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Abstract

Negative externalities stemming from export-oriented activity in the developing world spark concerns of a "race to the bottom" wherein countries sacrifice human or environmental health in the pursuit of growth. Efforts to mitigate these effects are often inherently political, and it is difficult to discern if those efforts reach all intended beneficiaries or are instead captured by socio-economic elites. We advance an argument that as spatial precision increases it is likely that donors lose control and recipients can capture foreign aid. Using a combination of observational and causal inference techniques, with a wide range of existing and novel geo-spatial data, we find evidence in Bangladesh that proximity to exporting firms is associated with higher levels of groundwater arsenic, but that mitigation measures only appear to have a causal effect in reducing arsenic when they are located near an exporting firm. We argue that this supports a political economy rationale wherein donors may achieve their aims at a *mezzo* level, while powerful socio-economic interests are able to capture and direct resources at a *micro* level, potentially exacerbating *intra*-country inequality.

Keywords: Aid; Race to Bottom; Exporter; Pollution; Bangladesh; Donor Control; Elite Capture

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Introduction

Export-led growth has been endorsed as a development strategy for decades. However, concerns exist that this economic growth model may put downward pressure on regulatory standards as countries engage in a "race to the bottom" (RTB) to attract export-oriented foreign capital (Davies & Vadlamannati 2013). At a country-level, these fears appear to be overblown (Drezner 2006). However, as development efforts have increasingly turned their attention to addressing issues of *intra*-country inequality, the possibility remains open of a race to the bottom within a country's borders. Studies of intra-country inequality are often political in nature, noting how social, economic or political standing can influence the distribution of resources (Briggs 2021).

When development efforts are funded by external donors, there is an inherent risk of non-alignment in the donor's and recipient's aims. While donors may wish to exert *control* over the allocation of resources, recipients may seek to *capture* those flows to advance their own political or economic goals (Milner et al. 2016). A raft of studies have examined these dynamics in a subnational setting (Briggs 2017; Jung 2020; Marineau and Findley 2020; Reinsberg and Dellepiane 2021; Song et al. 2021), often finding that donor aims may be ultimately frustrated and that aid does not reach its intended recipients or fulfill its expressed purpose.

Taking our cue from these discussions, in this paper we examine the extent to which the politics of arsenic poisoning and mitigation in Bangladesh displays evidence of recipient capture and/or donor control. Arsenic in the Bangladeshi water supply has long been flagged as a major human health concern and the Bangladeshi government and international donors have invested considerable resources in attempting to address the problem. We argue that the political dynamics of this mitigation will depend on the degree of *spatial precision*. As interventions and outcomes become increasingly spatially precise, we suggest that donors will be less able to exert control opening the door for elite capture and thus mitigation efforts may fail in reaching their intended targets in the "last mile".

In order to evaluate this argument, we combine a novel, geo-referenced, dataset of the population of 11,000 exporting firms with geo-referenced testing data of nearly 4,000,000 wells in almost 45,000 Bangladeshi villages from 2000 to 2005, geo-referenced data on the location and type of over 122,000 wells installed between 2006 and 2012, at the *Union* (administrative four) level, and responses on the presence of well-water arsenic from over 30,000 geo-referenced, pooled-cross section, household surveys conducted in 2005, 2010 and 2016 at the village or *Mouza* (administrative five) level. We then deepen our analysis by identifying a panel of 275 households within this data. We first establish a linkage between exporting firms and higher levels of arsenic before showing that, at the *mezzo* (Union) level, mitigation efforts indeed appear to be directed to areas with higher levels of arsenic. However, we then use a difference-in-difference-differences (DDD) type approach to show that, at the *micro* (Mouza) level, efforts appear to have a causal effect in reducing arsenic, but only when they are located near an exporting firm.

We argue that these findings are consistent detailed qualitative observations from the non-governmental organization *Human Rights Watch* (Pearshouse 2016) that shows while donors may have exerted control at a *mezzo* level, economically and politically powerful actors were able to influence the siting of arsenic mitigation efforts at the *micro* level. Politically powerful firms were able to direct allocation of wells to households in their vicinity, either their own households, or households of employees or relatives. However, these findings could also simply be consistent with a logic that households in areas near firms may simply be more likely to have contaminated water and, thus, the donor's preference are (also) being met. In this case, it may be that the interests behind elite capture and donor control coincide and therefore both explain the allocation patterns of the resource.

However, at a minimum, this spatial allocation means that households that already may be at a disadvantage with respect to employment or other socio-economic opportunities *because* they are further away from exporting firms may be further disadvantaged in receiving inferior water quality mitigation efforts. These dynamics have profound implications for *intra-country* politics in the developing world wherein development resources may only serve to further intra-country inequality.

Race to the Bottom? Arsenic and Exports in Bangladesh

The idea that developing countries can engage in a "race to the bottom" (RTB) with environmental, health or other regulatory standards in order to attract foreign direct investment (FDI) dates to the 1990s and is predicated on a logic that, in the absence of common standards, jurisdictions will compete with one another by lowering standards to increase competitiveness in trade or investment (Porter 1999, p. 136). Sheldon (2006, p.388) provides a formal treatment of the mechanism, showing that under of mobile factors of production there may well be pressures to weaken policies, or at a minimum not make them more stringent ("regulatory chill"). Davies and Vadlamannati (2013) find that neighboring countries appear to compete in labor standards, with proximate countries lowering their labor standards in response to cuts in neighboring states, while Mehmet and Tavakoli (2003) find that the RTB can lead to decreased wages. However, while the RTB logic is compelling, empirical and theoretical investigations have added nuance to this relatively straightforward concept. In her seminal book, Nudra (2008) argues that the RTB does not disproportionally impact the very poor in developing countries, but instead it can hurt the middle classes in these countries as RTB pressures can undermine government social programs that primarily benefited them. Other research is even more skeptical of the RTB, suggesting that the phenomenon does not occur. When considering social spending, Hecock and Jensen (2013) find *increases* in spending lead to greater inward investment. Likewise, Wheeler (2001) finds that air pollution declined in the major cities in countries which received inward investment in the 1990s.

Bangladesh Textile Industry

Bangladesh has long been noted as one country who has perhaps eschewed labor or environmental standards in pursuit of export led growth (Drezner 2000). Beyond that, it is well established that waste product (effluent) from the textile industry is highly polluting and can lead to high levels of arsenic contamination (Kaushik et al. 2012; Lellis et al. 2019; Panigrahi and Santhoskumar 2020). In Bangladesh, the textile industry has been an important driver of economic growth since its independence in 1971. However, the industry remained nationalized until the early 1980s, after which point it underwent sustained growth (Sikder 2019), with textiles accounting for 80 to 90 per cent of exports by the 2010s. The massive size of this industry in Bangladesh, and the documented pollution from textile effluent, leads to a strong expectation that the textile industry in Bangladesh has led to significant ground water contamination, including with arsenic, as would be suggested by RTB theorists. Indeed, several studies on Bangladesh textile effluent have found it to be contaminated with arsenic, along with other heavy metals and pollutants (Nasrin et al. 2015). Indeed, in Section I of the Supplemental Online Appendix, we utilized geo-referenced information on the location of exporting firms and on arsenic testing to evidence a spatial correlation between the two at a localized level.

Bangladesh Arsenic Remediation

This arsenic poisoning has been a significant public health concern in the country since at least the mid-1990s (Smith et al. 2000; Milton et al. 2012). It is estimated that over half of Bangladesh's population was at risk of drinking contaminated water, dwarfing the proportion of any other country in the world (Rahman et al. 2018). In addition to abnormalities including skin lesions and organ damage (Rahman et al. 2018), arsenic exposure in Bangladesh has doubled the risk of cancers including those of the liver, bladder and lung (Chen and Asan 2004). One estimate suggests that arsenic related mortalities could cost Bangladesh roughly $12.5 billion over a period of 20 years as it negatively affects productivity (Flanagan et al., 2012). These health consequences are often accompanied by socio-economic costs, including negative cognitive outcomes (Asadullah and Chaudhury 2011), mental health issues (Chowdhury et al 2016), ostracism, breakdown in familial relations, or difficulty in obtaining employment (Rahman et al. 2018).

