Biometric Identification Machine Failure and Electoral Fraud in a Competitive Democracy [1]

Miriam Golden*, Eric Kramon†, George Ofosu*, and Luke Sonnet*

*University of California, Los Angeles
†George Washington University

August 11, 2015

Word Count: 10675
(including notes, references, tables and figures;
excluding appendices)

Version 5.1

Key words: elections, electoral fraud, biometric identification, Ghana

[1]Corresponding author: Miriam Golden, Department of Political Science, University of California at Los Angeles, CA 90095; email:golden@ucla.edu. Earlier versions of this paper were presented at the 2014 annual meetings of the American Political Science Association, August 28–31, Washington, D.C., at EGAP: Experiments in Governance and Politics 13, University of California at Los Angeles, February 20–21, 2015, at Columbia University, April 15, 2015, and at the University of Michigan, April 24–25, 2015. We are grateful to Jasper Cooper and Tara Slough for the extensions they suggested. In Ghana, we acknowledge the collaboration of our research partner, the Centre for Democratic Development, as well as the Coalition of Domestic Election Observers. We also thank our 300 wonderful field assistants for data collection. Joseph Asunka and Sarah Brierley collaborated on the design and implemention of the original project. Bronwyn Lewis provided research assistance. Funding came from the U.K.'s Ghana office of the Department for International Development, a National Science Foundation Grant for Rapid Response Research (RAPID) SES–1265247, and the UCLA Academic Senate, none of which bears responsibility for the results reported here. This research was approved by the University of California at Los Angeles IRB #12 – 001543 on October 26, 2012.

Abstract

We study election fraud in a competitive but not fully consolidated multiparty democracy. Results from a randomized field experiment are used to investigate the effectiveness of newly-introduced biometric identification machines in reducing election fraud in Ghana's December 2012 national elections. We uncover a non-random pattern to the frequent breakdowns of the equipment. In polling stations with a randomly assigned domestic election observer, machines were about 50 percent less likely to experience breakdown as they were in polling stations without observers. We also find that electoral competition in the parliamentary race is strongly associated with greater machine breakdown. Machine malfunction in turn facilitated election fraud, including overvoting, registry rigging, and ballot stuffing, especially where election observers were not present. Our results substantiate that partisan competition may promote election fraud in a newly-established competitive democracy. They also show that domestic election observers improve election integrity through direct observation and also thanks to their second-order effects on election administration. [156 words]

1 Introduction to the Problem

Most countries in the world use elections to select their political leaders, but in new, fragile, or unconsolidated democracies, the electoral process may be compromised by strategic manipulation on the part of various actors. Election fraud is common in these settings. How fraud occurs, who perpetuates it, and which preventive efforts are effective are still poorly understood.

At least two classes of responses have been mounted in the contemporary world to the problem of election fraud. The first involves deployment of election observers, especially teams from international bodies whose missions include election integrity. Research shows that international election observers operate as anticipated, successfully reducing election fraud (Enikolopov et al., 2013; Hyde, 2007, 2010, 2011; Ichino and Schündeln, 2012; Kelley, 2012; Sjoberg, 2012). The second response to election fraud involves the introduction of new technologies aimed at exposing — and thereby reducing — malfeasance. Technological solutions, such as electronic voting machines, polling station webcams, and biometric identification equipment, offer the promise of rapid, accurate, and ostensibly tamper-proof innovations that are expected to reduce fraud in the processes of registration, voting, or vote count aggregation. Little is known, however, about the effectiveness of these technologies in reducing fraud, and it seems likely that this will vary according to the political context (Bader, 2013). Although we can be relatively certain that election observation reduces (without entirely eliminating) election fraud, we do not know whether or when new technologies operate as intended.

Using biometric markers, such as fingerprints, that are almost impossible to counterfeit, biometric identification machines authenticate the identity of the individual (Jain, Hong and Pankanti, 2000). Biometric identification is particularly useful in settings where governments have not previously established reliable or complete paper-based identification systems for their populations (Gelb and Decker, 2012). Thanks to their supposed in-built capacity to prevent or substantially reduce fraud in the distribution of government allocations or services, biometric identification systems are already in widespread use for voter registration. As of early 2013, 34 of the world's low and middle income countries had adopted biometric technology as part of their voter identification system (Gelb and Clark, 2013) and 25 sub-Saharan countries have held elections with biometric voter registers in place (Piccolino, 2015, p. 5).

