

where Y_{ikaj} is a dummy that captures the vaccination status of child i, born in month-year k, interviewed at age a, and living in district j. D_k is a dummy indicating whether the child belongs to month-year cohort k. I_j is the district-specific measure of treatment intensity, i.e. our proxy for support for Islamists parties. We define this measure in terms of standard deviations of the electoral support for Islamist parties, in order to facilitate the interpretation of the magnitudes. γ_k are monthly cohort fixed effects. γ_j are district fixed effect. γ_a are monthly age-at-interview fixed effects. c_i represents individual-level controls (in particular, month-of-interview fixed effects to control for seasonality and a dummy that takes value 1 for rural regions in the district). The sample includes children born between 2010 and 2012. The omitted category corresponds to the cohort born in January 2010 and standard errors are clustered at the parent district level.[38]

This specification allows a fully flexible pattern of treatment effect estimates by cohort. We expect β_k to take negative values for the fully exposed cohorts—born after July 2011—

figure for DPT would be equivalent to the one presented in Figure 2.

[38]During the sample period some districts experienced divisions. There were 109 districts in 2008 and 114 in 2012. We cluster the standard error at the level of districts in existence in 2008. Our measure of support for Islamist parties and district fixed effects are defined according to their boundaries in 2012. See Appendix section 10 for details on the construction of the data.

and possibly for the partially treated cohorts—born in the months leading to July 2011. Cohort fixed effects control for all factors that are common for all individuals in a cohort, such as nation-wide economic growth or improvements in health and nutrition over time. District fixed effects control for all time- (or cohort-) invariant factors such as geography, climate, or religiosity. Hence, the coefficients β_k are the cohort-specific *Difference-in-Differences* estimates that are identified out of within-cohort-variation across districts with different levels of support for Islamist groups.

Figure 4 plots the β_k estimates and 90% confidence intervals for different monthly cohorts. The pattern of coefficients is consistent with the predicted exposure to the information on the vaccination ruse. The estimates corresponding to the fully exposed cohorts —i.e. those born after July 2011— are negative. In contrast, the estimates for cohorts born much earlier than July 2011 fluctuate around 0 and are not statistically significant. This is consistent with the lack of differences in the evolution of vaccination rates across cohorts between districts with different levels of support for Islamist parties. In other words, it supports the lack of pre-trends assumption and, hence, our main identification assumption. We further discuss the identification issues later in the paper.

Consistent with the evidence on the age profiles, we also observe declines in vaccination rates for cohorts that are partially affected by the disclosure of the vaccination ruse. Children born 3 to 4 months prior to July 2011 experience drops in the likelihood of having received the polio or the DPT vaccines, whereas those born 8 months prior to July 2011 experience declines in the likelihood of the vaccination of measles.[39] The fact that the pattern of vaccination rates of partially treated children is consistent with the evidence obtained from the immunization age profile of the different vaccines is reassuring and consistent with the notion that the information disclosed in July 2011 affected the parental acceptance rates of vaccines.[40]

Appendix Figure 3 shows similar estimates for complete immunization of polio, DPT, and the three vaccines. We observe significant drops in immunization rates for fully exposed cohorts. Consistent with the age profiles of full immunization, we observe steady declines in immunization rates for those cohorts that were partially affected by the disclosure of information on the vaccine ruse.

[39]The cohorts in between the two vertical dashed lines correspond to the partially treated cohorts. Note that the age profiles of the polio and DPT suggest that the likelihood of receiving the first dose of these vaccines reaches a plateau in the third month of life. However, we also observe declines in the fourth month prior to the treatment. This is likely to be driven by measurement errors on the date of birth, with some children partially affected reporting dates of birth in the prior month.

[40]The figures are very similar when including only cohort and district fixed effects as controls. They are presented in Appendix Figure 4.

5 Main Regression Estimates

In this section, we present the main regression estimates to assess the magnitude and significance of the decline in vaccination rates. To provide a stark comparison, we compare vaccination rates between cohorts fully exposed to cohorts not-exposed to the new information environment. Hence, we exclude the partially treated cohorts from the sample.[41] We investigate how the difference between these two sets of cohorts varies across regions with different levels of Islamist groups. In other words, we implement the following *Difference-in-Differences* (DID, henceforth) empirical strategy:

$$Y_{ikaj} = \beta Post_k I_j + \gamma_k + \gamma_j + \gamma_a + \delta c_i + \epsilon_{ikaj} \tag{2}$$

where $Post_k$ takes value 1 for cohorts of children fully exposed to the disclosure of the vaccine ruse—that is, children born after July 2011—, and takes value 0 for not-exposed cohorts. The other variables are defined as in equation (1). Standard errors are clustered at the parent-district level.

Panel A of Table 1 presents the main DID estimates, $\hat{\beta}$, when the outcome variables are indicators of having received the first dose of different vaccines. All the estimates are negative and statistically significant at the 5% level: a one standard deviation increase in the support for Islamist groups is associated with declines of 4.5, 4.3, and 2.9 percentage points in the vaccination rates of polio, DPT, and measles, after the disclosure of information on the vaccine ruse. These declines in vaccination rates represent a 9 - 13% decline in vaccination rates over the corresponding sample mean. Column 4 shows that exposed cohorts are 3.2 percentage points less likely to have received the first dose of the three vaccines. This effect represents a 15% decline over the sample mean. Note that, the declines in effective protection against these diseases are likely to be larger since these estimates do not take into account the externalities generated by individual decisions to refuse vaccination.

Panel B of Table 1 presents the results on receiving all dosages of each vaccine. In column 4, we present the results on complete immunization defined by receiving all dosages of the three vaccines. The effects are similar in magnitude to those for the first dosage. For instance, one standard deviation increase in support for Islamist groups is associated to a 11% decline in full immunization rates. However, the sample size is smaller because there are more partially treated cohorts when we examine full immunization. Hence, we focus on the results on first dosages as our baseline estimates for the rest of the paper.

We verify the validity of these estimates by conducting a similar exercise using a different dataset: the Demographic Health Survey. See section 10 in the Appendix for details on the

[41] See the notes in Table 1 for details on the excluded cohorts.

construction of the sample and measures. The results are presented in Appendix Table 4. We obtain very similar estimates for the effects on the first doses of polio and DPT: 4.6 and 4.2 percentage points decline, respectively. The results for measles are negative, but small in magnitude and imprecisely estimated. Finally, the Demographic Health Survey also includes information on the vaccination status of the Hepatitis B vaccine. We find a negative and significant effect on the likelihood of being vaccinated for exposed cohorts. This outcome is of particular interest since the vaccination ruse consisted of a Hepatitis B vaccination campaign.

These results are consistent with the hypothesis that the disclosure of information on the vaccine ruse generated an increase in distrust towards formal medicine, which made parents become more hesitant about vaccines, and led some of them to actively refuse to vaccinate their children. It is likely that this increase in distrust was larger in regions with high support for Islamist groups, either because these regions were more exposed to the anti-vaccine propaganda campaigns by the Taliban, or because a larger fraction of the population was prone to believe the anti-vaccine messages spread by the Taliban. In section 7 we provide further discussion on the potential mechanisms behind these results and provide additional supporting evidence for a potential distrust channel.

6 Robustness Checks

Lack of Pre-Existing Trends

The main identifying assumption behind our empirical strategy is that, in the absence of the disclosure of information on the vaccine ruse, the across-cohorts evolution of vaccination rates would have been similar in districts with different levels of support for Islamist groups.

Note that the results presented in Figure 4 document the lack of differential trends across districts prior to the disclosure of the vaccine ruse. The point estimates of non-exposed cohorts fluctuate around zero and do not follow any specific pattern. The p-values of joint-significance of the coefficients of non-exposed cohorts are 0.69, 0.21, and 0.19 for the polio, DPT, and measles vaccines, respectively.

In Appendix Figure 5, we incorporate data from an earlier wave of the PSLM survey to show a longer sequence of pre-treatment coefficients. While the pre-treatment coefficients more distant from the vaccine ruse are more noisily estimated, they fluctuate around zero and confirm the absence of pre-existing differential trends across districts with different levels of Islamists support.[42]

[42] Appendix Figure 5 includes children born between 2007 and 2012. The omitted category corresponds to

Additional Controls for Differential Trends

Table 2 presents a number of additional robustness checks. Column 1 reproduces our main results for comparison. Column 2 incorporates as controls pre-treatment measures of access to health services interacted with yearly-cohort fixed effects. In particular, we control for the share of women that had received tetanus immunization, pre-natal care, and post-natal care during pregnancy. We measure these controls in the 2008/09 wave of the PSLM survey. In column 3 we include as controls the share of mothers with no formal schooling interacted with yearly-cohort fixed effects. The estimates are highly robust to the addition of these controls. These robustness checks mitigate the concern that our main estimates are driven by poorer districts—where Islamist groups tend to have stronger support— experiencing an underlying stronger decline in vaccination rates relative to more developed districts for reasons unrelated to the disclosure of the vaccine ruse.

Column 4 adds flexible controls for natural disasters. In 2010, a number of districts in Pakistan were affected by severe monsoon floods (Fair et al. 2017). To control for their effect, we incorporate as controls an indicator for flood affectedness interacted with yearly-cohort fixed effects. The results are highly robust to the addition of these controls.[43]

In column 5, we explore the possibility that our results are confounded by endogenous fertility decisions: if the disclosure of information on the vaccine ruse affected optimal fertility decisions, our sample may be selected on parents that decided not to postpone having children because of the disclosure of information. While we think it is unlikely that the shock affected the fertility decisions of a substantial fraction of the population, we nevertheless empirically explore this possibility. Column 5 reports the results when we restrict the sample to children conceived before the disclosure of the vaccine ruse—i.e. born before May 2012. The results are highly robust and, if anything, larger in magnitude.

Column 6 drops the district of Abbottabad, where the operations to capture Bin Laden took place. The results are robust, suggesting that the evolution of vaccination rates in this district are not driving the results.

In columns 7 and 8 we explore whether incidence of conflict affects our results. We construct different measures of the number of violent incidents based on the Armed Conflict Location & Event Data Project (ACLED). In column 7, we control for a the number of conflict events that occurred in a child's district of residence during her first year of life. In column 8, we construct a measure of pre-treatment conflict and interact it with yearly-cohort fixed effects. The results are highly robust to both set of tests.[44]

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children born in 2007.

[43]See section 10 in the Appendix for details on the construction of the flood affectedness measure.

[44]The measures of conflict contain battles, violence by non-state actors, violence against civilians, among

Selective Migration

Another potential concern is that the treatment may have induced differential migration across districts. If parents that are complying with (or intent to comply with) the vaccination schedule out-migrate in greater proportions from districts with high Islamist support, our results may be downward biased—i.e., biased towards finding a negative effect. Unfortunately, the PSLM data do not contain information on families' migration history or on parent's place of birth. Hence, in our baseline specification we assign children to the districts they are residing at the time of interview.

We conduct a number of tests to check whether selective migration could confound our estimates. First, we empirically investigate whether the composition of households changed differentially for districts with different levels of support for Islamist parties. We explore this in Appendix Table 5 by using child and household characteristics as dependent variables. Column 1 examines the gender of the child. In column 2 and 3, the dependent variables are the mother's education level and age, respectively. In column 4 the dependent variable is an indicator for residing in a rural area. In columns 5 and 6, we use as outcomes dummy variables to indicate whether a household owns either a radio or a television set, respectively. Lastly, in columns 7 and 8 we examine the number of household members as well as the number of rooms available to the household as dependent variables. The results show that all estimated interaction coefficients are close to zero and statistically insignificant. This supports the notion that there were no differential changes in the sample composition across districts that could confound our results.

In addition to these, we conduct a number of additional analyses using information from the Demographic Health Survey (DHS, henceforth). In the 2012 wave, the survey contains a module in which households are asked about their migration history and region of origin. We use these data to construct district-specific rates of in-migration and out-migration.[45] The average in-migration rate is 2.5%, the average out migration rate is 3.9%.[46] Given that the fraction of migrants is low, it is unlikely that selective migration could have large effects on our estimates. Nevertheless, we conduct a number of robustness checks.

In Panel A of Appendix Table 6, we control for the district-specific in- and out-migration rates interacted with a full set of cohort fixed effects. This addresses the concern that districts with different propensities to experience migration may have underlying different trends. The results are very similar to the baseline estimates.[47]

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others. See section 10 in the Appendix for details. Our results are robust to using measures of conflict that involve the Taliban as an actor. These results are available upon request.

[45] See section 10 for further details on the construction of these measures.

[46] The maximum rates of in- and out- migration are 11% and 22%, respectively.

[47] A caveat of this result is that the in- and out-migration rates are estimated with data from the 2012

In Panel B, we conduct an exercise to obtain a lower bound on the magnitude of our estimates assuming the most unfavorable scenario of potential selective migration. For each district, we compute the net out-migration rate.[48] We assume that districts with positive out-migration estimates have fewer observations in the post period, relative to a counterfactual scenario where the treatment—disclosure of the CIA's vaccine ruse—did not happen. Hence, we add "constructed" observations to those districts equal to the corresponding share of net out-migration.[49] In particular, the "constructed observations" are assigned to the post-treatment cohorts. In order to construct the most unfavorable scenario, we impute successful vaccination outcomes in districts where the level of support for Islamist groups exceeds the median in the sample, whereas we impute unsuccessful vaccination outcomes in districts, where the level of support for Islamist groups lies below the median in the sample. For districts where we estimate negative net out-migration rates, we proceed to drop observations. In particular, we drop observations with a successful vaccination outcome if the level of support for Islamist groups is below the median level in the sample, whereas we drop observations with an unsuccessful vaccination outcomes in districts where the level of support for Islamist groups exceeds the median in the sample.[50] Despite the extreme assumptions on the nature of selective migration, our estimates remain negative, large in magnitude and statistically significant, with the only exception of the measles vaccine, which is no longer statistically significant. These estimates constitute a lower bound on the negative effect of the vaccine ruse on vaccination rates. The fact that this lower bound is still large in magnitude is reassuring. In other words, it is unlikely that selective migration could entirely account for our estimates.