In response to these conditions, a number of international development partners, including the World Bank, have attempted to address the issue. The largest of these projects were the World Bank's Bangladesh Arsenic Mitigation and Water Supply Program (BAMWSP), the Bangladesh Water Supply Program Project (BWSPP) and the Bangladesh Rural Water Supply and Sanitation Program (BRWSSP) which implemented well testing and mitigation efforts in conjunction with the Government of Bangladesh's Department of Public Health Engineering (DPHE). These efforts were prompted by a 1997 survey which found that a considerable number of older tube wells were contaminated (Milton et al. 2012). This led to more widespread testing under the BAMWSP and mitigation efforts, including the drilling of deeper wells, under that project and the BWSPP and BRWSSP (van Green et al. 2016).

While evaluations of these projects have suggested their overall success in mitigating arsenic levels in Bangladeshi drinking water (Foster 2007, Ndaw 2016, World Bank 2018), there is still considerable subnational variation in contemporary reporting on arsenic levels. We contend that this variation is the result of *political economy* factors that determined the siting and type of remedial wells under the BAMWSP, BWSPP and BRWSSP projects. Like any government program, there are strong reasons to believe that an incumbent government will try and direct resources to secure political advantage. At the subnational level, aid targeting has been observed both to reward political support (Briggs 2014; Jablonski 2014; Knutsen and Kotsadam 2020) but also to try and capture the support of swing voters (Masaki 2018).

As discussed in BWSSP documentation, while project regions were targeted via analysis and discussion between the Bank and the Bangladesh National government, the siting of individual wells under the project was left to local level decision makers via local Water and Sanitation Committees (WATSANs) and Arsenic Mitigation Committees (Pearshouse 2016).[2] It is observed that well placement in some parts of Bangladesh has been inefficient, as the sitting of wells in many cases were at the discretion of local government officials and hence prone to elite capture (Krupoff et al 2020). For example, Mobarak and van Green (2019) provide evidence that national politicians facilitate such local elite capture of wells in the context of Bangladesh arsenic mitigation. In Bangladesh, export-oriented textile firms are some of the most significant economic and political actors (Taplin 2014; Kabir et al. 2014; Khan et al. 2020; Paton 2020). As noted by Ali et al. (2021), firm owners have influence over politicians due to their access to foreign currency, sway over their employees, and well as through direct political financing. Indeed, many factory owners are politicians themselves or direct relatives of politicians (Tripathi 2014; Algamir and Banerjee 2019). Thus, as support from local elites or firms within a constituency is very important for politicians it is reasonable to assume that politicians would try and appease the firms and the residents nearby by providing (better) wells in the proximity of the firms.

[2]http://documents1.worldbank.org/curated/en/403551468002665165/pdf/BRWSSP0PID000Appraisal0Stage000012612.pdf

The location of the firm thus provides a proxy of the interests of these elites as many of the exporting firm production facilities, especially those of Small and Medium Enterprises (SMEs), exist within compounds that also house the corporate offices. Likewise, the owner or directors' residence may also be either within the compound or nearby, as will the residences of many workers (Karim, 2021). As such, these influential individuals will work to ensure that they acquire the new wells in their area either for their own benefit or for the benefit of the health of their workers. This latter effect might be driven both by genuine concern for the well-being of a firm's workforce, but also by the recognition that a healthy workforce is more likely to be economically efficient. As a result, we expect that households living near those firms will be less likely to report arsenic as the result of allocation and installation of (high quality) wells.

A detailed qualitative review of arsenic remediation measures in Bangladesh by *Human Rights Watch* (HRW) indeed found considerable qualitative evidence of political influence in the allocation of the projects. Some select quotes from interviews with DPHE officials in 2015 (both in interviews and written records):

> "If the member of parliament gets 50 percent [of the allocation] and the upazila chairman gets 50 percent, there's nothing left to be installed in the areas of acute need." —DPHE official, Bangladesh (Pearshouse 2016, p. 53)
>
> "…sometimes influential or elite person [sic] influence the site selection process resulting in selection of less priority areas." (Department of Public Health Engineering and Japan International Cooperation Agency, Situation Analysis of Arsenic Mitigation 2009, p. 62, quoted in Pearshouse 2016, p. 55)
>
> "In 2013, we had an allocation of [approximately 100] tubewells from two projects and that year they were split 50-50 between the member of parliament and the upazila chairman." (Pearshouse 2016, p. 57)
>
> "Handwritten in the margins of the DPHE allocation record was the sentence: 'Around 15 (the exact number is not included here) are reserved for the Honorable member of parliament and the Honorable Upazila chairman.' " (Pearshouse 2016, p. 57).
>
> "Written on the letterhead of Bangladesh's National Parliament and signed by the member of parliament, it was addressed to the executive engineer of the district DPHE office. The letter listed the names of 25 people living in an upazila (sub-district) 'under my electoral area where deep tubewells need to be installed'." (Pearshouse 2016, p. 56)

> "Site selection of new tubewells is essentially all about politics. They give them to their political allies, their supporters, those close to them or those who work for them.
>
> It is very frustrating; they don't consider the real needs of the people." (Pearshouse 2016, p. 58)

and from HRW interviews with individuals:

> "Many government tubewells are installed in private homes: the owners bribe government people or use their political connections" (2 Human Rights Watch interview with Khaddro, Ruppur, September 2, 2015. quoted in Pearshouse 2016, p. 59).
>
> "Six people from my household drink from this well. We don't let others drink from it. My father-in-law is a friend of the upazila chairman. They are in the same political party, so they have a political friendship. We paid 30,000 taka (approximately US$ 390) to the upazila chairman" (HRW interview with caretaker of government tubewell , 2015. quoted in Pearshouse (2016, p. 60)

clearly identify the "smoking gun" of political interference from both national and local politicians.

These dynamics fall squarely into long-standing debates in the political economy of aid which highlight the tension between "donor control" and "(elite) aid capture" (Milner et al. 2016). Donor control is predicated on the understanding that donors wish to direct resources to areas where they can be most beneficial. In this case, the World Bank clearly intended well-mitigation efforts to be directed to those areas most affected by arsenic as their well-testing determined which upazilas were included in the remediation efforts. However, as the quotes above illustrate, within upazilas, the World Bank may have lost control and resources were captured by local elites – particularly local politicians and elites via the WATSANs.

Thus, the argument we put forward is that the tension between donor control and elite aid capture is one of (spatial) degree. Donors may be effective in controlling the allocation to a certain level of precision, especially when that allocation is driven by spatial data, such as the well-testing data. This data-driven allocation can ensure that donors can exert significant control at a *mezzo* level, corresponding to the granularity of their data. However, as the degree of spatial precision increases, monitoring costs also increase. At the most *micro* level, that of individuals or households, donors may lose control to local capture as the monitoring costs at that level of precision are very high. Thus, the "last mile" allocation may be susceptible to elite aid capture wherein resources can be doled out in an explicit exchange for support (or bribes). This is consistent with the explanation given by Briggs (2021) to account for why aid appears to not be directed to poor regions – the monitoring and implementation costs of reaching and/or operating in these regions is simply too high. This delineation between mezzo and micro donor control and recipient capture was also evidenced in a recent study on aid allocation in Bangladesh by Brazys et al. (2020) who found that while aid appeared to be targeted to poorer regions at a higher administrative aggregation (the Upazila level), the opposite was true when considering the same aid but at a more disaggregated level (the Union level).

Accordingly, we have two hypotheses reflecting donor control and recipient aid capture. Our elite aid capture hypothesis is that exporting firms, who are politically and economically influential, will have been able to attract the siting of (better) wells to their own households or households in the vicinity of their firms, where their workers live. Likewise, our donor control hypothesis is that (better) wells will be sited in areas that have the highest levels of initial arsenic. However, we expect the strength of these relationships to depend on the level of spatial precision. Donor-control should be more evident at the *mezzo* level while elite capture should be more prevalent at the *micro* level.