Despite the obvious difficulties in counterfeiting biometric markers, studies of biometric authentication systems have questioned whether they are tamper-proof in the real world. In India, a country in the process of distributing national identity biometric smartcards for the delivery of numerous government goods and services, including pensions and poverty relief, concern has been raised about the potential of local vested interests to strategically manipulate the process in ways that subvert the accurate delivery of government goods to intended recipients (Muralidharan, Niehaus and Sukhtankar, 2014). This concern overlaps with results from research claiming that polling place webcams reduce ballot stuffing but do not reduce electoral fraud overall; instead of ballot stuffing, incumbents switch to other methods of fraud that are out of sight of the camera (Sjoberg, 2014). New forms of monitoring may only induce new forms of evasion.

In this paper, we report results of a study that uses a randomized field experiment to study the impact of election observers on the malfunction of biometric identification machines. Our study is set in Ghana during the 2012 national elections, when biometric identification machines were introduced into every polling station in the country as a way to reduce the very high levels of fraud known in particular to affect voter registration. We randomly select a large sample of electoral constituencies and polling places in four of ten Ghanaian regions, home to half the country's population, and study whether election observers systematically affect machine malfunction. We also report the effect of observers on fraud in order to facilitate the analysis of the complex relationship between observers, machine malfunction, and electoral fraud. The results regarding the effect of observers on electoral fraud were first reported in Asunka et al. (2015) and are repeated and extended here.

Our main results include a non-random pattern in machine breakdowns. We first document that machines were much more likely to break down in polling stations without an election observer present. Second, we provide (non-experimental) evidence that machine breakdown was more prevalent in electorally competitive areas. Third, we also find that three markers of election malfeasance — overvoting, registry rigging, and ballot stuffing — were more common in polling stations affected by the breakdown of the biometric identification machines, especially when an election observer was not present. We interpret results as evidence that individuals intended to interfere with the operation of biometric identification machines and also took advantage of machine breakdowns to commit electoral fraud.

As far as we are aware, ours is the first study to find evidence of widespread and potentially consequential tampering with biometric identification equipment used at scale in a real-world setting. More than a third of polling stations without a trained, non-partisan domestic election observer experienced machine malfunction, double the rate at stations with an observer. The extent of the problems that we identify in the operation of the verification equipment in Ghana's 2012 elections may be a transitory artifact of the initial roll-out of the hardware. Nonetheless, one implication of our study is that technological solutions are valuable but insufficient for solving political problems when political interests have the incentive and ability to manipulate the actual operation of the technology. In the context of this investigation, our results underscore the importance of independent and non-partisan election observation by trained personnel who are professionally committed to clean elections.

The contribution of this paper is twofold. First, this is one of only a few studies to investigate the causal dynamics of election fraud in a competitive democracy (others include Cox and Kousser (1981); Ichino and Schündeln (2012); Lehoucq (2002)). Drawing on substantive insights from these earlier observational studies, we gather data using an experimental research design and test whether partisan competition and party organizational capacity encourage fraud. Second, to the best of our knowledge, this is the first systematic empirical investigation of how well biometric identification machines operate in an electoral context.

The paper is organized as follows. We first discuss the reasons that electoral fraud occurs, who commits it, and why they do so. From this, we draw out hypotheses. We then provide information on the setting we study. A fourth section presents our research design. A fifth section studies the patterns of breakdown of the biometric identification machines and a sixth investigates whether machine breakdown is associated with higher rates of electoral fraud.