In Panel C, we use the fact that for the DHS sample we do have data on the district of origin of households observed in the post period. We estimate our effects when assigning households observed in the post period to their district of origin, instead of to their district of residence. The results are very similar to the baseline effects when using the DHS sample, which are presented in Appendix Table 4.

Additional Robustness Checks

We provide a number of additional robustness checks in the Appendix. Appendix Table 7 shows our main outcomes when we only include cohort and district fixed effects as controls.

wave of the DHS. Hence, migration rates are measured after the disclosure of the vaccine ruse and, hence, can be endogenous to the treatment. Migration measures not available for earlier waves.

[48] The net out-migration rate is equal to the out-migration rate minus the in-migration rate.

[49] We assume that these observations have characteristics equal to the average in that district among the post-treatment cohorts.

[50] The observations dropped are selected at random among the observations that have the specified vaccination status.

Our results are robust to this basic *Difference-in-Differences* model. In Appendix Table 8, we assess the robustness of our results to non-linear specifications of support for Islamist parties. In Panel A, we show the results for above the median level of support for Islamist parties, whereas in Panel B we examine the effects by terciles. The panels are consistent with our baseline specification. The results indicate that the effects are monotonically increasing in the magnitude of support for Islamist groups. This is not affected by the particular functional form that we use for the support for Islamist parties.

7 Mechanisms

The results presented in this paper are consistent with the hypothesis that the disclosure of the vaccine ruse eroded the population's trust towards vaccines and towards formal medicine. In particular, the disclosure of this information lent credibility to the ongoing conspiracy theories and rumors spread by the Taliban. The Taliban used this opportunity to increase their efforts to discredit vaccines by intensifying their anti-vaccine propaganda. It is the combination of these factors that, we argue, led to a decline in the levels of trust in vaccines and to declines in the demand for immunization. In this section, we provide further evidence supporting this mechanism and we evaluate the validity of competing explanations.

7.1 Effects on Health Seeking Behavior

If the disclosure of information eroded the level of trust in vaccines and in the medical sector, we may expect that households also reduced their demand for other health services. In order to examine this, we modify the empirical specification from a cohort to a time dimension.

$$Y_{itj} = \beta Post_t I_j + \gamma_t + \gamma_j + \delta c_i + \epsilon_{itj} \tag{3}$$

Y_{itj} corresponds to a health seeking behavior measure related to child i, whose parents were interviewed in date t, in district j; $Post_t$ is a dummy that takes value 1 if the household was interviewed after July 2011; I_j is electoral support for Islamist parties in standard deviations; γ_t are quarter-year of interview fixed effects; γ_j are district fixed effects; c_i contains individual-level controls: dummy for rural region and monthly age of child i. We focus on the same sample of children, younger than 24 months old to facilitate the comparison with the immunization results.[51]

[51]Note, that we do not eliminate from the sample partially treated children in a cohort-sense. When we redefine the variation from a cohort to a time dimension, all health seeking behavior observed after July 2011 is subject to the new information scenario, while all behavior observed before July 2011 is not affected by the new information. The results are similar if we drop children partially treated in a cohort-sense.

Table 3 presents the results for a number of health outcomes. Panel A uses measures available in our baseline sample from the PSLM survey. The outcome variable in column 1 is an indicator for whether the child was sick in the two weeks prior to the date at which the survey took place. The results in Panel A show that the likelihood of children getting sick was differentially higher in areas with higher support for Islamist parties. This suggests that the declines in vaccination rates may have made children more vulnerable to diseases.

In columns 2 and 3, we restrict the sample to children that reported being sick in the last two weeks. The dependent variable in column 2 is a dummy that takes value 1 if parents consulted anyone for the sickness of their child. We estimate a negative and significant effect, suggesting that parents were less likely to seek help in the event of sickness. The survey also records the type of health provider consulted. Column 3 shows that the decline in seeking help is driven by a decline in the likelihood to consult the formal medical sector.[52] Hence, consistent with the demand channel, we find that parents in districts with higher Islamist sentiments reduced their demand for formal medicine after the disclosure of information about the vaccine ruse.

Panels B to D conduct similar analysis using as outcomes measures obtained from the DHS survey. The sample size is smaller and, hence, the results are less precisely estimated. Nevertheless, they confirm that parents in districts with more support for Islamic groups experienced a larger decline in their demand for health services when their children became sick.

7.2 Effects on Trust Measures

The evidence presented so far is consistent with the idea that the disclosure of the vaccine ruse led to a decline in the levels of trust in formal medicine, which was more acute in regions with greater support for Islamists groups. In this subsection, we provide suggestive evidence on the decline in trust levels by examining data from the South Asia Barometer.

These data report individual-level measures of trust in different organizations for a large sample of individuals. However, it does not explicitly record trust on formal medicine or in health organizations. The closest proxy for trust in the health sector is health in the civil service. We combine two waves of this survey—2005 and 2013—, which enable us to compare levels of trust before and after the disclosure of the vaccine ruse. A limitation of these data is that there is no information on the district of residence of individuals. Respondents are geocoded at the provincial level. Hence, we estimate a simple *Difference-in-Differences* model comparing measures of trust in the wave before and after the disclosure of information, and

[52]The non-formal medical sector comprises spiritualists, homeopaths, chemists, hakeem, or other.

across provinces with above or below the median support for Islamist groups.

Panel A in Table 4 presents the main results for measures of trust in different organizations. Column 1 shows the effects on trust in civil service. Provinces with high support for Islamist groups experienced a 7.6 percentage points decline in trust in the civil service after the disclosure of the vaccine ruse. This effect represents a 16% decline over the sample mean. Columns 2 to 9 show the effects on trust in other organizations. Most of the effects are negative and significant. The only exception is a positive effect on trust in the army, which could be influenced by the military operations in the north-west regions that took place in 2009. Column 10 evaluates the overall decline in trust measures by estimating the effects on a z-score index of the different trust measures. The results suggest that regions with high support for Islamist groups experienced a decline in trust measures of 0.08 standard deviations.

Given the coarseness in the geographic measure of support for Islamists groups, we enrich our empirical strategy by examining an individual-level predictor of sympathies for Islamist groups. In particular we add a triple interaction with a dummy that takes value 1 for individuals that do not own a TV. The Taliban have discouraged ownership of TV with the argument that that type of entertainment is contrary to the ultra-conservative lifestyle they advocate for.[53] The results, presented in Panel B, suggest that the decline in trust is driven by individuals that do not own a TV. The triple interaction is negative, large in magnitude, and typically statistically significant. (The only exception is again the results in trust in the army). Hence, these results suggest that the effects are driven by those individuals that are more likely to hold views aligned with Islamist groups.[54,55,56]

7.3 Alternative Channels: Changes in Supply of Health Services

An alternative explanation for our main results is that the supply of medical services may have endogenously reacted to the disclosure of the vaccine ruse. Starting in mid-2012 the Taliban carried out attacks against health workers. Hence, vaccination campaigns may have been more difficult to conduct in regions with higher Islamists support. However, a supply reaction is unlikely to fully account for the estimates presented in this paper, mainly for two

[53] Roul (2014).

[54] In Appendix Table 9 we present the coefficients of the post dummy, the "no TV" dummy, and the binary interactions of each of these variables.

[55] The results are robust to including measures of wealth of the individual, such as indicators for ownership of other items such as a car, phone, or fridge. The results are available upon request.

[56] Given that trust in the army seems to be affected by the particular political context, the last column shows the z-score for all trust measures except trust in the army. The effects are larger in magnitude and significance.

reasons. First, the intimidation campaign against health workers took place in the second half of 2012, while we find that vaccination rates declined substantially earlier. The results presented in Figure 4 indicate that the most affected cohorts are those born in the months around July 2011. Second, the region that suffered the most intense violence against health workers—i.e., the FATA region—is not part of our estimating sample. Nevertheless, we conduct a number of tests to assess the empirical relevance of a supply mechanism.

First, we examine measures of ease of access of health facilities as outcomes in our baseline specification. The results are presented in Appendix Table 10. The dependent variables in columns 1 and 2 correspond to the time required to travel to the nearest health clinic and basic health unit, respectively. This information was reported by parents in the PSLM survey. Hence, we have information at the child level.[57] The interaction coefficients are small and statistically insignificant. This suggests that access to health facilities did not differentially change across districts with different levels of Islamist support.

A remaining concern is that the supply of vaccines was affected by the disclosure of the vaccine ruse. As described in section 2, health workers suffered a number of attacks starting in the second half of 2012. To assess the empirical relevance of this channel, we collected administrative data from the Expandend Program on Immunization in Pakistan on the number of polio vaccination drives conducted between 2008 and 2013.[58] Column 3 shows the effects on an indicator for whether a vaccination drive took place. Column 4 shows the effect on the number of targeted children per capita. The unit of observation in these specifications is the month-district. The point estimates of our main interaction coefficient are small in magnitude and statistically insignificant. Hence, these results suggest that the supply of health services and vaccination campaigns did not differentially decline in regions with more Islamist support.

Next, we verify that our main estimates are robust to controlling for measures of supply. The results are presented in Table 5. Column 1 presents the baseline results for comparison. Column 2 controls for travel distance to the closest health clinic and basic health unit. The results are fully robust to the inclusion of these controls. In columns 3 to 6 we incorporate controls for the number of immunization campaigns and the number of targeted children per capita. For each child in our sample, we construct the corresponding average measure of supply of vaccines during her first three months of life or during her first month of life. The results are also fully robust to these different ways of controlling for the supply of vaccines.

[57]About 5% of the observations have missing values for distance to health facilities. In order to show results for our baseline sample, we fill in the missing values with the average distance to health facilities for children in the same district and year of interview. The results are similar when we do not conduct this imputation.

[58]See the section 10 in the Online Appendix for details.

Finally, we examine whether our baseline results are heterogenous as a function of the gender of the child. Note that it is unlikely that the gender of the child affects the supply of vaccines. Vaccinators should have the same willingness to vaccinate children regardless of the gender. However, some of the rumors spread by Islamist groups particularly targeted girls. In particular, they have recurrently claimed that polio vaccinations are a conspiracy to sterilize Muslim children, girls in particular.[59] If the disclosure of the vaccination ruse lent credibility to this rumor, we would expect the results to be larger when the child is a female.

In Table 6, we present results that include a triple interaction with a dummy that takes value 1 if the child is a female. The triple interaction is negative for all vaccines and statistically significant for polio and DPT. This suggests that girls were differentially less likely to be vaccinated after the vaccine ruse was disclosed. These results are consistent with parents lending higher credibility to defamation messages of Islamist groups and, hence, becoming even more skeptical of vaccinations when they had to decide about the vaccination of girls. Note that the interaction of a post dummy variable and support for Islamist groups is negative for the three vaccines. This suggests that the effect of the disclosure of the vaccine on boys was also negative, but lower in magnitude than the effect on girls.

Overall, while we cannot entirely rule out that supply of medical services reacted to the events described in this paper, the robustness of our results to controlling for supply suggest that changes in demand for vaccines are a key ingredient to explain the magnitude of our results.

7.4 Unbundling Demand: Changes in Beliefs or Intimidation

There are different reasons why the demand of vaccines may have changed as a response to the disclosure of information on the vaccine ruse. First, parents may have updated their beliefs according to the messages spread by the Taliban and, hence, may have become more skeptical about the benefits of vaccination.

There is substantial anecdotal evidence supporting this particular demand channel. For instance, an article under the title "We Believed Our Cleric" narrates the heartbreaking story of a father that did not vaccinate his son in 2012 and who later became paralyized from poliomyelitis.[60]

[59] Scientific American. 2013. Op. cit.

[60] Synovitz, Ron and Ahmad Ullah. 2017. "'We Believed Our Cleric': Pakistani Polio Victim's Regretful Father Urges Others To Use Vaccine". *Radio Free Europe Radio Liberty*, December 12. *https://www.rferl.org/a/pakistan-polio-vaccination-regretful-father-paralyzed-son/28912188.html* (last accessed 25.04.2018).

"Hamid Aziz says he listened to the advice of a cleric in his village, who announced over loudspeakers of the madrasah, a local Islamic religious school, that the vaccine was "not good" for children's health, and prevented it from being administered to any of his sons.

(...) Nooran Afridi, a pediatrician at a private clinic in Pakistan's Khyber tribal region, says one of the biggest obstacles to eradicating polio in Pakistan has been 'refusals' stemming from 'antipolio propaganda' spread by conservative Islamic clerics in 'backward areas.' "[61]

Interestingly, this article also describes the CIA vaccine ruse and anti-vaccine propaganda as a contributing factors to parental skepticism about vaccines.

"Antipolio propaganda also has been fueled by distrust in Western governments who fund vaccine programs—particularly after the CIA staged a fake hepatitis vaccination campaign in 2011 to confirm the location of Al-Qaeda leader Osama bin Laden in Abbottabad, Pakistan." [62]

Another piece of evidence consistent with a decline in demand in vaccines driven by vaccine skepticism is the fact that polio vaccination campaigns have actively tried to address parents' misconceptions since 2013. In particular, they have involved local community and religious leaders during vaccination drives. Vaccinators have been equipped religious books and videos on their mobile phones to address religious concerns regarding the usage of vaccines.[63]

An alternative channel that could have generated a decline in the demand for vaccination is intimidation by the Taliban or their supporters. Parents may have increasingly perceived vaccinating their children as an action in opposition to the Taliban's directives and may have feared that vaccination could have led to reprisals by Islamists groups.

This alternative mechanism is unlikely to fully account for our results. The main reason is that the regions with greater presence of the Taliban and more affected by conflict—FATA, Gilgit-Baltistan and Azad Kashmir—are not part of our estimating sample.

Nevertheless we empirically assess the relevance of this alternative channel. We obtain measures of conflict where the Taliban was a relevant actor from the ACLED data. There were 266 instances of conflict involving the Taliban in 2010 and 631 instances during the

[61] Ibid.
[62] Ibid.
[63] Khan, Taimur. 2017. Op. cit.
Synovitz, Ron and Ahmad Ullah. 2017. Op. cit.