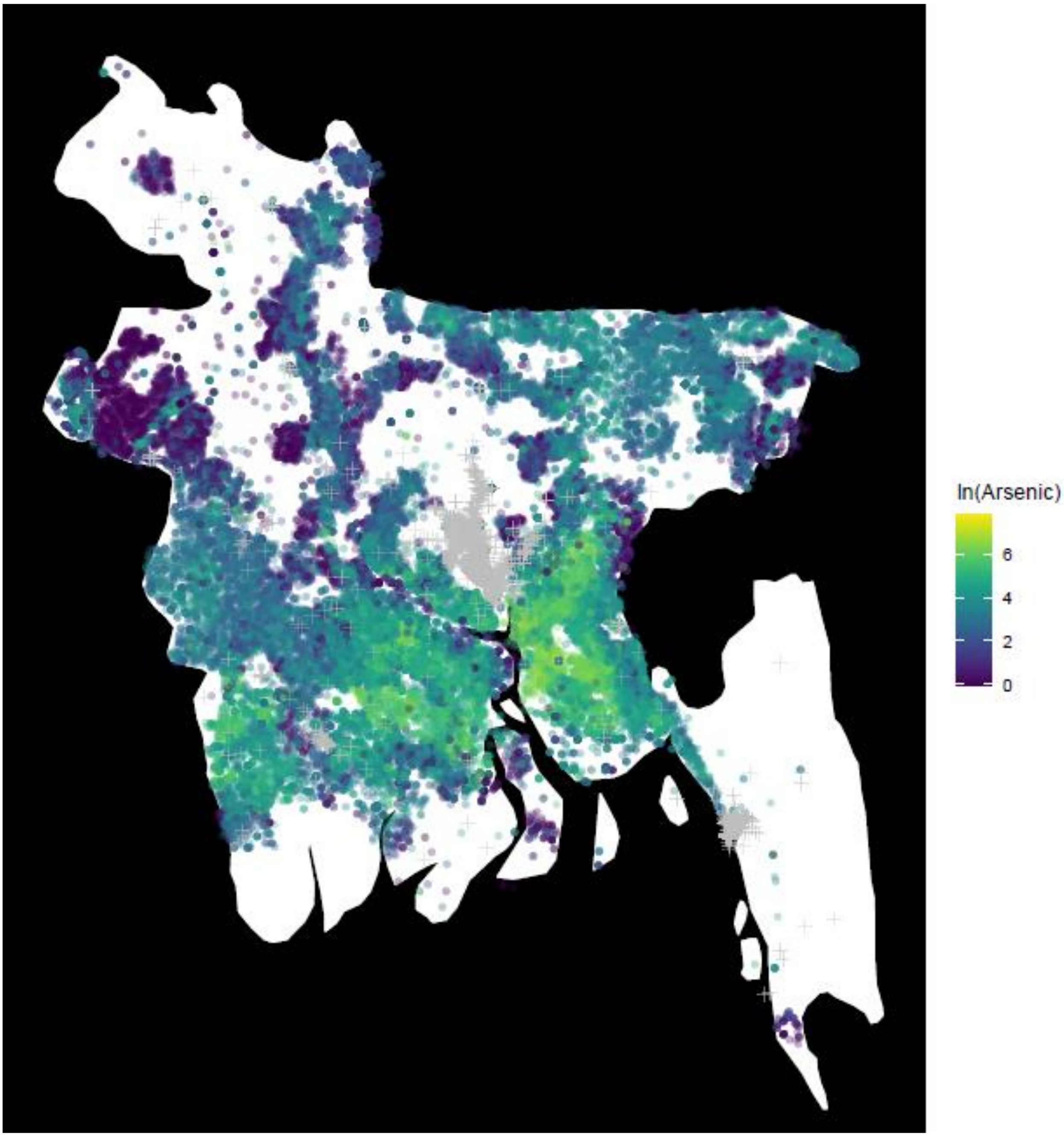
Data, Methods and Results

Firms and Arsenic

To investigate the politics of arsenic and mitigation in Bangladesh we draw on a range of different data and methodological approaches. In the first instance, as a baseline, we seek to establish a connection between the presence of exporting firms and increased levels of arsenic. Our firm-level data comes from a directory of the population of 11,124 exporting firms obtained from the Bangladesh Export Promotion Bureau first utilized by Brazys et al. (2020). As discussed there, this data was geo-referenced using Google's geo-coding application programming interface (API) and hand-reconciled resulting in geo-location information for 11,115 firms.

To establish "initial" arsenic levels, we utilize data gathered from 3,962,175 wells across 44,865 villages (*Mouzas*) tested from 2000 to 2005 as part of the (BAMWSP) and reproduced by Jamil et al. (2019). Again, using the Google geo-coding API, we are able to identify point coordinates for 43,780 (97.6%) of these villages. The location of these wells (colored circles) and firms (gray crosses) are presented in Map 1. The shading on the circles indicates the natural log of the mean level of arsenic in wells at the village level with purple shading indicating low levels of arsenic and yellow shading indicating high levels. Clustering can be observed with both firms and arsenic levels. Firms, unsurprisingly, are clustered around the major metropolitan areas, in particular Dhaka and, to a lesser extent, Chittagong. Likewise, mean arsenic levels are consistently higher in the southern (and eastern) parts of the country. However, at the village level there is a substantial amount of variation, with pockets of heavier and lower arsenic levels throughout the country.

Map 1: BAMWSP Well Testing and Firm Locations



Brighter colors (yellow) indicate higher arsenic, darker colors (purple) less. Exporting firm locations given by gray crosses.

To consider if the siting of arsenic mitigation measures, namely new wells provided by the Government of Bangladesh and its development partners, was driven by *donor control* at the mezzo level, we couple the firm and arsenic described above with data from 122,181 wells installed from 2006 to 2012 from Ravenscroft et al. (2014). Of these, 102,494 were installed by the Bangladesh Department of Public Health Engineering with support from the World Bank's Bangladesh Rural Water Supply and Sanitation Project (BRWSSP), 19,496 were installed as part of UNICEF efforts, 190 were installed by other Government of Bangladesh entities and 1 was installed by the Asian Development Bank (ADB).

Well placement data is available at the Union level (Bangladesh's administrative 4 level). Accordingly, we use this data to directly evaluate our *mezzo-level* claims. To evaluate if arsenic levels drove well allocation at this spatial level, we take the mean value of all the BAMSWP tests which occurred within the Union. This is the data upon which well-allocation decisions were ostensibly made for the BRWSSP. If the World Bank was able to exert control over siting, we would expect that higher levels of arsenic would be associated with a higher likelihood of well placement at the Union level. We first run models with only the arsenic level, before adding other confounders including Union-level averages of household poverty measures from the 2005 wave of the geographically and demographically representative Bangladesh Household Income and Expenditure (HIES) survey as well as a binary measure that equals one if the Union was home to at least one exporting firm. The poverty measures include the Union-level average of household financial assets, the proportion of houses built with improved walls, the proportion of households with electricity or mobile phones, and the proportion of Muslim households. We also run models both including and excluding the Dhaka and Chittagong metropolitan areas as the high degree of spatial concentration in these areas poses a challenge to spatial identification.

In terms of well outcomes, we evaluate models considering both all wells and deep tube-wells only, which are broadly acknowledged as being the most effective for avoiding arsenic contamination. However, as most Unions received multiple different kinds of wells, we identify the *mode* well-instillation type at the Union level to determine if a well site is a deep well site. In both instances, we consider a binary variable which equals one if Union is allocated (deep) wells, and zero otherwise.

The results in Table 1 using linear models and Conley (1999) standard errors show qualified support for our expectation of donor control at the *mezzo* level. While we find no significant relationship between the level of arsenic and the assignment of wells when considering *all* wells (models 1, 3 and 5), we see a positive and statistically significant association when considering only *deep* wells (models 2, 4 and 6). As these are the more effective well-types, we take this as evidence in support of our donor control hypothesis as these better wells were directed to areas with higher arsenic levels. The results suggest that the World Bank was able to make effective use of its testing under the BAMSWP to exercise control over well placement, at the Union level, under that and later projects. While it is interesting that the control measure of exporting firms is *negative* and significant in models 3 through 6, indicating that Unions with exporting firms were *less* likely to receive wells (both all wells and deep wells) compared to those without, we note that as we also expect (and as shown in Appendix I) that exporting firms are associated with higher levels of arsenic, we are hesitant to read too much into this finding. However, as the arsenic result is robust both to the inclusion of this and the various poverty measures, we take this as strong correlational support of our hypotheses that donors were able to control siting at the *mezzo* level based on known levels of arsenic.