2 Theory and Hypotheses

Election fraud is widespread globally. Eighty percent of elections around the world are observed by monitors in efforts to reduce fraud (Kelley, 2012). It is of sufficient magnitude that it reportedly affects the outcome for the executive branch of government in about a fifth of the world's elections (Keefer, 2002). Most elections that experience any significant level of fraud are in poor or middle income countries or in countries with incomplete, new or unstable democratic institutions. Because detecting fraud is difficult, understanding why it occurs and who perpetuates it constitute difficult intellectual problems. We distinguish two sets of theories of the causes and perpetrators of election fraud: incumbent-centered and party-centered theories. The first is relevant mainly to authoritarian or semi-authoritarian settings and the second to democratic settings.

An incumbent-centered theory of election fraud derives from studies set in non-democratic countries, defined as countries in which election outcomes do not exhibit uncertainty (Przeworski, 2008). Thanks to their control over the election administration, authoritarian incumbents are particularly well placed to commit election fraud. The incumbent-centered theory has been supported by experimental results of studies in contemporary countries that document that election observers reduce vote shares of incumbents in authoritarian or semi-authoritarian regimes (Callen and Long, 2015; Hyde, 2007; Enikolopov et al., 2013). These results imply that election fraud is centrally orchestrated to benefit a sitting president (or other executive branch office holder) and that it is perpetuated with the involvement of officials who are part of the body responsible for the administration of the election. Incumbent-centered theory resonates with historical research documenting widespread election fraud during the extended process of democratization in Europe (Mares, 2015; Ziblatt, 2009) and in Latin America (Baland and Robinson, 2008), when economic and political elites utilized fraud to obstruct and delay democratization.

When there is no uncertainty over who will win the election — which occurs under non-democratic political institutions — election fraud is not conducted in order to win the election. This raises the question of why it takes place. One reason that incumbents commit fraud is to increase their vote shares to levels that allow them to retain constitutional veto power (Magaloni, 2006). In these situations, election fraud is aimed at retaining a supermajority. Other reasons that authoritarian leaders commit fraud is to signal to voters that potential opponents comprise small numbers, that opposition is likely to be fruitless, and that the current rulers are invincible. In this case, election fraud is aimed at discouraging anti-regime protest or the formation of an organized opposition. The second set of reasons that incumbents commit fraud even when they know they will retain power is thus informational (Simpser, 2013).

Democratic settings, which are marked by robust party competition and genuine uncertainty over whether the sitting executive will retain office, naturally give rise to an alternative theory of election fraud. In democracies, electoral competition is organized by political parties. These are therefore the relevant actors with interests in committing election fraud. Election fraud occurs when political parties use localized control over the administrative apparatus to rig the vote or when they engage in intimidation or patronage-based threats over voters in order to gain votes or reduce turnout. The heart of the theory of election fraud that we utilize is that *it is committed by political party agents in order to win competitive elections*. The localized and incomplete control over the election machinery exerted by any single party — even the governing party — means that both the governing party and the opposition have the ability to engage in election fraud.

In a democratic context, we expect that more election fraud occurs where political parties have more incentive and opportunity to carry it out. We study two hypotheses regarding electoral fraud (similar to Asunka et al. (2015)). With respect to *incentives*, parties will seek to commit fraud in order to increase their vote shares in the settings where electoral competition is most intense (Lehoucq, 2002; Molina and Lehoucq, 1999). This will vary in systematic ways with the nature of the electoral system (Birch, 2007) as well as locally with the specific balance of partisan forces. *Opportunities* to commit fraud, finally, are reduced where other independent actors, including other political parties as well as the courts and a free press, are able to monitor and report on it. The deployment of trained and neutral election observers is one of the most common ways that international and domestic actors seek to reduce electoral fraud (Hyde, 2011; Kelley, 2012). The effectiveness of these observers lies in part in the domestic political context, and whether the government self-commits to the rule of law and fair elections (Fearon, 2011). These considerations generate in a natural and straightforward way the following two hypotheses that are testable across localities within a single country:

H1 Incentives: Fraud should be more prevalent with greater partisan competition;

H2 Opportunity (a): Fraud should be more prevalent where election observation is less or absent.