2010-2013 period. Most of these events of conflict are classified as battles between the Pakistani security forces and the Taliban that did not result in an actual change of territory, incidences of remote violence, and violence against civilians.

We include as controls in our specifications the interaction of the indicator for fully exposed cohorts with the different measures of violence perpetrated by the Taliban. The results are presented in Appendix Table 11. Our main results are unaffected by the inclusion of these controls. Furthermore, the interaction of the post dummy with the measures of Taliban conflict are small and statistically insignificant. Hence, ideological proximity to Islamist groups is more closely related to the declines of vaccines than the violence exerted by the Taliban. This evidence is suggestive that the changes in attitudes is a more likely explanation for the decline in vaccination rates than the threat of violence or reprisals from the Taliban.

8 Conclusion

In this paper, we estimate the effects of the disclosure of information that damages the reputation of vaccines on immunization rates. We exploit the disclosure of information on the vaccine ruse that the CIA staged in 2011 as part of the operations to locate and capture Osama Bin Laden. This information lent credibility to a number of rumors and conspiracy theories spread by the Pakistani Taliban. In reaction, the Taliban intensified their anti-vaccine propaganda campaign by issuing religious edicts claiming that vaccination campaigns were a Western conspiracy to sterilize and spy on the local population.

We estimate a large negative effect on immunization rates. One standard deviation increase in support for Islamist parties is associated with 9 to 13% declines in vaccination rates. These effects correspond to 24 to 27% persuasion rates, which are among the highest estimated in the literature (see Della Vigna and Gentzkow (2010)).

We provide additional empirical evidence that suggests that these effects are likely to be driven by a reduction in the demand for vaccines: We show that other forms of health seeking behavior were also negatively affected. Our main results are robust to the inclusion of controls for the supply of vaccines and of health facilities. Furthermore, we find stronger declines in vaccination rates for girls than for boys. This is consistent with parents believing some of the rumors spread by Islamists groups that linked vaccines to attempts to sterilize Muslim girls.

We also provide suggestive evidence from the South Asia Barometer that suggests that regions with more Islamist support experienced larger declines in trust measures. Finally, we show that our results are robust to controlling for the presence of the Taliban and the incidence of Taliban attacks. This suggests that the decline in vaccine take-up is more likely to be driven by an increase in vaccine skepticism rather than by fears of retaliation by violent groups.

One limitation of our study is that we cannot disentangle the extent to which our results are driven by the disclosure of information on the vaccine ruse or by the subsequent intensification of the Taliban anti-vaccine propaganda. However, the events that we analyze in this paper have close parallels with other situations that have led to declines in the reputation of vaccines. For instance, the publication of the article in The Lancet linking autism to the measles vaccine took place in a context where a number of conspiracy theories had been circulating. This publication lent credibility to these theories, and resulted in an intensification in the distribution of the anti-vaccine rumors. The effects of statements made by celebrities questioning the efficacy of vaccines could be conceptualized in a similar way. Hence, an advantage of our setting is that it offers greater external validity when considering the potential damaging effects of the disclosure of these other pieces of information.

Finally, this paper offers—to the best of our knowledge—the first quantification of the negative effects of using health services as a covert for espionage operations. Despite the efforts of vaccination workers in regaining credibility in their work, the most affected cohorts exhibit persistent lower vaccination rates. Furthermore, the information that a vaccine drive was once used for espionage can resurface in the future, hence, making trust in vaccines vulnerable to future conspiracy theories.

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Figure 1: Distribution of Electoral Support for MMA

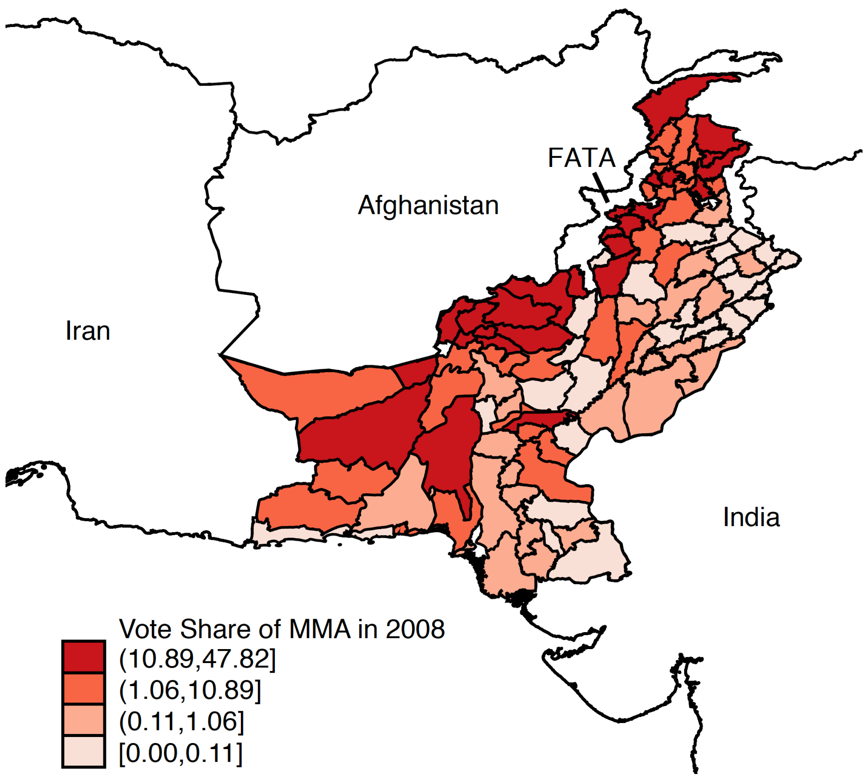


Figure 2: Age Profiles of Vaccines (Pre-Treatment Period)

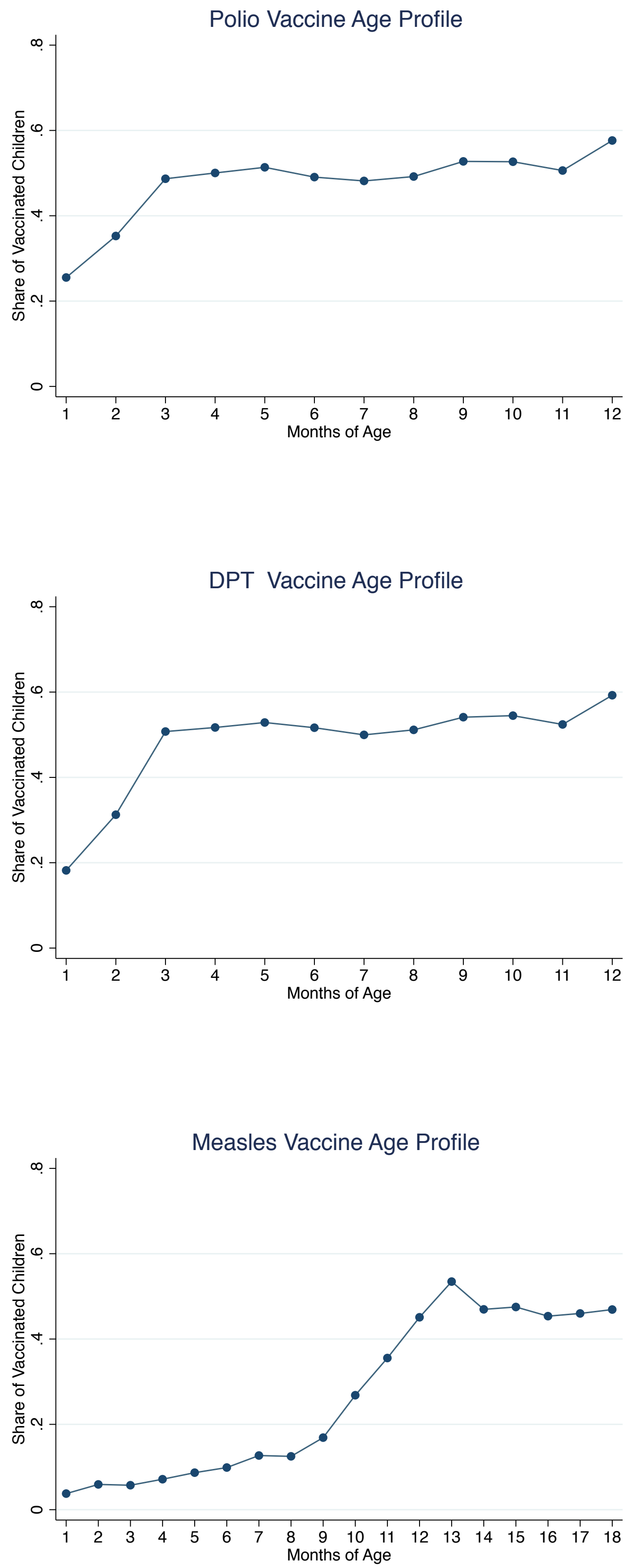


Figure 3: Age Profiles of Vaccines. Before & After Treatment. By level of Islamist Support

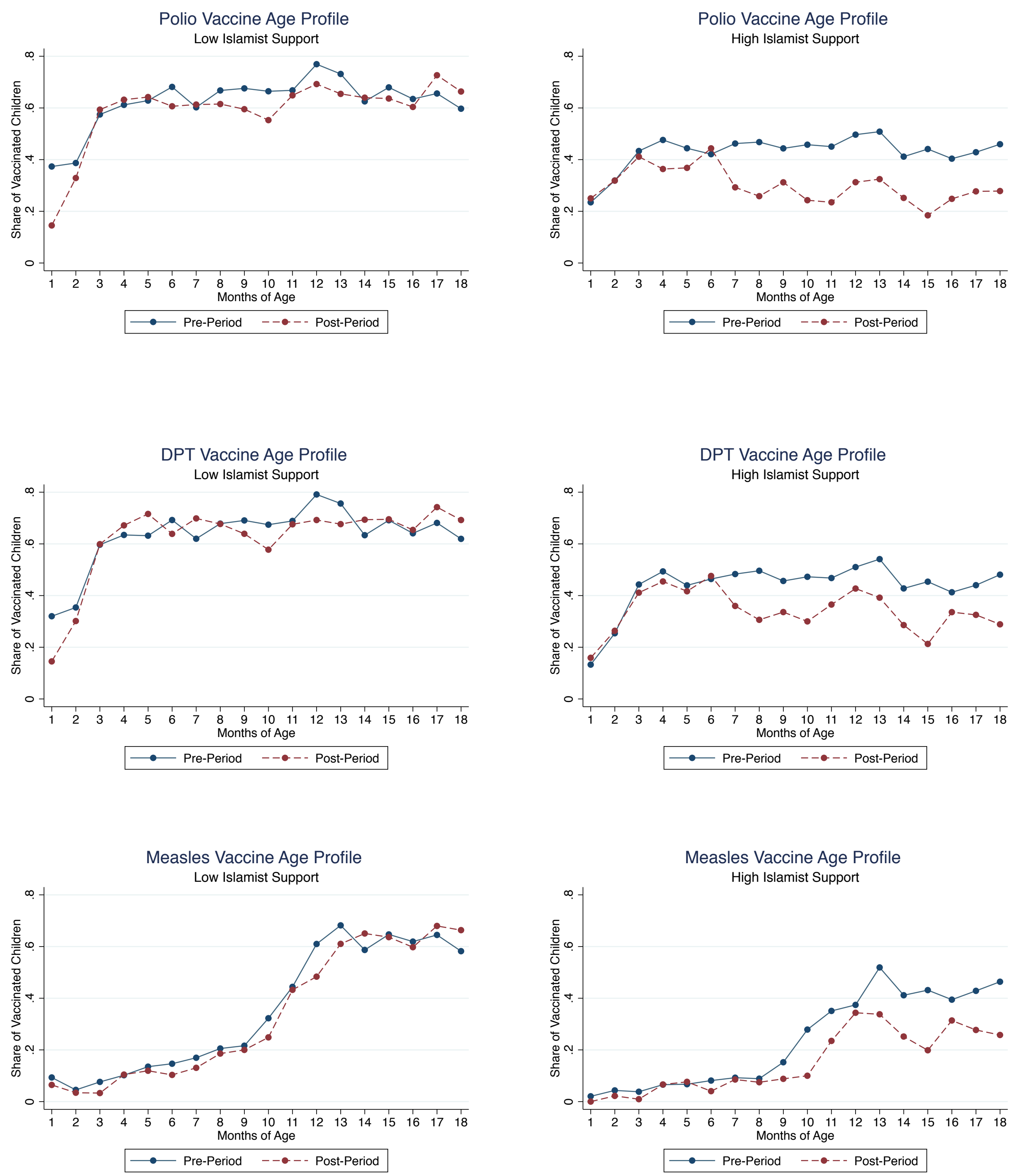
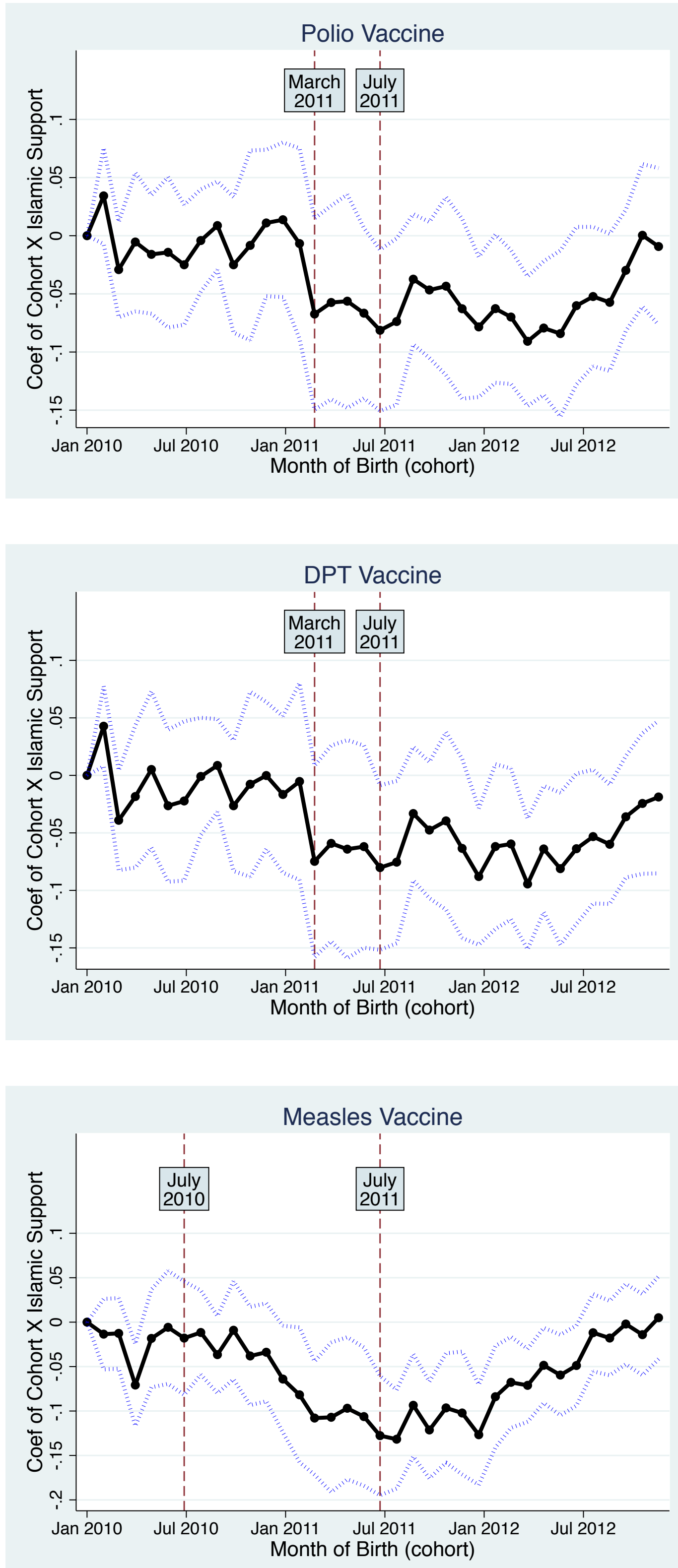