Table 1: Arsenic and Well Treatment (ADM 4 Level)

VARIABLES	(1) All	(2) Deep	(3) All (Controls)	(4) Deep (Controls)	(5) All (ex Dhaka Chittagong)	(6) Deep (ex Dhaka Chittagong)
Arsenic Level	-0.009	0.043***	0.001	0.130***	0.003	0.132***
	(0.009)	(0.007)	(0.010)	(0.007)	(0.010)	(0.013)
ln(Exporter Count)			-0.299***	-0.276***	-0.201***	-0.228***
			(0.063)	(0.070)	(0.045)	(0.070)
Financial Assets			-0.004***	-0.000	-0.003***	-0.000
(10000s of Taka)			(0.001)	(0.001)	(0.001)	(0.001)
Improved Walls			0.093	0.024	0.074	-0.014
			(0.091)	(0.110)	(0.094)	(0.117)
Flush Toilet			-0.111	0.250	-0.065	0.359
			(0.121)	(0.221)	(0.125)	(0.224)
Electricity			-0.323***	-0.273*	-0.373***	-0.275*
			(0.104)	(0.159)	(0.106)	(0.154)
Mobile Phone			-0.724***	-0.168	-0.724***	-0.178
			(0.117)	(0.186)	(0.123)	(0.193)
Muslim			0.017	-0.139	0.027	-0.130
			(0.050)	(0.089)	(0.050)	(0.089)
Constant	0.356***	0.028	1.205***	0.237	1.199***	0.224
	(0.036)	(0.029)	(0.073)	(0.130)	(0.074)	(0.131)
Observations	3,211	3,211	1,160	1,160	1,127	1,127

Conley standard errors in parentheses

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

However, this data only identifies wells at the Union level, and we are thus unable to directly ascertain what types of wells went where *inside* the Unions. While Unions are relatively small geographic areas, the largest can extend to hundreds of square kilometers and tens of thousands of residents.[3] As such, there is still the possibility of elite capture within the Union, the *micro* level, and indeed the qualitative evidence from the Human Rights Watch reporting above suggests this was indeed taking place. These wells were ultimately designed to be used by a single household or, at most, a small cluster of households. It is entirely plausible that wells within a Union may have only served a small

[3] http://203.112.218.65:8008/WebTestApplication/userfiles/Image/National%20Reports/Union%20Statistics.pdf pg. 24-33. Accessed 31-02-2022

number of households and that there is a considerable amount of within-Union variation in allocation of the wells.

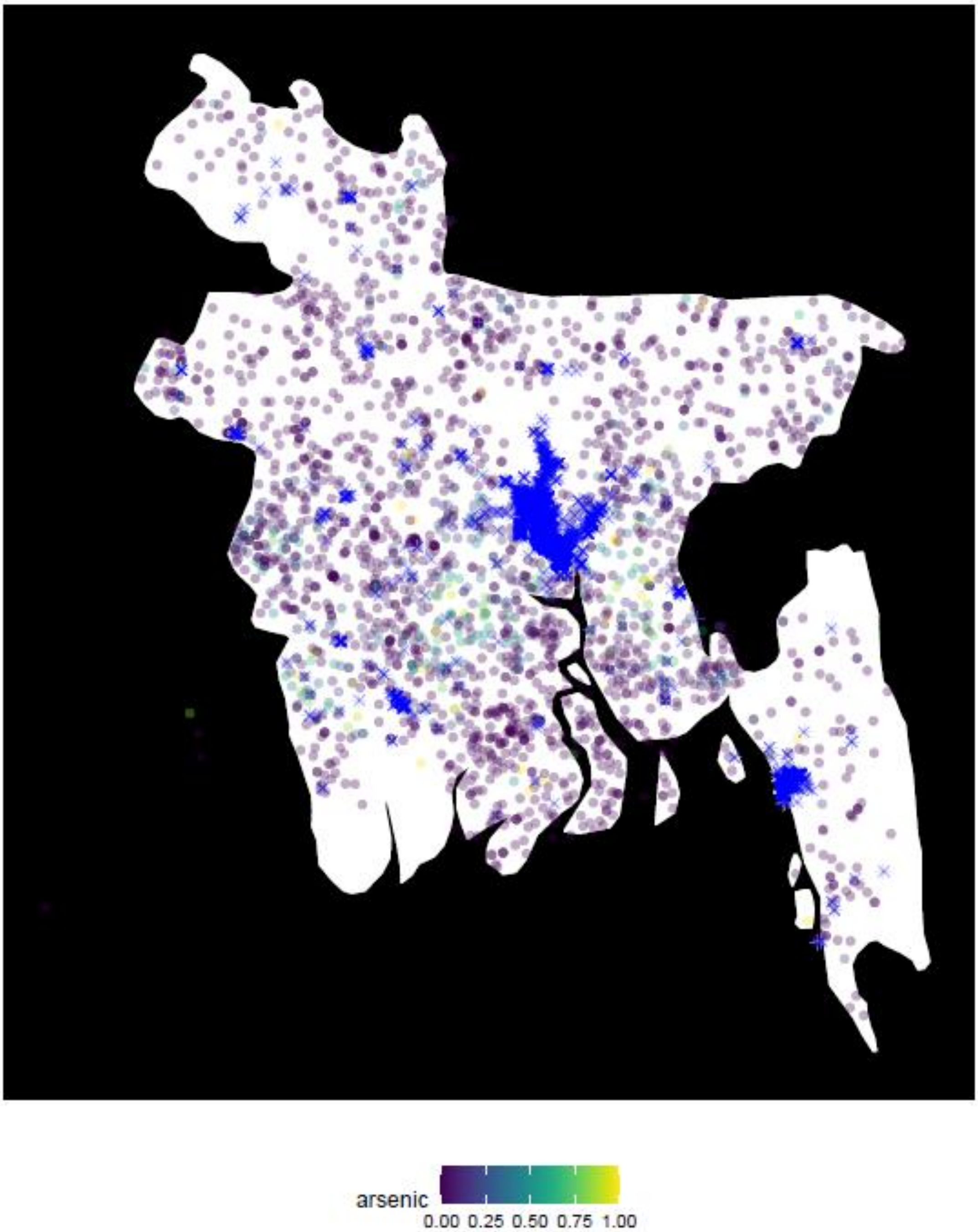
Accordingly, in our final step, we use data from two waves of the Bangladesh Household Income and Expenditure (HIES) survey. Briefly mentioned above, this geographically and demographically representative household survey conducted in 2005, 2010 and 2016 captured responses from over 290,000 individuals in over 67,000 households. In each wave, households were asked to self-report the presence of arsenic in a household tube well test. Of these households, 30,013 responded to questions regarding testing for arsenic in their well, "Has your tubewell been tested for arsenic?" and "Was arsenic found?". We use this information to create a binary measure that equals "1" if arsenic was found and "0" otherwise. Summary statistics show that the average proportion of households reporting arsenic fell over time, with 11.23% reporting arsenic in 2005, 7.16% in 2010 and 6.3% in 2016.

Of these households, 271 were panel observations, meaning that we were able to find a unique household identifier in multiple waves of the survey. The households were sampled from a total of 2,692 *mouzas* or villages. Bangladesh, according to the latest population census, has roughly 66,000 total mouzas and they are the smallest administrative units, typically consisting of a village comprised of a few hundred households.[4] Households were geo-referenced into these mouzas using Bangladesh Bureau of Statistics (BBS) geo-codes to obtain location information which was then geo-referenced with latitude and longitude coordinates using Google's geocoding API.[5] These coordinates were then hand-checked for errors. Of the 2,692 mouzas, 232 were sampled in two waves and 36 were sampled in all three waves. Just under 25% (672) of mouzas had at least one household reporting arsenic, while just over 5% of mouzas (145) had at least half of their household's reporting arsenic. As with the household data, we see a declining trend over time with 32.86% of mouzas reporting "any" arsenic in 2005, 29.08% in 2010 and 21.84% in 2016. As there is a clear secular trend in arsenic reduction, we employ a difference-difference-in-differences (DDD) approach to identify the impact of well-installation. We limit our analysis to two survey periods, 2005 and 2010 as we only have complete well-installation during this period. This data includes a total of 11,824 households, 222 of which are panel. However, as we are only interested in the treatment effect of *mitigation* efforts, we identify mouzas that had *any* household who reported arsenic in 2005 and only keep households from these mouzas. This leaves 4,222 households and this forms our first sample, a pooled-cross section. As shown in Table AII.3, with one notable exception discussed below, these pooled cross sections appear quite comparable on most measures when considering the different "treatment" arms

[4] A Mouza may comprise one or more villages.
[5] The Google geocoding API https://developers.google.com/maps/documentation/geocoding/start was implemented via the R function "mutate_geocode" https://www.rdocumentation.org/packages/ggmap/versions/2.6.1/topics/mutate_geocode

created by the DDD approach. Turning to the panel data, since we can only include households who answered yes to “Has your tubewell been tested for arsenic” in both periods, we lose some households who do not answer yes to this question in the post period and are thus left with a total of 92 panel households, 24 who were in Unions not treated by the well program and 68 who were treated by the program. This panel data forms our second sample.