Theories of election fraud do not offer any particular guidance regarding the possible impact of biometric verification machines other than the obvious expectation that this technology reduces fraud. Because in Ghana the machines were introduced to every polling station in the country in the 2012 election, we have no way to assess how effective this introduction was or the size of the impact of the machines on the overall incidence of fraud. This would require that machines have been delivered to a random sample of polling stations, which was not the case. As an alternative, we can make inferences based on observing what happens when a machine fails to operate. This is not identical to a situation where no biometric verification machine is present in the polling station, but it gives rise to a similar idea: namely, an operational biometric verification machine reduces opportunities for interested parties to commit election fraud. If biometric verification machines reduce election fraud, then we can expect:

H3 Opportunity (b): Fraud should be more prevalent where machines break down.

These hypotheses are all relatively intuitive. Less obvious is how much election fraud to expect in a context such as the Ghanaian. The country boasts a stable, well-functioning two party system, a relatively low degree of corruption, a vibrant and rapidly growing economy, and a respected system of courts and law. These characteristics suggest that election fraud will be contained. But it is nonetheless a relatively new democratic system, where the rules of the game are still being internalized, where the rents of public office are highly valued, and where public confidence in the political system is still evolving. The latter characteristics make Ghana vulnerable to election fraud.

3 The Setting

Ghana is one of sub-Saharan Africa's democratic success stories. Home to a population of 25 million, the country has a competitive, stable two-party system. Alternation of the political party holding the presidency has twice occurred (2000 and 2008) since adoption of the 1992 constitution and establishment of the country's Fourth Republic. The two major parties — the New Patriotic Party (NPP) and the National Democratic Congress (NDC) — enjoy support from roughly equal numbers of voters, together claiming more than 95 percent of the vote, and the NDC and the NPP hold all but four of the country's 275's parliamentary constituencies. In the 2008 presidential elections, the NDC won the executive with a margin of $40,000$ votes out of an electorate of 14 million, illustrating the highly competitive nature of national politics. Electoral violence is relatively rare, voter turnout is high, and the NDC and NPP exhibit modest but genuine programmatic differences as well as partially distinct social bases of support.

The president is elected by majority vote in a single, nationwide district. The country's unicameral parliament comprises 275 representatives elected from single-member constituencies, which constitute the main levels of party organization. Elections are held simultaneously for parliament and presidency. Partisan competition is not evenly distributed across the country nor its ten regions; each party has stronghold areas. The NPP is especially concentrated in the Ashanti region, whereas the NDC receives a particularly concentrated vote share in Volta (Fridy, 2007; Morrison and Hong, 2006). These two regions are commonly thought of as party strongholds, whereas the other eight regions exhibit greater partisan competition. We include constituencies from both stronghold regions in our sample as well as from two regions that are highly competitive.

Elections in Ghana have been systematically observed by a Coalition of Domestic Election Observers (CODEO) since 2000, building on experience observing the 1996 election. The organization recruits and trains professionals — typically school teachers and college students — in neutral, non-partisan observation of the electoral process. Thanks to their professions, observers benefit from high status in their communities; for this reason, CODEO assigns observers to polling stations in their home areas, where observers are likely to be personally known and to enjoy community respect. CODEO itself is nationally well known, with a strong public reputation for its work in improving electoral integrity. Its observers are recognized and accredited by the Electoral Commission of Ghana (EC) and have the legal right to enter and observe election proceedings. Each CODEO observer is assigned a single polling station to observe for the whole of the election day, including the public counting of votes that occurs at the end of the process. Polling places selected for observation are not identified publicly in advance of the election itself, meaning that officials and voters at every polling station may realistically anticipate an observer. Observers are distinguishable by uniforms and identifying paraphernalia (tee-shirts, hats, etc) and carry official accreditation materials with them.