Figure 4: Treatment Effects by Monthly Cohort



9 Tables

Table 1. Effects of the Disclosure of the Vaccine Ruse on Vaccination Rates. Main Results

	Dependent Variables:			
	Polio	DPT	Measles	All Vaccines
	(1)	(2)	(3)	(4)
	Panel A. 1st Dose of Each Vaccine			
Mean Dep. Var.	*0.422*	*0.455*	*0.231*	*0.207*
Post × Islamist Support	-0.045	-0.043	-0.029	-0.032
	(0.019)	(0.017)	(0.014)	(0.013)
Observations	20,350	20,350	16,175	16,175
R-squared	0.269	0.251	0.253	0.251
Number of Clusters	109	109	109	109
	Panel B. All Doses of Each Vaccine			
Mean Dep. Var.	*0.338*	*0.371*	*0.231*	*0.213*
Post × Islamist Support	-0.042	-0.042	-0.029	-0.025
	(0.017)	(0.017)	(0.014)	(0.014)
Observations	14,901	14,901	16,175	14,901
R-squared	0.279	0.260	0.253	0.263
Number of Clusters	109	109	109	109

Notes: Standard errors clustered at the parent district-level in parentheses. The unit of observation is the child level. The sample consists of children born between 2010 and 2012 that are less than 24 months of age at the time of interview. We exclude partially treated children: for the first dose of Polio and DPT, we exclude children born between March and June 2011; for first dose of measles, we exclude children born between July 2010 and June 2011. In panel B as well as for all vaccines, we exclude children born between May 2010 and June 2011. All regressions include district, monthly cohort, monthly age, and calendar month of interview fixed effects and a dummy for rural regions. The dependent variables in Panel A take value 1 if the first dose of each vaccine was received, 0 otherwise. The dependent variables in Panel B take value 1 if a child has received all doses of a given vaccine, 0 otherwise. The outcome for *all vaccines* takes value 1 if the child has obtained the corresponding dosage of the three vaccines.

Table 2. Main Robustness Checks

	Baseline	Initial Health x Cohort FE	Initial Education x Cohort FE	Flood-Affected x Cohort FE	Dropping children born after May 2012	Drop District of Abottabad	Conflict Events in the First Year of Life	Conflict Events in 2010 x Cohort FE
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
				Panel A. First Dose of Polio Vaccine				
Post × Islamist Support	-0.045	-0.036	-0.032	-0.039	-0.058	-0.042	-0.044	-0.044
	(0.019)	(0.016)	(0.019)	(0.017)	(0.020)	(0.018)	(0.018)	(0.018)
Observations	20,350	20,350	20,350	20,350	14,526	20,171	20,308	20,308
R-squared	0.269	0.271	0.269	0.271	0.253	0.271	0.268	0.269
				Panel B. First Dose of DPT Vaccine				
Post × Islamist Support	-0.043	-0.039	-0.045	-0.042	-0.056	-0.040	-0.043	-0.043
	(0.017)	(0.015)	(0.018)	(0.017)	(0.019)	(0.016)	(0.016)	(0.017)
Observations	20,350	20,350	20,350	20,350	14,526	20,171	20,308	20,308
R-squared	0.251	0.254	0.251	0.251	0.234	0.253	0.251	0.252
				Panel C. First Dose of Measles Vaccine				
Post × Islamist Support	-0.029	-0.028	-0.034	-0.029	-0.065	-0.027	-0.029	-0.029
	(0.014)	(0.014)	(0.015)	(0.014)	(0.018)	(0.013)	(0.014)	(0.014)
Observations	16,175	16,175	16,175	16,175	10,351	16,038	16,143	16,143
R-squared	0.253	0.257	0.257	0.254	0.255	0.254	0.253	0.254
				Panel D. All Vaccines				
Post × Islamist Support	-0.032	-0.028	-0.028	-0.029	-0.070	-0.030	-0.032	-0.032
	(0.013)	(0.014)	(0.014)	(0.013)	(0.019)	(0.013)	(0.013)	(0.013)
Observations	16,175	16,175	16,175	16,175	10,351	16,038	16,143	16,143
R-squared	0.251	0.256	0.258	0.254	0.261	0.252	0.251	0.252

Notes: Standard errors clustered at the parent district-level in parentheses. There are 109 parent districts in the baseline sample. The unit of observation is the child level. All regressions include district, monthly cohort, monthly age, and calendar month of interview fixed effects and a dummy for rural regions. Column 2 adds controls for district-level measures of access to health services as reported in the 2008/9 PSLM survey, respectively interacted with yearly cohort fixed effects. The health measures are the share of mothers that received pre-natal care, post-natal care, and tetanus vaccine during previous pregnancy. Column 3 adds controls for share of mothers that had no formal education in 2008/9 interacted with yearly cohort fixed effects. Column 4 adds as controls a dummy for whether the district was severely affected by floods in 2010 interacted with yearly cohort fixed effects. Column 5 drops children born after May 2012. Column 6 drops the district where Abottabad is located. Column 7 adds as a time-varying control the number of conflict events in the first year of life (excluding protests and riots). Column 8 adds controls for the number of conflict events in 2010 (excluding protests and riots) interacted with yearly cohort fixed effects.

Table 3. Effects on Health Seeking Behavior

	Dependent Variables:		
	Dummy for Illness in Last 2 Weeks	Dummy for Consulted Anyone	Dummy for Consulted Formal Medical Sector
	(1)	(2)	(3)
	Panel A. PSLM Survey		
Mean Dep. Var.	*0.191*	*0.981*	*0.926*
Post July 2011 × Islamist Support	0.032	-0.018	-0.040
	(0.013)	(0.010)	(0.022)
Observations	22,346	4,260	4,260
R-squared	0.063	0.063	0.144
	Panel B. DHS Survey: Diarrhea		
Mean Dep. Var.	*0.306*	*0.738*	*0.669*
Post July 2011 × Islamist Support	-0.016	-0.106	-0.055
	(0.019)	(0.026)	(0.025)
Observations	7,011	2,142	2,143
R-squared	0.078	0.157	0.159
	Panel C. DHS Survey: Cough		
Mean Dep. Var.	*0.343*	*0.798*	*0.816*
Post July 2011 × Islamist Support	-0.028	-0.017	0.018
	(0.031)	(0.024)	(0.024)
Observations	7,006	2,393	2,141
R-squared	0.088	0.087	0.143
	Panel D. DHS Survey: Any Illness		
Mean Dep. Var.	*0.507*	*0.937*	*0.901*
Post July 2011 × Islamist Support	-0.029	-0.042	-0.018
	(0.026)	(0.016)	(0.022)
Observations	7,003	2,991	2,847
R-squared	0.110	0.105	0.099

Notes: Standard errors clustered at the district-level in parentheses. The unit of observation is the child level. All regressions include district fixed effects, quarter of interview fixed effects, monthly age, and a dummy for rural regions. In Panel A, column 3, the formal medical sector corresponds to hospital, basic health units and lady health workers. In Panels B, C and D, columns 3, the formal sector is defined as seeking medical treatment or treatment in public facilities.

Table 4. Effects on Trust Measures

	Dependent variables. Trust in:										
	Civil Service	Police	The Courts	Parliament	Political Parties	Army	Central Government	Provincial Government	Local Government	z-score	z-score (ex. Army)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Mean Dep. Var.	*0.46*	*0.53*	*0.49*	*0.47*	*0.58*	*0.50*	*0.53*	*0.50*	*0.58*	*0.00*	*0.00*
	Panel A. Effects on Trust										
Post x (Islamist Support > Average)	-0.076	-0.135	-0.063	-0.094	-0.190	0.144	-0.052	0.012	0.089	-0.081	-0.127
	(0.039)	(0.036)	(0.039)	(0.039)	(0.036)	(0.035)	(0.039)	(0.039)	(0.039)	(0.049)	(0.051)
Observations	3,252	3,252	3,252	3,252	3,252	3,252	3,252	3,252	3,252	3,252	3,252
R-squared	0.054	0.208	0.029	0.054	0.215	0.204	0.050	0.041	0.055	0.069	0.100
	Panel B. Effects on Trust by Ownership of TV										
Post x (Islamist Support > Average)	0.040	-0.100	-0.031	-0.030	-0.099	0.158	0.003	0.107	0.153	0.045	0.011
	(0.050)	(0.045)	(0.051)	(0.050)	(0.047)	(0.042)	(0.050)	(0.050)	(0.050)	(0.063)	(0.065)
Post x (Isl. Support > Average) x No TV	-0.271	-0.218	-0.120	-0.154	-0.305	0.109	-0.236	-0.268	-0.084	-0.345	-0.415
	(0.108)	(0.098)	(0.103)	(0.106)	(0.096)	(0.096)	(0.105)	(0.107)	(0.103)	(0.136)	(0.139)
Observations	3,212	3,212	3,212	3,212	3,212	3,212	3,212	3,212	3,212	3,212	3,212
R-squared	0.054	0.209	0.034	0.056	0.222	0.215	0.052	0.045	0.058	0.071	0.102

Notes: Robust standard errors in parentheses. The unit of observation is the individual. The dependent variables are indicators for whether the respondent reported trusting the different organizations "a great deal" or "quite a lot". In Panel A, the regressor of interest is the interaction of an indicator for the 2013 wave of the South Asia Barometer and an indicator for provinces with support for MMA above the average (i.e., Khyber Pakhtunkhwa, Balochistan, Sindh). All regressions include as controls: province fixed effects, wave fixed effects, age, gender, years of schooling, and type of locality indicators. In Panel B also include interactions for the 2013 wave and province fixed effects with an indicator for TV ownership.

Table 5. Robustness to Controlling for Supply of Health Services

	Baseline	Additional Controls: Travel Distance to Health Facilities	Number of Immunization Campaigns: First 3 months of life	Number of Immunization Campaigns: First year of life	Number of Targeted Children per Capita in Immunization Campaigns: First 3 months of life	Number of Targeted Children per Capita in Immunization Campaigns: First year of life
	(1)	(2)	(3)	(4)	(5)	(6)
			Panel A. 1st Dose of Polio Vaccine			
Post × Islamist Support	-0.045	-0.045	-0.044	-0.047	-0.045	-0.048
	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)
Observations	20,350	20,343	20,350	20,350	20,298	20,298
R-squared	0.269	0.270	0.269	0.269	0.267	0.268
Number of Clusters	109	109	109	109	109	109
			Panel B. 1st Dose of DPT Vaccine			
Post × Islamist Support	-0.043	-0.044	-0.043	-0.045	-0.044	-0.047
	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)
Observations	20,350	20,343	20,350	20,350	20,298	20,298
R-squared	0.251	0.253	0.251	0.251	0.249	0.250
Number of Clusters	109	109	109	109	109	109
			Panel C. 1st Dose of Measles Vaccine			
Post × Islamist Support	-0.029	-0.030	-0.029	-0.032	-0.030	-0.035
	(0.014)	(0.013)	(0.014)	(0.014)	(0.014)	(0.015)
Observations	16,175	16,168	16,175	16,175	16,123	16,123
R-squared	0.253	0.254	0.253	0.253	0.253	0.253
Number of Clusters	109	109	109	109	109	109
			Panel D. Full Immunization			
Post × Islamist Support	-0.032	-0.033	-0.032	-0.035	-0.033	-0.038
	(0.013)	(0.013)	(0.013)	(0.014)	(0.013)	(0.015)
Observations	16,175	16,168	16,175	16,175	16,123	16,123
R-squared	0.251	0.251	0.251	0.252	0.251	0.252
Number of Clusters	109	109	109	109	109	109

Notes: Standard errors clustered at the parent district-level in parentheses. The unit of observation is the child level. The sample consists of children born between 2010 and 2012 that are less than 24 months of age at the time of interview. We exclude partially treated children. See the notes of Table 1 for details on the excluded cohorts. All regressions include district, monthly cohort, monthly age, and calendar month of interview fixed effects and a dummy for rural regions. Column 2 adds controls for travel distance to basic health facilities. Column 3 and 4 add controls for the number of polio vaccination campaigns conducted in the district of residence in the first three months of life and in the first year of life, respectively. Columns 5 and 6 add similar controls for number of targeted children during polio vaccination campaigns. The number of observations is slightly lower because of missing information on the number of targeted children for some periods. The dependent variable in Panels A, B and C take value 1 if the first dose of the respective vaccine (Polio, DPT, Measles) was received, 0 otherwise. The dependent variables in Panel D take value 1 if a child has received all doses of a given vaccine, 0 otherwise.