Map 2: Household Arsenic and Firm Locations



Brighter colors (yellow) indicate a higher, and darker colors (purple) a lower proportion of households reporting arsenic at HIES survey sites (*Mouza* level) (circles). Exporting firm locations given by blue “Xs”.

We assign the treatment variable for any household inside a Union which received a well between 2005 and 2009. While there is strong reason to think that well selection was endogenous to the presence of arsenic, as suggested by our results above, our identifying assumption is that, within a Union that had at least one household reporting arsenic, the well assignment is likely to be exogenous to any pre-trend or *changes* of arsenic. In other words, we do not suspect that, within the sample of Unions who had households which reported any arsenic, wells were more or less likely to go to Unions that had a *pre-trend* of increasing/decreasing levels of arsenic. We base this assumption primarily on the fact that the well-mitigation projects were based off static testing of wells and, accordingly, the program allocators would not have known of any trends by location. We thus consider households in mouzas who were "treated" by well programs compared to those that were in mouzas which reported arsenic but did not receive wells under the program. We again consider the allocation of both all wells and of deep tubewells only.

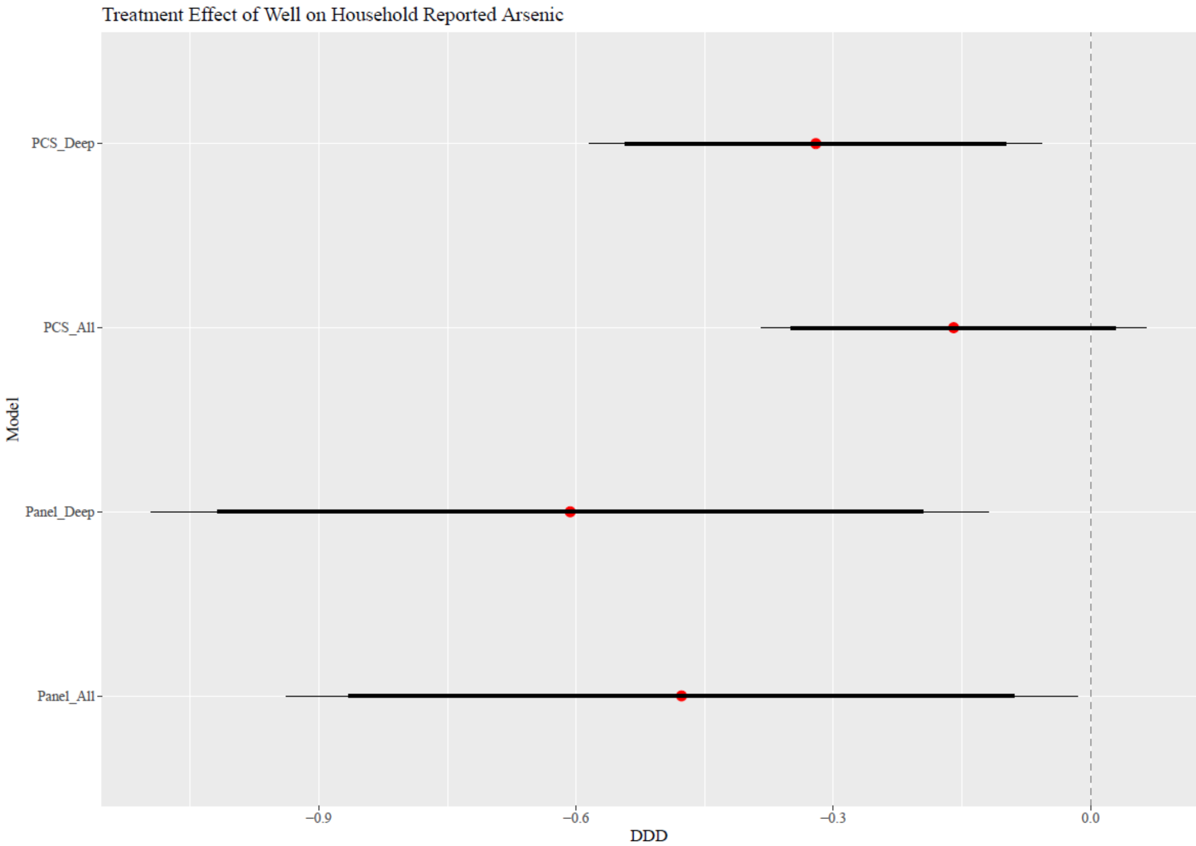
While well-treatment and timing give our first two dimensions of our difference-in-difference-in-difference approach, to proxy elite capture we add a further dimension by generating a "near firm" variable which indicates if the household was near an exporting firm, or not, splitting the sample based on the median distance. Adding this dimension allows us to evaluate if the effectiveness of the well-treatment is conditional on also being proximate to an exporting firm, where this proximity is indicative of the elite capture motive as discussed above. Given the strong expectation, backed by empirical investigation (Ravenscroft et al. 2014, van Green et al. 2003) that deep tubewell installation *does* reduce arsenic, we can infer if households near exporting firms were more likely to receive tubewells compared to those far from firms if they show reduced arsenic in the post-treatment period vis-à-vis that comparison group. The reduced form of the DDD equation is given by:

$$y_{it}=\beta 1\ TREAT_i + \beta 2\ POST_t + \beta 3\ NEAR_i + \beta 4 TREAT_i{*}POST_t + \beta 5 NEAR_i{*}POST_t + \beta 6 NEAR_i{*}TREAT_i + \beta 7 TREAT_i{*}POST_t{*}\ NEAR_i + \varepsilon_{it}$$

Where y_{it} is the presence of arsenic reported by household *i* at time *t*. "TREAT" is an indicator variable that equals 1 if the household *i* is in a treated Union, "POST" is an indicator variable that equals 1 for the 2010 period *t*, "NEAR" is an indicator that equals 1 if the nearest firm to the household is less than the median sample distance and ε_{jt} is the error term, where our estimated errors are clustered at the ADM4 (Union) level. The $\beta 7$ coefficient is the difference-in-difference-in-difference estimate which indicates the treatment effect of well placement when the household is also near an exporting firm. Summary statistics are presented in the Appendix Table AII.1 and we present our findings graphically in Figure 1 and in tabular form in Appendix Table AII.2.

As shown in the figure and table, the difference-in-difference-in-difference is negative in all four models, reaching significance at the $p<0.05$ level in three of the models. As expected, the effect on arsenic reporting is stronger when considering deep tube well allocation, with the difference-in-difference-in-difference significant at the $p<0.05$ level both when using the pooled cross-section (PCS) and when using the household panel. The substantive effect on the panel models is noticeably larger, with the difference-in-difference-in-difference of the deep model equal to 0.606. This means that the local average treatment effect of households near firms minus the local average treatment effect of household far from firms is equivalent to a decrease of 61% in the likelihood of reporting arsenic in the post period.

Figure 1: Treatment effects of wells on arsenic by type/sample



Difference-in-difference-in-differences estimates (red dot) with 90% (thick line) and 95% (thin line) confidence intervals based on standard errors clustered at the Union level.

Thus, households in treated Unions *that are proximate to exporting firms* see a substantial reduction in the likelihood of reporting arsenic in their well compared to households in treated Unions that are far from firms and households in non-treated Unions. We infer from this result that this comparative reduction in reported arsenic is because the households *near firms* were allocated (deep) wells at a higher rate than those households further away. While this result is entirely consistent with the qualitative evidence presented above and supports our hypothesis of *micro* level elite capture, we cannot entirely rule out alternative explanations. Indeed, while, our models accounted for existing arsenic at the Union level, one potential explanation is that households near firms received deep tubewells precisely because households in comparative proximity to firms *within* a Union had a higher likelihood of arsenic in their water *because of that proximity*. Indeed, the descriptive statistics in Table AII.3 show that the proportion of firms, who were both near firms and in Unions treated with tubewells, that reported arsenic in the 2005 survey was 0.35 (increasing to 0.41 when considering only *deep* tubewells). In contrast, the proportion of households reporting arsenic in 2005 who were in Unions treated with tubewells but *far* from exporting firms was only 0.25 (decreasing to 0.15 when considering only *deep* tubewells). Thus, we cannot entirely rule out an explanation wherein donors were aware that households (or areas) near firms had a higher probability of reporting arsenic and, as such, targeted the (deep) tubewells to these locations. While the qualitative evidence above provides strong "smoking gun" evidence of local elite capture, it could still be that this capture resulted in a well allocation that was ultimately consistent with, if not driven by, donor allocation preferences. Thus, in this instance, there may have simply been a coincidence of wants wherein both donors and local elites wanted the same ultimate allocation choices, albeit for different reasons or by different means.