The training of election observers includes instructions to observe the EC mandate and to not interfere in election proceedings. The official CODEO training manual opens with explicit instructions not to help any aspect of the voting processes. The manual's first two rules and regulations are that "An Observer shall not offer advice or give direction to or in any way interfere with an election official in the performance of his or her duties" and "An Observer shall not touch any election material or equipment without the express consent of the Presiding Officer at the polling station or the Returning officer at the constituency center. Observers may not involve themselves in the conduct of the election" (Coalition of Domestic Election Observers, 2012, p. 6). Observers are trained to contact constituency-level CODEO supervisors if election materials, such as ballots, are needed, and observers also record administrative or other irregularities on incident forms. In 2012, CODEO's observers were trained to use SMS to report irregularities and disruptions to a national data center. If an incident is serious, CODEO has communication structures in place to immediately alert appropriate legal and security officials. CODEO also releases press statements throughout election day and its Accra election headquarters serve as a major locus of public information about the process. Deliberate election malfeasance committed in front of a CODEO observer is likely to be reported nationally and to elicit a speedy response by security forces.

During the voting process, the observer usually places himself at a distance from other individuals allowed into the polling place. These include the presiding officer, a security officer, and a representative designated by each of the major political parties, as well as those persons in the process of voting. No one else is legally permitted to enter the polling station which, although usually outdoors, are clearly demarcated.

Despite two decades of election observation, fraud was known to have occurred regularly in elections in Ghana. Perhaps thanks to the very effectiveness of election observation during the voting process, fraud appears to have been especially marked in the pre-election phase, which is also observed by CODEO but less extensively. Implausibly large numbers of names appeared on the voter rolls in the aughts (Oduro, 2012). Earlier experimental research in Ghana confirmed this, and also identified spillover effects of CODEO observers on fraudulent registrations (Ichino and Schündeln, 2012). Spillovers were interpreted to mean that political party operatives were relocating fraudulent voter registration efforts to nearby polling stations when a CODEO observer was present during the registration process. This suggests that party operatives are experienced in reacting strategically to monitoring intended to reduce fraud in the electoral process.

Biometric voter registration and polling place identification processes were introduced by the Electoral Commission for the concurrent parliamentary and presidential elections of 2012 in a deliberate attempt to eliminate the irregularities and delays that had occurred in previous elections. The entire electorate was reregistered using biometric markers (ten fingerprints) in a six-week period in spring 2012. New voter identification cards were issued featuring head shots. Reregistration was effective in identifying $8,000$ double registrations, of which $6,000$ were judged intentional (Darkwa, 2013). Verification machines were delivered to all 26,000 polling stations in the country prior to December's election. The EC also purchased another 7,500 backup machines for use in the event of equipment failure. Because the equipment is battery-operated, spare batteries accompanied each machine. Legal stipulations meant that only persons whose identities could be verified biometrically would be permitted to vote on December 7.

Approximately 19 percent of polling stations experienced a breakdowns of the verification machine at some point during the day, according to CODEO's reports (Coalition of Domestic Election Observers, 2013).[1] Breakdowns appear associated with battery overheating and exhaustion; when battery replacement was attempted, the machines froze up and operation was restored only after a minimum of two hours. Breakdowns thereby delayed voting. By noon, Ghana's President, John Dramani Mahama, appealed to the Electoral Commission to allow individuals with valid voter ID cards to vote at polling stations where biometric verification machines were not functioning.[2] The Electoral Commission rejected the proposal, instructing their local officials to permit voting

[1] In our sample, we find machine breakdowns in 25 percent of polling stations but in 17 percent of polling stations with a CODEO observer. The CODEO figure reflects information collected only from the latter, so our sample result is approximately the same as the national figure for observed polling stations.

[2] "Let people with valid IDs vote; verification or not — Prez Mahama," myjoyonline.com, (2012, December 7, 15:33 GMT), *http://politics.myjoyonline.com/pages/news/201212/98391.php*; accessed 4 June 2014.

to continue into a second day where necessary. This occurred at a handful of polling stations. Breakdowns mainly caused delays in voting that did not require extension of the electoral process.

4 Research Design, Sample Selection, and Measures

In collaboration with CODEO, we randomly assigned election observers to $1,292$ of Ghana's $26,000$ polling stations in the 2012 general elections. We collect data from these $1,292$ stations and from an additional randomly selected $1,000$ control stations. We collect identical information from polling stations with and without observers. (Details appear in Appendix B.)