Table 6. Heterogenous Effects by Child's Gender

	Dependent Variables:			
	Polio	DPT	Measles	All Vaccines
	(1)	(2)	(3)	(4)
	Panel A. 1st Dose of Each Vaccine			
Mean Dep. Var.	*0.422*	*0.455*	*0.231*	*0.207*
Mean Dep. Var. for Males	*0.426*	*0.459*	*0.235*	*0.212*
Mean Dep. Var. for Females	*0.419*	*0.451*	*0.228*	*0.202*
Post × Islamist Support	-0.031	-0.030	-0.018	-0.018
	(0.018)	(0.018)	(0.014)	(0.014)
Post × Islamist Support x Female	-0.029	-0.029	-0.024	-0.028
	(0.012)	(0.013)	(0.016)	(0.016)
Observations	20,350	20,350	16,175	16,175
R-squared	0.269	0.251	0.253	0.251
Number of Clusters	109	109	109	109
	Panel B. All Doses of Each Vaccine			
Mean Dep. Var.	*0.338*	*0.371*	*0.231*	*0.213*
Mean Dep. Var. for Males	*0.342*	*0.375*	*0.235*	*0.217*
Mean Dep. Var. for Females	*0.334*	*0.368*	*0.228*	*0.208*
Post × Islamist Support	-0.016	-0.020	-0.018	-0.011
	(0.018)	(0.019)	(0.014)	(0.015)
Post × Islamist Support x Female	-0.057	-0.048	-0.024	-0.028
	(0.021)	(0.022)	(0.016)	(0.019)
Observations	14,901	14,901	16,175	14,901
R-squared	0.280	0.261	0.253	0.264
Number of Clusters	109	109	109	109

Notes: Standard errors clustered at the parent district-level in parentheses. The sample consists of children born between 2010 and 2012 that are less than 24 months of age at the time of interview. We exclude partially treated children. See the notes of Table 1 for details on the excluded cohorts. All regressions include district, monthly cohort, monthly age, and calendar month of interview fixed effects and a dummy for rural regions. All regressions include all the double interactions: post x female, IslSup x female. The dependent variables in Panel A take value 1 if the first dose of each vaccine was received, 0 otherwise. The dependent variables in Panel B take value 1 if a child has received all doses of a given vaccine, 0 otherwise. The outcome for all vaccines takes value 1 if the child has obtained the corresponding dosage of the three vaccines.

APPENDIX (For Online Publication Only)

10 Data Appendix

10.1 Data Sources

Pakistan Social and Living Standards Measurement (PSLM)

The PSLM Project is designed to provide social and economic indicators at the district level. It is implemented by the Pakistan Bureau of Statistics. We use the PSLM survey waves implemented in 2010/11 and 2012/13 for our main analysis. For robustness, we further complement the analysis with data from the survey wave implemented in 2008/09. The 2008/09 was fielded between August 2008 and June 2009. The 2010/11 was fielded between June 2010 and June 2011. The 2012/13 was fielded between October 2012 and June 2013.

We construct the following outcomes of interest from survey responses in the Vaccination module of the PSLM survey. Firstly, we construct indicators for the receipt of different doses of vaccines. In particular, we consider and construct indicators for polio, DPT, as well as, measles vaccines. Enumerators for the PSLM surveys could choose among the following options in order to record a child's vaccination status: 1) yes (based on vaccination card); 2) yes (based on recall); 3) no; 4) yes (polio campaign). The last option is selected when households report having received the vaccine during regular polio vaccination campaigns. This option is also based on recall. Vaccination status measures based on recall have been shown to be prone to suffer from severe measurement error (Research and Development Solutions (2012); Sheikh et al (2011)). In order to minimize the concern of misreporting, we focus on immunization status that can be verified in the vaccination card. In particular, our outcome variable take value one the child received a given vaccine as shown in his/her vaccination card, and 0 otherwise. Hence, the immunization rates reported in this study should be considered as a lower bound of immunization rates in this context.

We also construct indicators for full immunization. The PSLM survey only records the first three doses of polio and DPT, as well as the first dose of measles.[64] Hence, we consider children fully immunized against polio or DPT if the three doses reported in the survey have been provided and registered in the vaccination card.[66] Similarly, the survey only recorded

[64] Three doses of polio and DPT and one dose of measles, were the World Health Organization (WHO, henceforth) recommended dosages prior to 2009. In that year, the WHO updated their guidelines by recommending to administer an additional dose of the polio vaccine at birth, and an additional dose of the measles vaccine at 15 months.[65] However, the PSLM survey did not update their questionnaire according to the new WHO guidelines. That is the reason why only three doses of polio and one dose of measles are recorded in the data.

[66] See Appendix Table 1 for the official vaccination calendar.

information regarding the first dose of the measles vaccine. Hence, we cannot assess full immunization for measles. We also combine information on the three vaccines to create a measure of *"complete immunization"*. We consider a child to be completely immunized if all doses of polio, DPT vaccine, and measles, were recorded in the survey.

Secondly, the vaccination & diarrhea module of the PSLM survey also contains some information on general measures of health seeking behavior. The available information allows us to construct the following measures:

- *Dummy for Illness in Last 2 Weeks:* Survey respondents are asked in the survey - for each child separately - whether a child was ill or injured in the two weeks prior to the survey. We use this information to construct a dummy variable that has value 1 if the respondent states that a given child was ill or injured in the two weeks prior to the survey, 0 otherwise.

- *Dummy for Consulted Anyone:* For each child which was reported to have been ill or injured in the two weeks prior to the survey, the survey respondent was then asked whether anyone was consulted regarding the reported illness or injury. We use this information to construct a dummy variable that assumes value 1 if the respondent states that someone had been consulted regarding the illness or injury, 0 otherwise.

- *Dummy for Consulted Formal Medical Sector:* If a respondent reported that a child had been ill or injured in the two weeks prior to the survey and also stated that someone had been consulted regarding the illness or injury, the survey enumerators also elicited which part of the medical sector in Pakistan had been consulted. This allows us to construct a dummy variable that assumes value 1 if the respondent states that the formal medical sector in Pakistan was consulted regarding the illness or injury. In particular, we consider the answer choices *"Private Dispensary/Hospital"*, *"Government Hospital"*, *"Rural Health Clinic/Basic Health Unit"* and *"Lady Health Worker"* as representing the formal medical sector. The categories that correspond to the non-formal medical sector are: *"spiritualist"*, *"homeopath"*, *"chemist"*, *"hakeem"* and *"other"*.

Electoral Data

Provinces elect provincial assemblies as their legislature. The members of these provincial assemblies are directly elected during general elections and serve 5-year terms.

We obtained constituency-level data for the general election to the provincial assembly of 2008. We obtained the names of all the contesting candidates, their political parties, and the number of votes obtained by each candidate. We use the official delimitation of 2002 and the amendments of 2008 published in the *Gazette of Pakistan* to locate constituencies within the districts of Pakistan (The Gazette of Pakistan (2002)).

Since electoral constituencies are smaller than districts, we construct a district-level measure of support for different parties. In particular, we calculate the population-weighted average share of votes across all constituencies of a district. The weights correspond to the share of the population living in the respective constituency relative to the overall district population. In the absence of population data, we use number of total votes as a proxy for population numbers. Hence, our main measure of Islamist sentiments is the population-weighted share of votes obtained by the Islamist parties alliance MMA, across all constituencies within a given district in the 2008 provincial legislative election. The spatial distribution of this measure of support for Islamist political parties across the districts of Pakistan is presented in Figure 1.

Data on 2010 Floods

Pakistan suffered from important floods in 2010, which had severe negative impact on the population and the distribution of health services in particular.[67]

In order to verify robustness of our results to potentially confounding effects, we construct an indicator variable that equals 1 if a district was regarded as severely flood-affected by the FAO in a detailed livelihood assessment of 2012, 0 otherwise. (Food and Agriculture Organization of the United Nations (2012)). There are a total of 28 districts in our sample that were classified as severely flood-affected.

Demographic Health Surveys

We rely on data from two waves of the Demographic Health Surveys (DHS) in Pakistan to obtain further measures of immunization and health-seeking behavior. In particular, we rely on the 2006/07 DHS survey to obtain measures prior to the disclosure of the vaccine ruse, as well as the 2012/13 DHS survey to study outcomes after the vaccine ruse had been disclosed.

In order to make the DHS sample as comparable as possible to the PSLM sample from which we derive our main estimates, we impose the same sample restrictions. In particular, we focus on children that were at most 24 months of age at the time of interview. Thus the sample consists of children born in the years 2004 to 2007 and 2010 to 2013. Paralleling the restrictions applied to the PSLM sample, we exclude partially treated children. In particular, for both the first dose of Polio, DPT and HBV, we exclude children born between March

[67] Statistics obtained from Pakistan Disaster Knowledge Network. *http://www.saarc-sadkn.org/countries/pakistan/disaster_profile.aspx* (accessed 14.06.2015)

and June 2011. In the case of Measles, we exclude children born between July 2010 and June 2011. This yields a final sample size of 6,562 children.

We construct indicators for the receipt of different doses of vaccines analog to the procedure applied in the PSLM survey. In particular, we consider and construct indicators for Polio, DPT, HBV, as well as, measles vaccines. Enumerators for the DHS surveys could choose among the following options in order to record a child's vaccination status: 1) yes (vaccination date marked on the vaccination card); 2) yes (vaccination marked on the vaccination card); 3) yes (based on mother's recall); 4) no. Analog to the procedure applied in the PSLM data, we focus only on the first two choices as a measure of immunization. Hence, in the outcome variable "received one shot of *vaccine type*", we code answers based on recall as 0.

The 2012/13 wave of the DHS also contains detailed information on the migration status of survey respondents. In particular, for each household member, the survey elicits whether the individual was born in the current district of residence. If the respondent denies this, he is subsequently asked about the district of origin, that is the district where he lived prior to moving to the current district of residence. Moreover, respondents are also asked about the year in which this movement took place. We use this migration data in a series of robustness checks. In particular, we use the available information to calculate approximate in- and out-migration rates in the period after the vaccine ruse disclosure for each district in the sample.

To this end, we classify households as migrant households if at least one member migrated to the current district of residence in the years 2011 or 2012. To calculate the in-migration rate, we count the number of migrant households within a given district and divide this number by the total number of households included in the 2012/13 DHS survey that currently reside in the district of interest. To calculate the out-migration rate, for each district, we count the number of migrant households that are currently observed in a different location and report that at least one family member migrated to this place from the district of interest in the years 2011 or 2012. We then divide this number by the total number of households included in the 2012/13 DHS survey that still reside in the district of interest.

The DHS survey also provides information on morbidity outcomes and individuals' health seeking behavior. In particular, the survey inquires whether children in suffered from diarrhea or fever and cough in the two-week period prior to the interview. If so, follow-up information on health-seeking behavior and the course of medical treatment is elicited. This information enables us to construct the following two indicators: First, we generate a dummy which equals one if any treatment was sought out to treat the respective illness, zero otherwise. Second, we generate an indicator which equals one if a child received formal, medical treatment to treat the respective illness, zero otherwise. In particular, we consider a child to have received formal medical treatment either if the parents declared that the child received medical treatment or if they visited a public, medical facility in order to receive treatment for their child.

South Asia Barometer Data

We use two rounds of the South Asia Barometer (SAB) data to examine trust outcomes before and after the disclosure of the vaccine ruse in Pakistan. The South Asia Barometer data was provided by the Asian Barometer office, located within the Department of Political Science at the National Taiwan University.

In particular, we rely on a first wave of the SAB that was fielded in 2005 in order to obtain trust measures prior to the vaccine ruse disclosure and a second wave of the SAB that was conducted in 2013 to obtain trust measures after the vaccine ruse disclosure. Both datasets are geo-referenced to the province level within Pakistan. Overall, the SAB data provides us with 3,252 observations in the pre- and post-treatment period for which we observe complete trust measures.

Individual can express 4 different levels of trust towards a given institution in the SAB survey. In particular, the available answer choices are: 1) A great deal of trust; 2) some trust; 3) not very much trust; 4) no trust at all. We construct indicators for trust towards a given institution that equal 1 if individuals express that they have either *"A great deal of trust"* or *"some trust"* towards a given institution, 0 otherwise.

Expanded Program on Immunization Data

The Expanded Program on Immunization in Pakistan was established in 1978 and aims to vaccinate children aged 0 to 11 months against nine target diseases, one of which is poliomyelitis. To this end, provincial EPI cells conduct regular immunization activities which take the form of vaccination campaigns. During these campaigns, teams of vaccinators distribute oral polio vaccine to eligible children in a specific target area. While these activities are implemented by the provincial EPI cells, the role of federal cell is restricted to the provision of policy and technical guidelines, coordination for international assistance, surveillance and monitoring.

We obtained administrative data on the polio immunization activities carried out in the period between 2008 and 2013 from the EPI's internal monitoring and surveillance system. This enables us to construct the following measures to control for the supply of polio immunization activities in the districts of the 4 main provinces of Pakistan across the study period of interest: First, we construct measures that record the number of monthly immunization campaigns carried out in a child's district of residence during the first 3 and 12 months of her life, respectively. Moreover, the administrative data also contains the number of children that were targeted during a monthly immunization drive in a given district. We combine this information with district-level population estimates in 2011 from the Pakistan Bureau of Statistics to record the per-capita number of targeted children during the first 3 and 12 months of a child's life, respectively.