Robustness Checks

We consider several robustness checks with results available in Appendix II. First, our models in Figure 1 above include both the Dhaka and Chittagong metropolitan regions. However, as discussed when considering well allocation, the density of firms and the small geographic size of the administrative units poses a challenge to spatial identification. Accordingly, we re-run these with results presented in Table AII.3 and Figure AII.1, respectively. We find no substantive difference in our results when excluding these regions. Second, at the *mezzo* level, we would expect our results on donor control from Table 1 to be consistent at a *higher* level of spatial aggregation. As our argument is that donors will *lose* control as spatial precision increases, we would expect them to *gain* (or at least have no worse) control at higher degrees of spatial aggregation. Accordingly, we collapse our data into the administrative three level, sub-districts or *Upazilas*. We again create binary indicators for well and firm presence. These results in Table AII.4 are substantively consistent with those produced using the *Union* level aggregation and, if anything, even more indicative of donor control.

Finally, in Figure AII.2 and Table AII.5 we also evaluate DDD models where we include several pre-treatment household level covariates proxying for measures of household wealth. These measures come from the HIES survey and include household measures of electricity connection, the presence of a flush toilet, the number of rooms in the house, the presence of a mobile phone, and the use of improved building materials in the house. The results using the pre-treatment covariates are nearly identical to our main results in Figure 1.

Conclusions

Despite decades of recognition and mitigation efforts, arsenic in drinking water remains a major public health concern in Bangladesh. Arsenic contamination is likely due, to a great extent, to the exporting firms that have powered Bangladesh's economic development over the pats 30 years. Arguably, Bangladesh's development model was predicated on "race to the bottom" (RTB) dynamics, wherein environmental standards were sacrificed in order to attract investment to spur growth. While these efforts have largely succeeded in increasing Bangldesh's material wealth, they have also spurred a number of externalities which have impacted different parts of the country at differing levels of severity.

Efforts by the Bangladeshi government and international donors to mitigate one of these externalities has led to a reduction in overall levels of contaminated drinking water in the country. However, the levels are still higher than almost anywhere else in the world. Moreover, while RTB dynamics are usually considered at the country level, there can also be significant *sub*-national variation in these effects, as industry (and its environmental consequences) may be spatially concentrated and indeed there is substantial *sub-national* variation in the instance of water contamination in Bangladesh. Accordingly, this manuscript has considered the subnational dynamics and politics of the subnational RTB in Bangladesh. Specifically, the manuscript has investigated if the World Bank was able to exert spatial control of its arsenic and drinking water mitigation efforts, or if the wells under these programs became subject to political capture.

After first showing that arsenic levels can be spatially linked to exporting firms across Bangladesh, we then demonstrated that mitigation wells are allocated, at the *mezzo* level, to areas in which testing found higher levels of arsenic, suggesting a degree of donor control in directing well resources to the areas where they are needed most. However, when looking at the *micro*-level, we find evidence of dynamics consistent with the detailed qualitative evidence of elite aid capture documented by the NGO *Human Rights Watch*. Using a difference-in-difference-in-differences approach we find that, in *mezzo-level* (Union) areas which received well mitigation efforts, *micro-level* households that were *also* proximate to politically-influential exporting firms saw a considerably larger drop in the likelihood of reporting arsenic in their water supply after the arrival of wells in their area than their compatriots who were farther from these firms but also in *mezzo-level* regions that received wells.

A plausible interpretation of these findings is that households "near" exporting firms were able to secure (better) wells which improved their well-water quality due to the political influence of these firms. As the workers, if not managers, directors and owners, of these enterprises often live near (or at) the firm site, this suggests that these politically influential actors were able to influence the siting of resources *within* the mezzo level. In this reading, the donors would have “lost control” in the “last mile”. These findings build on the damning qualitative evidence of political cronyism and capture in the Bangladesh arsenic mitigation programs produced by *Human Rights Watch* by empirically demonstrating patterns that are consistent with this behavior across Bangladesh. This influence could exacerbate intra-country inequalities, as individuals who were not located near firms did not receive (high quality) wells and thus did not experience the same magnitude of improvement in their water.

That said, the results also lend themselves to an alternative explanation. Descriptive statistics show that the households that were comparatively nearer to firms were also *more likely* in the pre-treatment period to report arsenic in their water supply (presumably *because* of the proximity of those firms). Thus, wells locating to these households would also be entirely consistent with the donor control logic of directing wells to where they are needed most. While the qualitative evidence points to elite capture, the results may simply suggest that, in this particular case, there was an overlap between the interests of local elites looking to capture resources and a donor who wanted to allocate those resource to an area where they were needed most. While donor control and elite capture interests *may* be at odds, they need not always be, and this program could be an example of the latter.

While it is not possible with the existing data to completely untangle these competing mechanisms, the findings add to a growing literature which shows that understanding patters of *intra*-country aid allocation are vitally important to understanding intra-country inequalities. The subnational political economy of aid may well lead to elite capture in the “last mile” wherein existing inequalities can be exacerbated, leaving the poor and marginalized even further behind. The “race to the bottom”, and other development efforts and their externalities, are likely to exhibit significant heterogeneity at the sub-national level. Paying close attention to how local aid allocation decisions are made is vitally important to ensure that aid efforts do not simply result in local elites benefitting themselves and becoming more firmly entrenched.

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Supplemental Online Appendix

Section I - Firm location and Arsenic Levels

In order to investigate the relationship between firms and arsenic levels we spatially join firms to the BAMWSP well testing data. Unfortunately, we do not have precise timing on the date firms commenced operations which would allow for a stronger causal analysis and, as such, we are only able to investigate associations between firms and reported levels of arsenic. That said, evidence from a 2013 World Bank Enterprise Survey shows that 70.6% of surveyed firms were established as of 2000, suggesting that it is plausible to assume that many firms in our exporter directory would have been established at the time of the BAMWSP well testing.[6] Using a linear model, we investigate how the mean level of arsenic of wells within a village is related to the distance to the nearest exporting firm. This variable ranges from exactly co-located to a distance of nearly 200km. We would expect that wells nearer to firms are more likely to report higher levels of arsenic. Because our analysis depends on spatial identification, we run the models both with and without the incredibly dense Dhaka and Chittagong metropolitan areas. The extremely high spatial concentration of firms, along with numerous other potential pollution sources, means that the spatial identification approach may be more suspect. We account for potential spatial dependence in the model by using Conley (1999) standard errors.

Table AI.1: Arsenic Levels and Proximity to Firms (BAMWSP Baseline)

VARIABLES	(1) Distance	(2) Distance (ex Dhaka/Chittagong)	(3) (ln)Distance	(4) (ln)Distance (ex Dhaka/Chittagong)
Nearest Firm ((ln)KM)	-0.025***	-0.025***	-0.336***	-0.355***
	(0.006)	(0.008)	(0.104)	(0.109)
Observations	43,780	42,594	43,780	42,594

Conley standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The results in Table 1 show a clear association between the proximity of exporting firms and higher levels of arsenic. This result holds for both when including or excluding the Dhaka and Chittagong regions. As mentioned above, as we do not have precise timing on when firms began operations, we refrain from making any *causal* claims that firms have increased arsenic. That said, combined with direct evidence of arsenic in textile firm effluent, we certainly think it more plausible that the correlations are driven by firms increasing pollution

[6] https://login.enterprisesurveys.org/content/sites/financeandprivatesector/en/library/library-detail.html/content/dam/wbgassetshare/enterprisesurveys/economy/bangladesh/Bangladesh-2013-full-data.dta Accessed 05-11-2019.

as opposed to a spurious correlation and or reverse-causality wherein firms *locate* to areas with higher levels of arsenic. As such, we think it eminently reasonable to suggest that these firms are (at least somewhat) responsible for higher levels of arsenic in their proximity.