ACLED Data

We use the data from the Armed Conflict Location & Event Data Project (ACLED) to account for potential impacts of conflict across Pakistani districts during the study period on vaccination rates. The ACLED dataset collects the dates, actors, types of violence, locations, and fatalities of all reported political violence and protest events in Pakistan starting from January 2010. In particular, the dataset records information on the following types of conflict events: a) battles, in which the government regains territory b) battles, from which no change of territory resulted c) battles, in which a non-state actor overtakes territory d) events where a headquarter or a base were established e) non-violent transfers of territory f) remote violence g) riots/protests h) strategic development i) violence against civilians.

Given our focus on conflict and violence, we focus on all events except for riots and protests. In particular, we construct a time-varying control which counts the number of conflict events that occurred in a child's district of residence in the first twelve month of her life. In addition to this time-varying control, we also generate a pre-determined measure of conflict and violence by constructing a measure that records the total number of conflict events in the year 2010. In a series of robustness checks, this pre-determined measure is then interacted with cohort fixed effects.

The fact, that the ACLED dataset also provides information on the actors involved in a particular conflict event, allows us to also construct measures of conflict that are directly linked to Taliban activity. In particular, we construct district-specific measures of the number of conflict events associated with the Taliban in the year 2010 as well as in the time period 2010 to 2013.

10.2 Construction of the Dataset

We combine datasets from multiple sources to conduct our analysis. The different datasets are matched by district and time period (month and year). The matching is performed by current district of residence as well as month and year of child birth.

Over the course of our sample period, Pakistan experienced a mild process of district splitting. In particular, the number of districts in our study provinces increased from 109 to 114 between 2008 and 2012. We refer to the former set of districts as the *parent* districts and to the later set of districts are labeled *current* districts. Given the lower level of aggregation of our electoral data, we are able to calculate our measure of support for Islamist political parties at the level of current districts. Moreover, all regressions use district fixed effects at the current district level. However, in our analysis, we cluster standard errors at the level of parent districts to allow for potentially correlated errors across current districts that originated from the same parent district.

11 Estimation of Persuasion Rates

Following DellaVigna and Gentzkow (2010), we calculate "persuasion rates" as suggested by DellaVigna and Kaplan (2007). These rates estimate the percentage of individuals that change their vaccination behavior among those that receive the vaccine ruse message and are not already persuaded, i.e. did not already vaccinate their children.

In a setting with a binary behavioral outcome such as immunization status, a treatment group T, and a control group C, the persuasion rate f (in percent terms) is defined as

$$f = 100 * \frac{y_T - y_C}{e_T - e_C} \frac{1}{1 - y_0}$$

where e_i is the share of group i receiving the message, y_i is the share of group i adopting the behavior of interest, and y_0 is the share that would adopt if there were no message. The persuasion rate thus captures the effect of the treatment on the relevant behavior $(y_T - y_C)$, adjusting for exposure to the message $(e_T - e_C)$ and for the size of the population left to be convinced $(1 - y_0)$.

In our setting, we define the outcome of interest as *not* vaccinating the children, since that is in accordance to the anti-vaccine propaganda messages. We derive estimates for $y_T - y_C$ from a specification that compares the vaccination outcomes for children in districts with above and below median levels of support for Islamist groups. These estimates are presented in Appendix Table 8. We multiply those estimates by -1 in order to be able to interpret the estimates as the increase in likelihood that children *do not* receive the respective vaccine doses.

Given that the information on the vaccine ruse was very salient in Pakistan, we assume that the entire population was exposed to the message after July 2011, while no one was exposed to the message prior to that. Hence, we assume $e_T - e_C = 100\%$. This approach follows the assumptions made in DellaVigna and Gentzkow (2010) to compute persuasion rates.[68] Note that if exposure to the news of the vaccine ruse were indeed lower, the resulting persuasion rate would be larger. Hence, the reported persuasion rate can be considered as a lower bound.

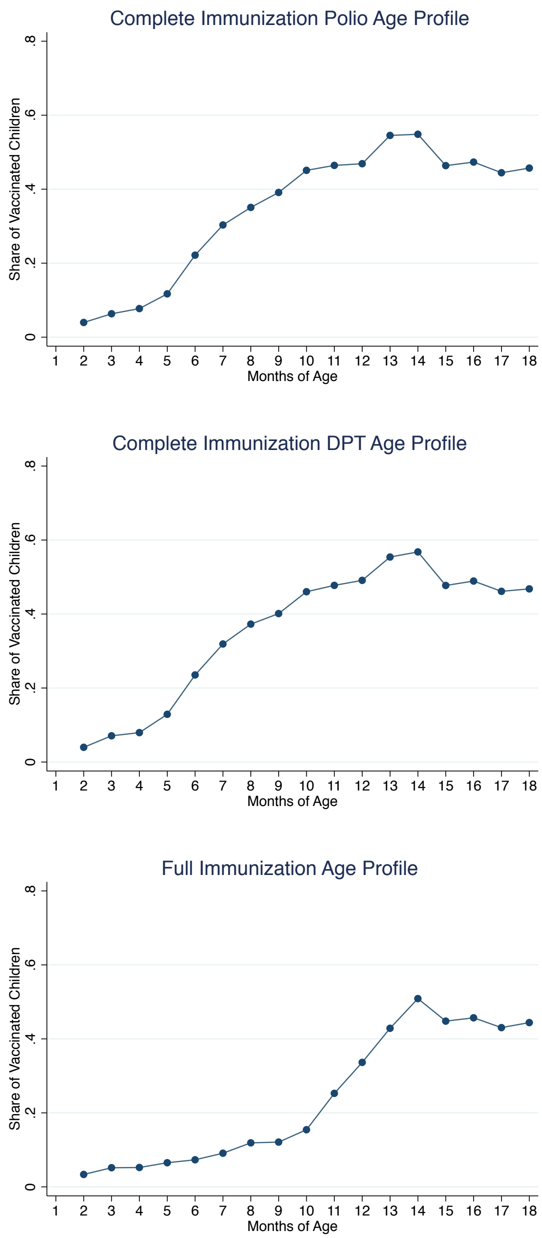
Lastly, we proxy the share of the population that would adopt, i.e. not vaccinate their children even in the absence of any messages, y_0, by calculating the share of the children in our baseline sample that are observed in the pre-treatment survey wave and did not receive the respective vaccine doses.

Our calculations of the persuasion rate for the polio vaccine are as follows: $\widehat{y_T - y_C} = 0.117$ as obtained from Appendix Table 8; $\widehat{e_T - e_C} = 1$; and $\widehat{1 - y_0} = 0.43$, which corresponds to the polio vaccination rate for unexposed cohorts—i.e., those observed in the pre-treatment survey wave. The resulting persuasion rate for the polio vaccine is 27.5%. The persuasion rates for the other vaccines are estimated in a similar way.

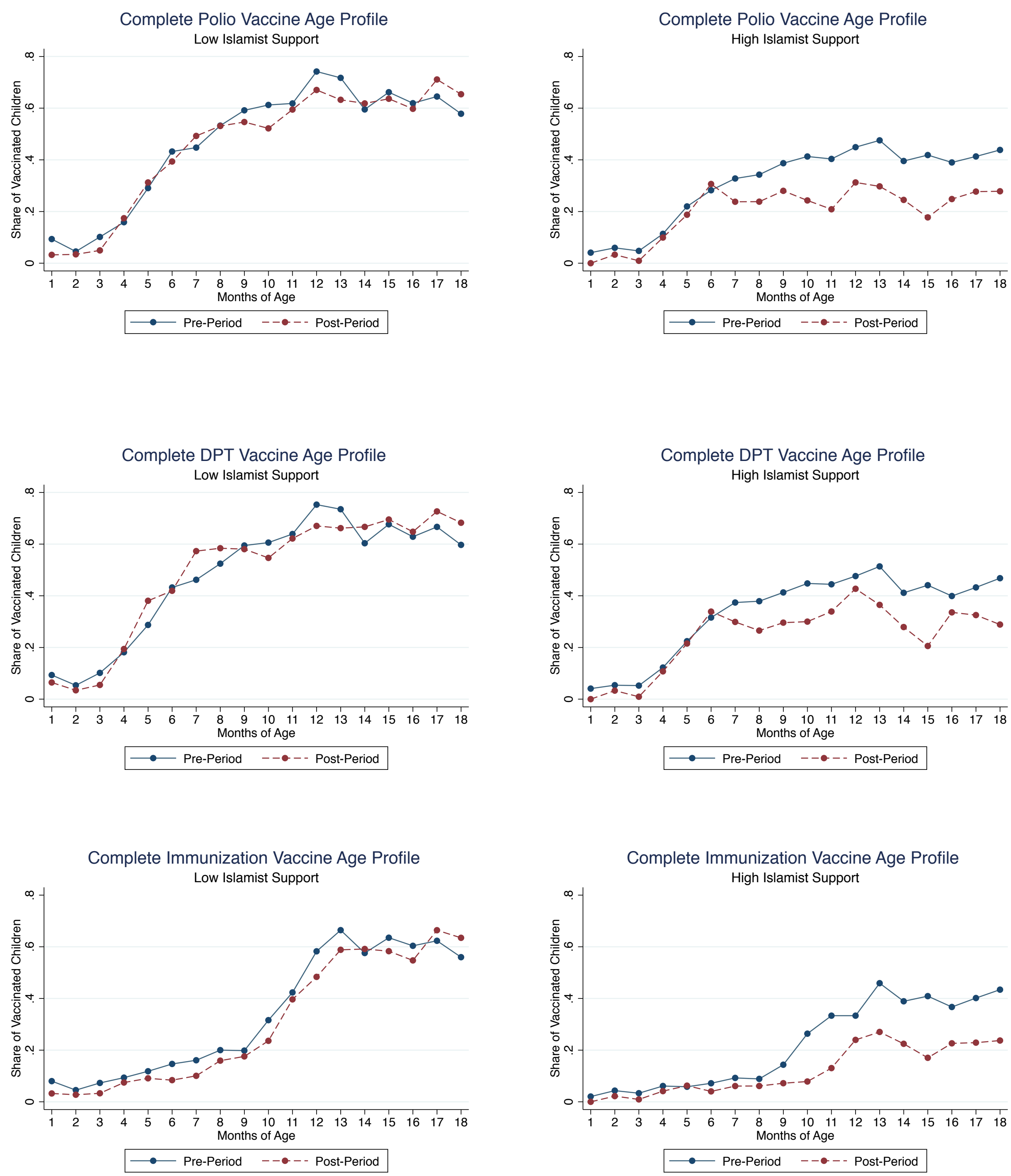
[68]For instance the assume $e_T - e_C = 100\%$ when computing the persuasion rate of newspaper endorsements estimated in Chiang and Knight (2011). The reason is that the sample only contains newspaper readers and, hence, all individuals are subject to the information on newspaper endorsements.

12 Appendix Figures

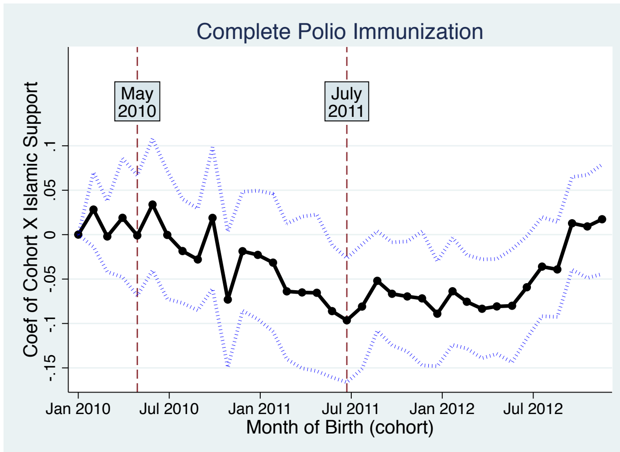
Appendix Figure 1. Age Profile for All Doses of Vaccines. Pre-Treatment Period

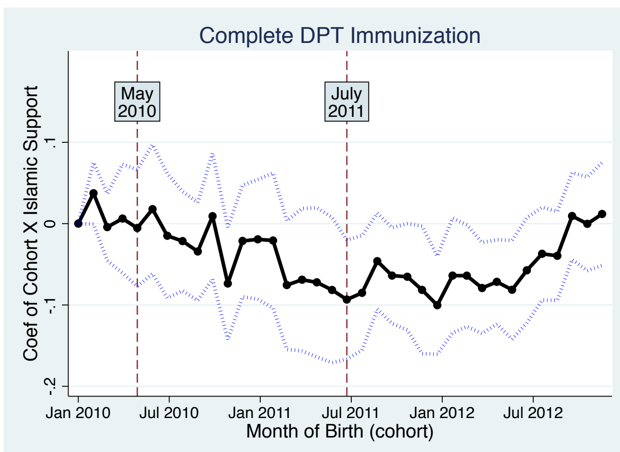


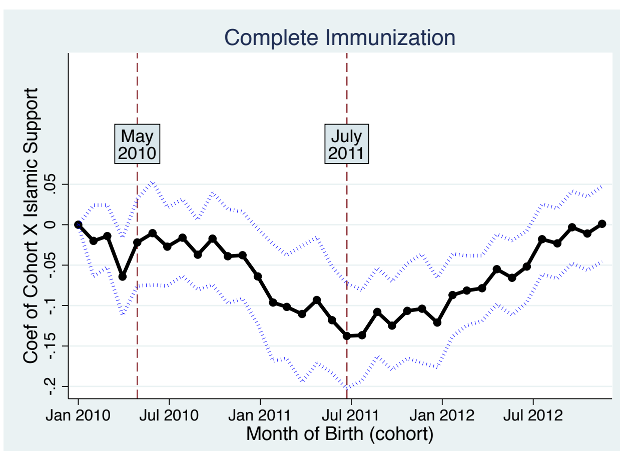
Appendix Figure 2. Age Profile for All Doses of Vaccines. Before & After Treatment. By Level of Islamist Support



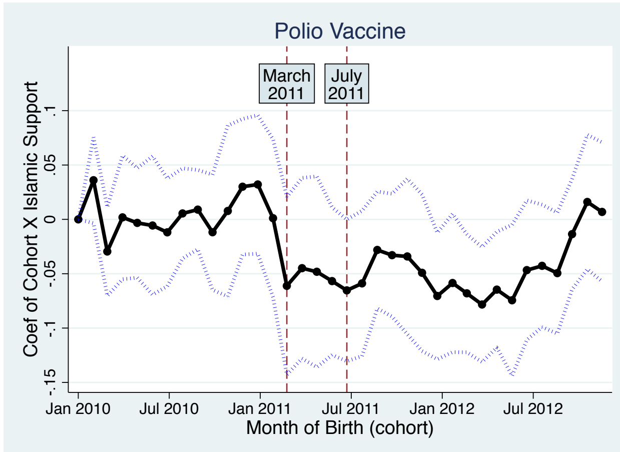
Appendix Figure 3. Treatment Effects by Monthly Cohort. Full Immunization

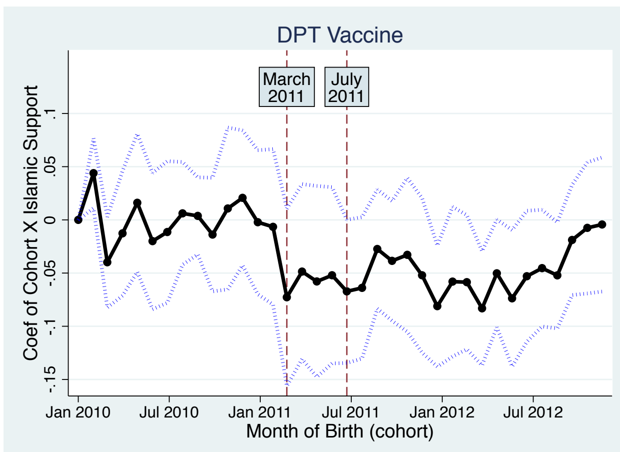


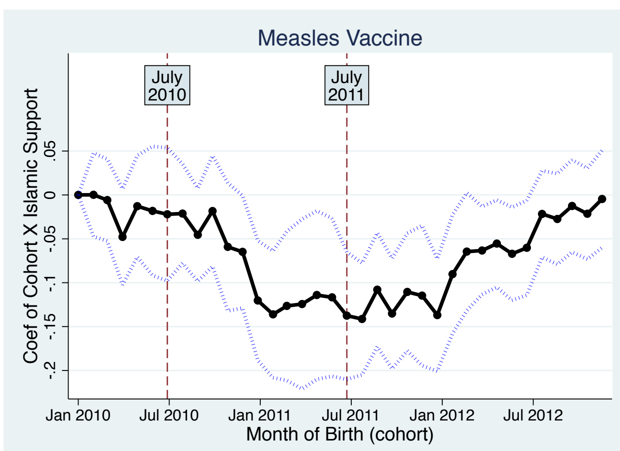




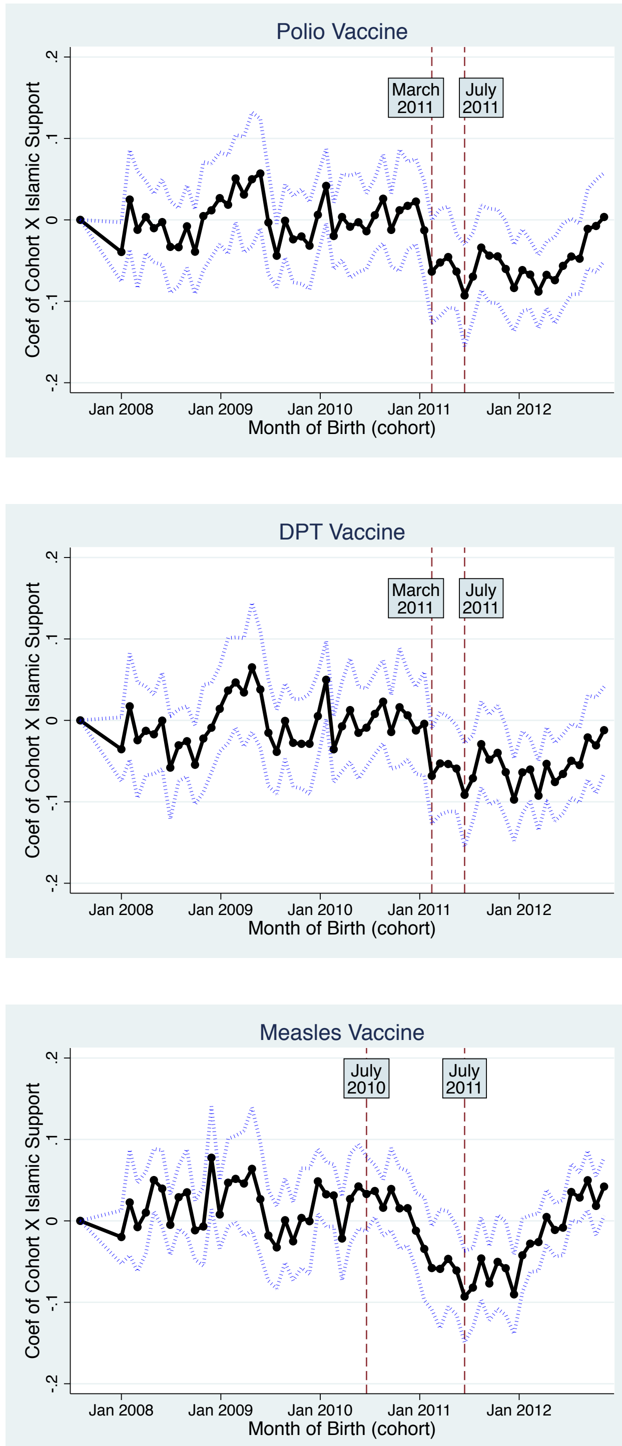
Appendix Figure 4. Treatment Effects by Monthly Cohort. Only Controlling for Monthly-Cohort and District Fixed Effects





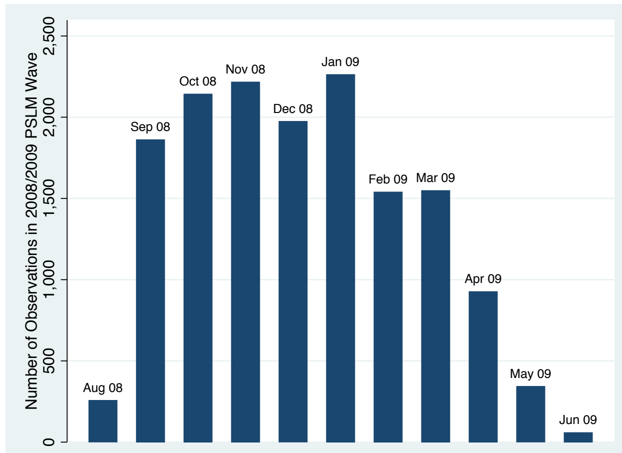


Appendix Figure 5. Treatment Effects by Monthly Cohort. Longer Pre-Treatment Period.

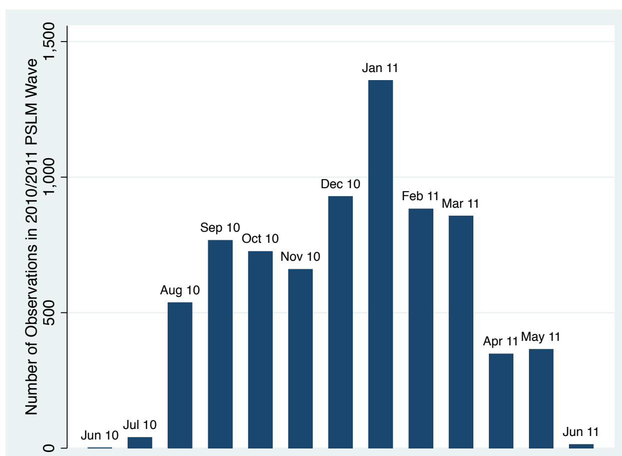


Appendix Figure 6. Timing of Surveys of the PSLM waves

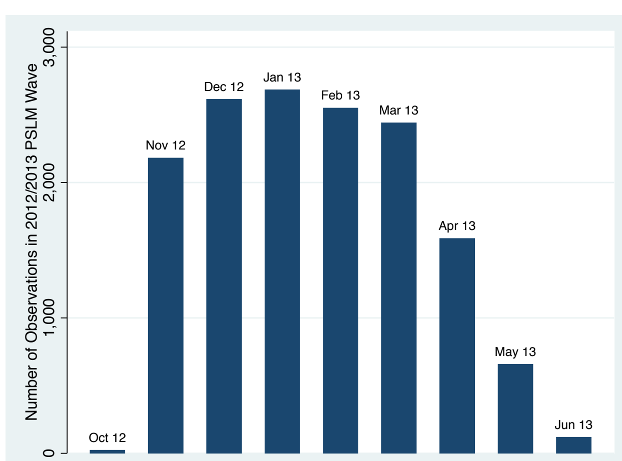
2008/09 PSLM Wave



2010/11 PSLM Wave



2012/13 PSLM Wave



13 Appendix Tables

Appendix Table 1. Immunization Calendar of Pakistan

Vaccine	First Dose	Second Dose	Third Dose	Fourth Dose
Polio	At birth	6 Weeks	10 Weeks	14 Weeks
DPT	6 Weeks	10 Weeks	14 Weeks	
Measles	9 Months	15 Months		

Notes: Official immunization schedule of Pakistan for the main three vaccines. Published by the Expanded Program on Immunization (EPI), Pakistan http://epi.gov.pk/?page_id=139 (last accessed April 18th, 2017)

Appendix Table 2. Descriptive Statistics

	Observations	Mean	Std. Dev.
	(1)	(2)	(3)
	Panel A. Child Characteristics		
Received one dose of Polio vaccine	22,346	0.420	0.494
Received one dose of DPT vaccine	22,346	0.453	0.498
Received one dose of Measles vaccine	22,346	0.226	0.418
Received three doses of Polio vaccine	22,346	0.313	0.464
Received three doses of DPT vaccine	22,346	0.341	0.474
Received all vaccines	22,346	0.202	0.401
Illness or injury (two weeks prior to interview)	22,346	0.191	0.393
Age (in months)	22,346	9.910	6.358
Male	22,346	0.514	0.500
	Panel B. Mother Characteristics		
Mother's education level	22,346	3.528	4.369
Mother's age	22,346	27.926	6.049
	Panel C. Household Characteristics		
Rural region	22,346	0.658	0.474
Radio ownership	22,346	0.223	0.416
Television ownership	22,346	0.581	0.493
Number of rooms	22,346	2.637	1.558
Number of household members	22,346	8.268	3.891
	Panel D. District Characteristics		
Vote Share MMA	114	0.073	0.113
Vote Share PPP	114	0.261	0.204
Vote Share PML (N)	114	0.105	0.140

Notes: In Panel A, B and C, the unit of observation is the child level. The sample consists of children born between 2010 and 2012 that are less than 24 months of age at the time of interview. In Panel D, the unit of observation is the district.

Appendix Table 3. Tabulation of Cohorts in the Baseline Sample

Survey Wave	Cohort	Number of Observations	Share of the Sample
2010/11	2010/01	725	3.24
	2010/02	721	3.23
	2010/03	561	2.51
	2010/04	518	2.32
	2010/05	588	2.63
	2010/06	686	3.07
	2010/07	721	3.23
	2010/08	793	3.55
	2010/09	582	2.60
2010/11 & 2012/13	2010/10	444	1.99
	2010/11	427	1.91
	2010/12	457	2.05
	2011/01	447	2.00
	2011/02	304	1.36
	2011/03	398	1.78
	2011/04	410	1.83
	2011/05	515	2.30
2012/13	2011/06	673	3.01
	2011/07	731	3.27
	2011/08	717	3.21
	2011/09	705	3.15
	2011/10	752	3.37
	2011/11	628	2.81
	2011/12	550	2.46
	2012/01	670	3.00
	2012/02	649	2.90
	2012/03	558	2.50
	2012/04	592	2.65
	2012/05	582	2.60
	2012/06	766	3.43
	2012/07	780	3.49
	2012/08	964	4.31
	2012/09	802	3.59
	2012/10	772	3.45
	2012/11	639	2.86
	2012/12	519	2.32

Appendix Table 4. DHS Immunization Outcomes

	Dependent Variables: Received 1st Dose of Each Vaccine:				
	Polio	DPT	Measles	HBV	All Vaccines
	(1)	(2)	(3)	(4)	(5)
Mean Dep. Var.	*0.281*	*0.286*	*0.117*	*0.272*	*0.111*
Post × Islamist Support	-0.046	-0.042	-0.006	-0.057	-0.012
	(0.019)	(0.019)	(0.013)	(0.024)	(0.015)
Observations	6,562	6,476	6,074	6,414	6,009
R-squared	0.191	0.188	0.172	0.176	0.163
Number of Clusters	112	112	112	112	112

Notes: Standard errors clustered at the district-level in parentheses. There are 112 districts in the sample. The unit of observation is the child level. The sample consists of children born in the years 2004 to 2007 and 2010 to 2013 that are less than 24 months of age at the time of interview. We exclude partially treated children. See the notes of Table 1 for details on the excluded cohorts. All regressions include district, monthly cohort, monthly age, and a dummy for rural regions. The dependent variables take value 1 if the first dose of each vaccine was received, 0 otherwise.