Table AII.1: Summary Statistics

VARIABLES	Model	Mean	SD	Max	Min	N	Source
(ln)Arsenic	Table 1	3.21	1.67	7.82	0	44,865	Jamil et al. 2019
Nearest Firm(km)	Table 1	17.76	14.07	199.70	0.00	44,865	Brazys et al. 2022
ln(Firm Count)	Table 1	0.01	0.09	3.48	0	44,865	Brazys et al. 2022
(ln)Arsenic	Table 2	3.55	1.39	6.68	0	3,211	Jamil et al. 2019
Well	Table 2	0.31	0.46	1	0	5,141	Ravenscroft et al. 2014
Deep Well	Table 2	0.15	0.36	1	0	5,141	Ravenscroft et al. 2014
Any Firm	Table 2	0.09	0.28	1	0	5,141	Brazys et al. 2022
ln(Firm Count)	Table 2	0.16	0.67	7.12	0	5,141	Brazys et al. 2022
Arsenic	Fig 1	0.07	0.26	1	0	29,874	HIES 2005, 2010, 2016
Treat (All)	Fig 1	0.65	0.47	1	0	29,874	Authors' Calculations
Treat (Deep)	Fig 1	0.51	0.50	1	0	21,178	Authors' Calculations
Electricity	Fig 1	0.68	0.47	1	0	29,871	HIES 2005, 2010, 2016
ln(House Size)	Fig 1	5.78	0.70	10.40	0	29,873	HIES 2005, 2010, 2016
ln(Financeprofit)	Fig 1	0.02	0.41	13.24	0	30,157	HIES 2005, 2010, 2016
ln(Rentalincome)	Fig 1	0.53	2.39	15.57	0	30,157	HIES 2005, 2010, 2016
ln(ClassComplete)	Fig 1	2.03	0.65	3.00	0	27,702	HIES 2005, 2010, 2016

Table AII.2: Full DDD Models

	(1)	(2)	(1)	(2)
VARIABLES	PCS	PCS Deep	Panel	Panel Deep
Treat Well	0.041	-0.057	-0.057	-0.024
	(0.073)	(0.077)	(0.211)	(0.223)
Near Firm	-0.018	-0.018	-0.033	-0.033
	(0.072)	(0.072)	(0.218)	(0.221)
Post	-0.062	-0.062	-0.200	-0.200
	(0.070)	(0.070)	(0.202)	(0.205)
Treat*Post	-0.034	0.066	0.200	0.200
	(0.082)	(0.094)	(0.207)	(0.223)
Near*Post	0.030	0.030	0.144	0.144
	(0.086)	(0.087)	(0.238)	(0.241)
Near*Treat	0.119	0.280**	0.390	0.488
	(0.104)	(0.122)	(0.257)	(0.267)
DDD (Near*Post*Treat)	-0.160	-0.320**	-0.603**	-0.723**
	(0.115)	(0.135)	(0.227)	(0.281)
R^2	0.026	0.040	0.137	0.219
Observations	4,222	3,294	184	132

Clustered (ADM4) Standard Errors in parentheses

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

Table AII.3: Full DDD Models (Excl Dhaka & Chittagong)

VARIABLES	(1) PCS	(2) PCS Deep	(1) Panel	(2) Panel Deep
Treat Well	0.030	-0.057	-0.061	-0.024
	(0.073)	(0.077)	(0.201)	(0.221)
Near Firm	-0.037	-0.037	0.011	0.011
	(0.070)	(0.071)	(0.221)	(0.223)
Post	-0.062	-0.062	-0.200	-0.200
	(0.070)	(0.070)	(0.202)	(0.204)
Treat*Post	-0.020	0.066	0.200	0.200
	(0.081)	(0.094)	(0.206)	(0.222)
Near*Post	0.052	0.052	0.095	0.095
	(0.086)	(0.086)	(0.238)	(0.241)
Near*Treat	0.139	0.294**	0.351	0.413
	(0.108)	(0.122)	(0.248)	(0.259)
DDD (Near*Post*Treat)	-0.171	-0.332**	-0.532**	-0.614**
	(0.119)	(0.140)	(0.258)	(0.273)
R^2	0.022	0.061	0.201	0.201
Observations	3,973	3,139	184	132

Clustered (ADM4) Standard Errors in parentheses

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

Table AII.4: Arsenic and Well Treatment (ADM 3 Level)

VARIABLES	(1) All	(2) Deep	(3) All (Controls)	(4) Deep (Controls)	(5) All (ex Dhaka Chittagong)	(6) Deep (ex Dhaka Chittagong)
Arsenic Level	-0.020	0.149***	0.026	0.184***	0.023*	0.181***
	(0.018)	(0.038)	(0.012)	(0.031)	(0.012)	(0.033)
Exporting Firm			-0.091**	-0.062	0.013	0.015
			(0.041)	(0.057)	(0.020)	(0.048)
Financial Assets			-0.008	-0.002	-0.002	0.002
(10000s of Taka)			(0.005)	(0.005)	(0.002)	(0.004)
Improved Walls			0.178	0.161	0.269	0.080
			(0.128)	(0.211)	(0.164)	(0.356)
Flush Toilet			-1.085***	-0.613	-0.598**	0.101
			(0.167)	(0.597)	(0.275)	(0.798)
Electricity			-0.135	-0.682	-0.282	-0.835
			(0.248)	(0.449)	(0.256)	(0.541)
Mobile Phone			-0.550**	0.153	0.082	0.620
			(0.276)	(0.431)	(0.159)	(0.497)
Muslim			0.060	-0.251*	0.127	-0.202
			(0.127)	(0.141)	(0.088)	(0.199)
Constant	0.946***	0.016	1.156***	0.291	0.818***	0.043
	(0.055)	(0.170)	(0.223)	(0.213)	(0.075)	(0.280)
Observations	459	459	434	434	397	397

Conley standard errors in parentheses

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

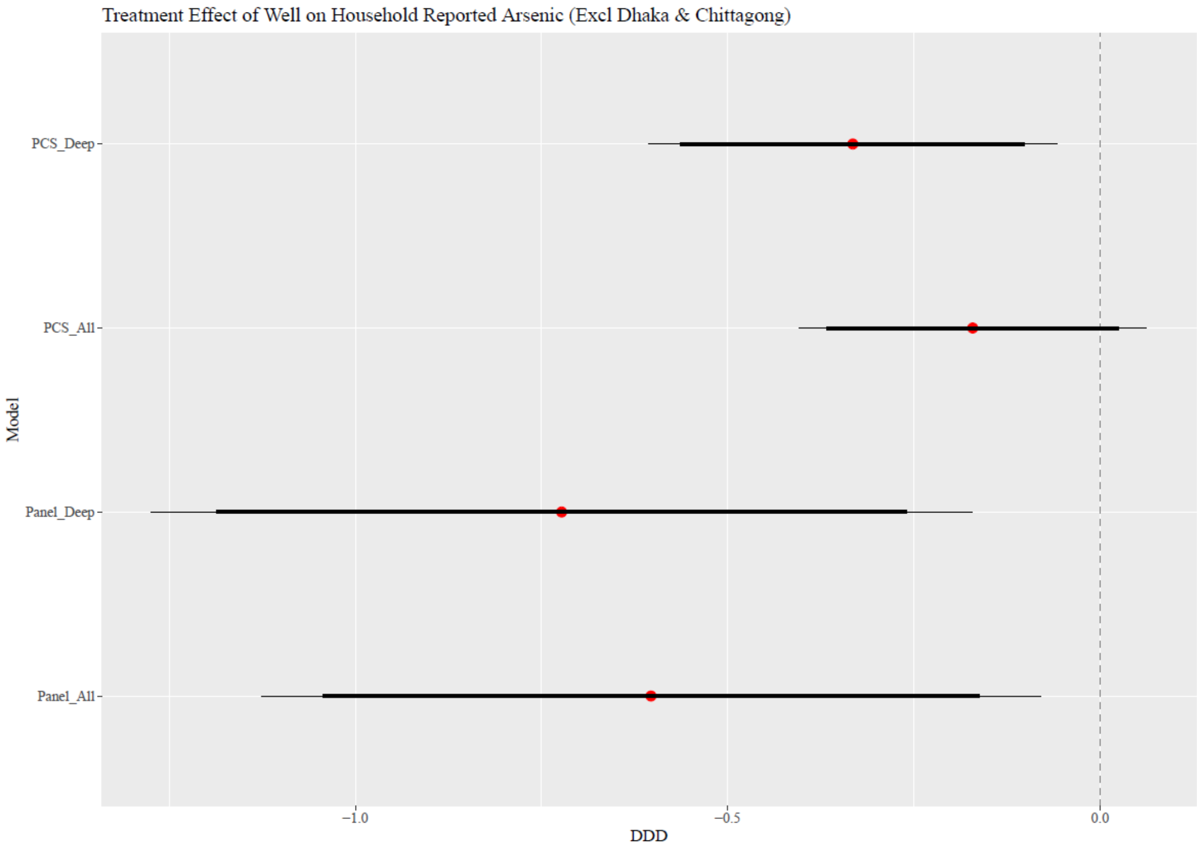
Table AII.2: Full DDD Models with Pre-Treatment Covariates