Appendix Table 5. Robustness Checks. Lack of Household Compositional Changes

	Dependent Variables:							
	Dummy for Male Child	Mother's Education	Mother's Age	Dummy for Rural Region	Dummy for Radio Ownership	Dummy for Television Ownership	Number of Household Members	Number of Rooms
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Mean Dep. Var.	*0.514*	*3.528*	*27.930*	*0.658*	*0.223*	*0.581*	*8.268*	*2.637*
Post July 2011 × Islamist Support	-0.006	0.012	-0.087	-0.004	-0.003	-0.018	0.065	0.063
	(0.008)	(0.061)	(0.147)	(0.009)	(0.017)	(0.017)	(0.083)	(0.044)
Observations	22,346	22,346	22,346	22,346	22,346	22,346	22,346	22,346
R-squared	0.008	0.261	0.027	0.190	0.145	0.230	0.094	0.112

Notes: Standard errors clustered at the district-level in parentheses. The unit of observation is the child level. The sample consists of children born between 2010 and 2012 that are less than 24 months of age at the time of interview. All regressions include district, monthly cohort, monthly age, and calendar month of interview fixed effects and a dummy for rural regions (except for the specification displayed in column 4).

Appendix Table 6. Robustness Checks Selective Migration

	Dependent Variables:			
	Polio	DPT	Measles	All Vaccines
	(1)	(2)	(3)	(4)
	Panel A. Controlling for In- and Out-migration Rates			
Mean Dep. Var.	*0.426*	*0.459*	*0.233*	*0.208*
Post × Islamist Support	-0.047	-0.044	-0.030	-0.034
	(0.019)	(0.018)	(0.014)	(0.014)
Observations	20,167	20,167	16,025	16,025
R-squared	0.269	0.250	0.256	0.255
Number of Clusters	104	104	104	104
	Panel B. Lower Bound (in Magnitude) if Most Unfavorable Selective Migration			
Mean Dep. Var.	*0.424*	*0.457*	*0.229*	*0.204*
Post × Islamist Support	-0.038	-0.036	-0.023	-0.026
	(0.019)	(0.018)	(0.014)	(0.014)
Observations	20,000	20,000	15,858	15,858
Number of Modified Observations	728	728	728	728
R-squared	0.268	0.249	0.252	0.250
Number of Clusters	104	104	104	104
	Panel C. Assigning Households to District of Origin (DHS sample)			
Mean Dep. Var.	*0.281*	*0.286*	*0.117*	*0.111*
Post × Islamist Support	-0.044	-0.041	-0.006	-0.012
	(0.019)	(0.019)	(0.013)	(0.015)
Observations	6,562	6,476	6,074	6,009
Number of Reassigned Observations	340	340	340	340
R-squared	0.191	0.188	0.172	0.164
Number of Clusters	112	112	112	112

Notes: In Panels A and B, standard errors clustered at the parent district-level are shown in parentheses. In Panel C, standard errors clustered at the district-level are shown in parentheses. The unit of observation is the child level. In Panels A and B, the sample consists of children born between 2010 and 2012 that are less than 24 months of age at the time of interview. We exclude partially treated children. See the notes of Table 1 for details on the excluded cohorts. In Panel B, we modify a number of observations in a bounding exercise. In particular, while we drop 167 observations in districts with negative net outmigration rates (as calculated from DHS data), we add 561 observations in districts with positive net outmigration rates. In particular, we drop observations with a successful vaccination outcome if the level of support for Islamist groups is below the median level in the sample. In contrast, we drop observations with an unsuccessful vaccination outcomes in districts where the level of support for Islamist groups exceeds the median in the sample. When adding additional observations, we impute successful vaccination outcomes in districts where the level of support for Islamist groups exceeds the median in the sample. In contrast, we impute unsuccessful vaccination outcomes in districts, where the level of support for Islamist groups lies below the median in the sample. In Panel C, the sample consists of children born in the years 2004 to 2007 and 2010 to 2013 that are less than 24 months of age at the time of interview. We exclude partially treated children (same as in Panels A and B). In Panels A and B, all regressions include district, monthly cohort, monthly age, and calendar month of interview fixed effects and a dummy for rural regions. In Panel C, all regressions include district, monthly cohort, monthly age, and a dummy for rural regions. The dependent variables take value 1 if the first dose of each vaccine was received, 0 otherwise. The outcome for all vaccines combines all of these requirements.

Appendix Table 7. Only Controlling for District and Cohort Fixed Effects

	Dependent Variables:			
	Polio	DPT	Measles	All Vaccines
	(1)	(2)	(3)	(4)
	Panel A. 1st Dose of Each Vaccine			
Mean Dep. Var.	*0.422*	*0.455*	*0.231*	*0.207*
Post × Islamist Support	-0.042	-0.041	-0.041	-0.042
	(0.019)	(0.018)	(0.016)	(0.016)
Observations	20,350	20,350	16,175	16,175
R-squared	0.257	0.235	0.230	0.231
Number of Clusters	109	109	109	109
	Panel B. All Doses of Each Vaccine			
Mean Dep. Var.	*0.338*	*0.371*	*0.231*	*0.213*
Post × Islamist Support	-0.038	-0.038	-0.041	-0.037
	(0.018)	(0.017)	(0.016)	(0.017)
Observations	14,901	14,901	16,175	14,901
R-squared	0.258	0.238	0.230	0.244
Number of Clusters	109	109	109	109

Notes: Standard errors clustered at the parent district-level in parentheses. The unit of observation is the child level. The sample consists of children born between 2010 and 2012 that are less than 24 months of age at the time of interview. We exclude partially treated children. See the notes of Table 1 for details on the excluded cohorts. All regressions include district and monthly cohort fixed effects. The dependent variables in Panel A take value 1 if the first dose of each vaccine was received, 0 otherwise. The dependent variables in Panel A take value 1 if the first dose of each vaccine was received, 0 otherwise. The dependent variables in Panel B take value 1 if a child has received all doses of a given vaccine, 0 otherwise. The outcome for all vaccines takes value 1 if the child has obtained the corresponding dosage of the three vaccines.

Appendix Table 8. Robustness Checks. Alternative Specifications of Support for Islamist Groups

	Dependent Variable: Dummy for Receipt of 1 Vaccine Dose		
	Polio	DPT	Measles
	(1)	(2)	(3)
Mean Dep. Var.	*0.422*	*0.455*	*0.231*
	Panel A. Cutoff-Level: Median		
Post × 1(IslSup>P50)	-0.117	-0.104	-0.049
	(0.033)	(0.031)	(0.023)
Observations	20,350	20,350	16,175
R-squared	0.271	0.252	0.253
	Panel B. Cutoff-Levels: Terciles		
Post × 1(IslSup>P33 & IslSup<P66)	-0.097	-0.074	-0.033
	(0.040)	(0.037)	(0.024)
Post × 1(IslSup>P66)	-0.140	-0.133	-0.075
	(0.037)	(0.037)	(0.032)
Observations	20,350	20,350	16,175
R-squared	0.271	0.253	0.253

Notes: Standard errors clustered at the parent district-level in parentheses. The sample consists of children born between 2010 and 2012 that are less than 24 months of age at the time of interview. We exclude partially treated children. See the notes of Table 1 for details on the excluded cohorts. All regressions include district, monthly cohort, monthly age, and calendar month of interview fixed effects and a dummy for rural regions. The dependent variables in Panel A take value 1 if the first dose of each vaccine was received, 0 otherwise.

Appendix Table 9. Effects on Trust Measures (Displaying Estimates of All Interaction Terms)

	Dependent variables. Trust in:										
	Civil Service	Police	The Courts	Parliament	Political Parties	Army	Central Government	Provincial Government	Local Government	z-score	z-score (ex. Army)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Mean Dep. Var.	*0.46*	*0.53*	*0.49*	*0.47*	*0.58*	*0.50*	*0.53*	*0.50*	*0.58*	*0.00*	*0.00*
	Panel A. Effects on Trust										
Post	0.139	0.449	0.114	0.152	0.498	-0.441	0.065	-0.048	0.063	0.223	0.361
	(0.026)	(0.023)	(0.026)	(0.026)	(0.023)	(0.023)	(0.026)	(0.027)	(0.026)	(0.032)	(0.033)
Post x (Isl Support > Average)	-0.076	-0.135	-0.063	-0.094	-0.190	0.144	-0.052	0.012	0.089	-0.081	-0.127
	(0.039)	(0.036)	(0.039)	(0.039)	(0.036)	(0.035)	(0.039)	(0.039)	(0.039)	(0.049)	(0.051)
Observations	3,252	3,252	3,252	3,252	3,252	3,252	3,252	3,252	3,252	3,252	3,252
R-squared	0.054	0.208	0.029	0.054	0.215	0.204	0.050	0.041	0.055	0.069	0.100
	Panel B. Effects on Trust by Ownership of TV										
Post	0.039	0.439	0.073	0.088	0.434	-0.498	0.005	-0.142	0.003	0.100	0.237
	(0.038)	(0.032)	(0.039)	(0.038)	(0.035)	(0.030)	(0.038)	(0.038)	(0.037)	(0.046)	(0.048)
No TV	-0.146	-0.004	-0.030	-0.095	-0.102	-0.084	-0.085	-0.130	-0.104	-0.174	-0.175
	(0.042)	(0.035)	(0.043)	(0.042)	(0.039)	(0.033)	(0.042)	(0.042)	(0.042)	(0.052)	(0.055)
Post x No TV	0.189	0.066	0.226	0.111	0.084	0.110	0.154	0.237	0.033	0.270	0.276
	(0.067)	(0.060)	(0.065)	(0.068)	(0.061)	(0.061)	(0.067)	(0.069)	(0.067)	(0.079)	(0.082)
Post x (Isl Support > Average)	0.040	-0.100	-0.031	-0.030	-0.099	0.158	0.003	0.107	0.153	0.045	0.011
	(0.050)	(0.045)	(0.051)	(0.050)	(0.047)	(0.042)	(0.050)	(0.050)	(0.050)	(0.063)	(0.065)
Post x (Isl Support > Average) x No TV	-0.271	-0.218	-0.120	-0.154	-0.305	0.109	-0.236	-0.268	-0.084	-0.345	-0.415
	(0.108)	(0.098)	(0.103)	(0.106)	(0.096)	(0.096)	(0.105)	(0.107)	(0.103)	(0.136)	(0.139)
Observations	3,212	3,212	3,212	3,212	3,212	3,212	3,212	3,212	3,212	3,212	3,212
R-squared	0.054	0.209	0.034	0.056	0.222	0.215	0.052	0.045	0.058	0.071	0.102

Notes: Robust standard errors in parentheses. The unit of observation is the individual. The dependent variables are indicators for whether the respondent reported trusting "a great deal" or "quite a lot" the different organizations. In Panel A, the regressor of interest is the interaction of an indicator for the 2013 wave of the SouthAsia Barometer and an indicator for provinces with support for MMA above the average (i.e., Khyber Pakhtunkhwa, Balochistan, Sindh). All regressions include as controls: province fixed effects, wave fixed effects, age, gender, years of schooling, and type of locality indicators. In Panel B also include interactions for the 2013 wave and province fixed effects with an indicator for TV ownership. *** p<0.01, ** p<0.05, * p<0.1

Appendix Table 10. Effects on Supply of Health Services

	Dependent Variable:			
	Time travel to Health Clinic	Time travel to Basic Health Unit	Indicator: Any Immunzation Activity	Number of Targeted Children Per Capita
	(1)	(2)	(3)	(4)
Mean Dep. Var.	*1.509*	*1.566*	*0.601*	*0.136*
Post × Islamist Support	-0.039	0.068	-0.010	-0.004
	(0.048)	(0.068)	(0.014)	(0.006)
Observations	20,314	20,307	8,208	8,136
R-squared	0.397	0.438	0.578	0.535
Number of Clusters	109	109	114	113

Notes: Standard errors clustered at the district-level in parentheses in columns. The unit of observation is the child-level in Columns 1 and 2. In Columns 3 and 4, the unit of observation is the district-month level. In Columns 1 and 2, the sample consists of children born between 2010 and 2012 that are less than 24 months of age at the time of interview. We exclude children that were partially treated. See the notes of Table 1 for details on the excluded cohorts. In Columns 3 and 4, the sample consists of all districts, observed at monthly frequency for the time period 2008 to 2013. All regressions include district and monthly time of interview fixed effects. *** p<0.01, ** p<0.05, *p<0.1.

Appendix Table 11. Disentangling Demand Channels: Changes in Beliefs or Intimidation by the Taliban

	Dependent Variables: First Dose of			
	Polio	DPT	Measles	All Vaccines
	(1)	(2)	(3)	(4)
Mean Dep. Var.	*0.423*	*0.456*	*0.232*	*0.207*
	Panel A. Taliban Conflict Events in 2010			
Post × Islamist Support	-0.041	-0.038	-0.024	-0.028
	(0.019)	(0.017)	(0.014)	(0.013)
Post × Conflict Measure	-0.006	-0.010	-0.010	-0.008
	(0.009)	(0.009)	(0.009)	(0.009)
Observations	20,308	20,308	16,143	16,143
R-squared	0.268	0.250	0.253	0.251
Number of Clusters	108	108	108	108
	Panel B. Taliban Conflict Events 2010 - 2013			
Post × Islamist Support	-0.040	-0.037	-0.028	-0.032
	(0.019)	(0.018)	(0.014)	(0.013)
Post × Conflict Measure	-0.008	-0.013	-0.001	0.001
	(0.010)	(0.011)	(0.007)	(0.007)
Observations	20,308	20,308	16,143	16,143
R-squared	0.268	0.250	0.253	0.251
Number of Clusters	108	108	108	108

Notes: Standard errors clustered at the parent district-level in parentheses. The sample consists of children born between 2010 and 2012 that are less than 24 months of age at the time of interview. We exclude partially treated children. See the notes of Table 1 for details on the excluded cohorts. In Panel A, the measure of conflict is the number of conflict events within a given district in the year 2010 for which one of the actors involved was identified as the Pakistani Taliban. In Panel B, the measure of conflict is the total number of conflict events within a given district in the time period 2010-2013 for which one of the actors involved was identified as the Pakistani Taliban. All regressions include district, monthly cohort, monthly age, and calendar month of interview fixed effects and a dummy for rural regions. The dependent variables take value 1 if the first dose of each vaccine was received, 0 otherwise. The outcome for all vaccines combines all of these requirements. *** p<0.01, ** p<0.05, *p<0.1.