VARIABLES	(1) PCS	(2) PCS Deep	(1) Panel	(2) Panel Deep
Treat Well	0.038	-0.066	0.041	0.105
	(0.074)	(0.076)	(0.232)	(0.266)
Near Firm	-0.023	-0.025	0.106	0.153
	(0.069)	(0.069)	(0.233)	(0.258)
Post	-0.088	-0.089	-0.159	-0.121
	(0.067)	(0.067)	(0.248)	(0.268)
Treat*Post	-0.026	0.069	0.131	0.088
	(0.082)	(0.094)	(0.242)	(0.266)
Near*Post	0.030	0.025	0.042	0.018
	(0.084)	(0.084)	(0.262)	(0.275)
Near*Treat	0.119	0.282**	0.229	0.290
	(0.102)	(0.114)	(0.267)	(0.289)
DDD (Near*Post*Treat)	-0.169	-0.326**	-0.482*	-0.559*
	(0.112)	(0.130)	(0.281)	(0.299)
Number of Room	0.018*	0.021**	0.031	0.068**
	(0.009)	(0.009)	(0.025)	(0.032)
Improved Walls	0.011	-0.004	-0.017	-0.097
	(0.026)	(0.026)	(0.067)	(0.078)
Flush Toilet	0.020	0.024	0.092	0.041
	(0.027)	(0.030)	(0.077)	(0.096)
Electricity Connection	0.013	0.034	0.020	0.018
	(0.025)	(0.030)	(0.058)	(0.075)
Mobile Phone	0.046**	0.050*	0.075	0.089
	(0.023)	(0.026)	(0.074)	(0.083)
R^2	0.037	0.055	0.187	0.277
Observations	4,222	3,294	184	132

Clustered (ADM4) Standard Errors in parentheses

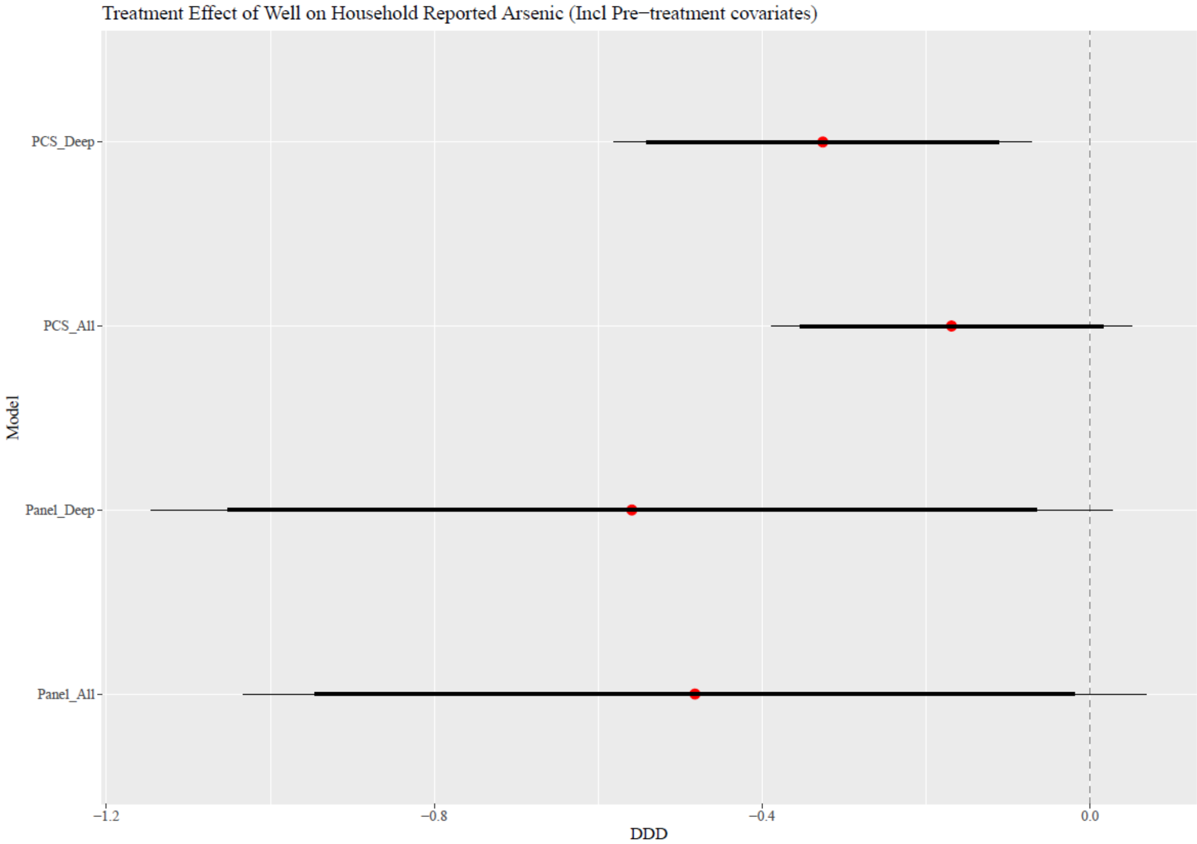
*** p<0.01, ** p<0.05, * p<0.1

Figure AII.1: Treatment effects of wells on arsenic by type/sample (Excl. Dhaka and Chittagong)



Difference-in-differences estimates (red dot) with 90% (thick line) and 95% (thin line) confidence intervals based on clustered standard errors.

Figure AII.2: Treatment effects of wells on arsenic by type/sample (Incl. pre-treatment covariates)



Difference-in-differences estimates (red dot) with 90% (thick line) and 95% (thin line) confidence intervals based on clustered standard errors.

Table AII.3: Descriptive Statistics of Pooled-Cross Section Cohorts (Mean with Standard Deviation in Parentheses)

	Near Treated	Far Treated	Near non-Treat	Far non-Treat
Pre (N)	545	691	1,036	420
Firm Distance (KM)	6.68 (3.56)	24.37 (9.59)	4.10 (4.10)	20.10 (5.34)
Arsenic	0.35 (0.48)	0.25 (0.43)	0.19 (0.39)	0.21 (0.41)
Asset	10049.63 (22823.12)	11048.84 (20940.69)	11587.41 (37040.99)	7885.98 (12610.98)
Education	5.71 (2.80)	5.09 (3.03)	5.50 (3.06)	4.00 (2.72)
Rooms	2.74 (1.46)	2.75 (1.49)	2.60 (1.41)	2.69 (1.47)
Age	26.95 (10.67)	28.41 (12.12)	26.97 (10.55)	26.62 (10.65)
Muslim	0.91 (0.28)	0.88 (0.28)	0.89 (0.30)	0.92 (0.27)
Walls	0.62 (0.48)	0.58 (0.49)	0.64 (0.48)	0.64 (0.48)
Toilet	0.29 (0.46)	0.23 (0.42)	0.25 (0.43)	0.20 (0.40)
Male	0.49 (0.19)	0.48 (0.19)	0.49 (0.18)	0.49 (0.19)
Phone	0.11 (0.31)	0.09 (0.28)	0.157 (0.36)	0.079 (0.27)
Post (N)	391	433	584	122
Firm Distance (KM)	6.86 (3.85)	24.14 (9.42)	3.69 (3.78)	17.50 (3.91)
Arsenic	0.13 (0.33)	0.15 (0.36)	0.16 (0.37)	0.15 (0.36)
Asset	23367.49 (52125.43)	19304.68 (69401.60)	29658.13 (65299.27)	20438.52 (41640.24)
Education	3.30 (2.52)	3.17 (2.70)	3.93 (2.95)	3.27 (2.44)
Rooms	2.60 (1.48)	2.20 (1.14)	2.40 (1.29)	2.53 (1.13)
Age	28.42 (11.34)	29.09 (12.32)	29.06 (10.55)	29.58 (10.90)
Muslim	0.91 (0.28)	0.89 (0.31)	0.90 (0.30)	1.00 (0.00)
Walls	0.78 (0.42)	0.68 (0.47)	0.74 (0.44)	0.78 (0.42)
Toilet	0.17 (0.38)	0.21 (0.41)	0.19 (0.39)	0.15 (0.36)
Male	0.48 (0.19)	0.46 (0.19)	0.48 (0.19)	0.51 (0.16)
Phone	0.73 (0.44)	0.65 (0.48)	0.73 (0.44)	0.69 (0.47)