4.1 Sampling and Treatment Assignment

We implement the project in four of Ghana's ten regions.[3] Almost half of the Ghanaian population (46.5 percent) resides in our sampled regions. More relevant for the external validity of our study is the fact that the party system is similar in the six regions other than those included. Although the four regions where we sample were not selected to be statistically representative of the entire country, we have no reason to believe results would differ significantly had our sample been national.

We randomly sample 60 (out of 122) political constituencies from the four regions.[4] We construct the sample as follows. First, each region is assigned a target number of sample constituencies based on its proportion of the total 122 constituencies.[5] Since each region's number of electoral constituencies is determined by the Electoral Commission on the basis of population, this means the number of constituencies included in the sample from each region makes the regional sample proportional to population.

[3]For logistical reasons, we sample only in the south of the country. We exclude the Greater Accra region, the location of Ghana's capital, because we anticipated that international election observers might focus on the easy-to-reach polling stations there and that their presence could contaminate the treatment.

[4]Sample size was determined on the basis of power calculations and logistical constraints.

[5]For example, the largest region we study is Ashanti, which has 47 constituencies, or about 38 percent of the 122 total. We sample 23 constituencies in Ashanti: 23 is approximately 38 percent of the total sample size of 60.

To select constituencies within regions, we block on electoral competitiveness and urbanization. We construct a sample with roughly equal numbers of constituencies that vary on these characteristics. We block on electoral competitiveness because we hypothesized that election fraud would vary with competitiveness. To generate our indicator of constituency-level electoral competition, we use data from the prior (2008) presidential elections. We define a constituency as *competitive* if the vote margin between the top two presidential candidates was less than 10 percent and as uncompetitive otherwise. Constituencies that experienced alternations in the party winning a majority in the 2008 presidential elections had a 2004 average margin of victory of 12 percent. Therefore, a 10 percent margin is, in the context in which we operate, easily reversible. We block on urbanization because of the hypothesized relevance of polling stations density to the strategic relocation, or spillover, of malfeasance; spillover is not a focus of the present paper, however. We code urban and rural constituencies using a measure of polling station density. We define as *urban* those constituencies with a higher-than-the-median number of polling stations per square kilometer (where the median in our sample is 0.14 polling stations per square kilometer) and rural as those with lower-than-the-median.

Constituency sampling was performed as follows. Within each region, constituencies are coded as competitive/stronghold and as urban/rural. We select a random sample of constituencies from each of these four possible combinations (competitive-urban, competitive-rural, stronghold-urban, stronghold-rural) such that the total number of constituencies sampled from each region equals its target number. To the extent feasible, we sample equal numbers of constituencies within regions from each of the four conditions.[6]

Our units of analysis are individual polling stations, which are nested within the 60 constituencies in our sample. We randomly sample 30 percent of the polling stations in each constituency. We then randomly assign each polling station to either treatment (observer) or control (no observer). Appendix B further details the experimental design. In Appendix C, we provide ev-

[6] In some regions, equal numbers of competitive and stronghold constituencies do not exist, narrowing our choices.

idence that treated and control polling station areas are comparable across developmental, political and ethnic characteristics.

In our analyses, we report average treatment effects of election observers.[7] Our underlying research design allows us to account for spillover effects when estimating the causal effect of observers. Spillovers occur when parties shift fraud to control polling stations in response to an election observer (Ichino and Schündeln, 2012). To study spillover, we implement a randomized saturation design (Baird et al., 2014), which assigns varying proportions of polling stations to treatment in different constituencies. We saturate the constituencies at three rates: in the low condition, 30 percent of the polling stations in the constituency sample is assigned to treatment; in the medium condition, 50 percent; and in the high condition, 80 percent. Differences in saturation are used to study spillovers effects.[8] In this paper, we do not study spillover effects but (in Appendix B) we report estimates that incorporate spillover effects. The results there confirm that incorporating spillover does not change the direct effects that we report in the body of the paper. The direct results are more easily interpretable than results that incorporate spillover, which is why we place the latter in an appendix.

4.2 Measuring Machine Breakdown

We gathered data at treated and control polling stations on election day. Enumerators gathered polling station level election results and completed a questionnaire that CODEO observers use to report activities at their assigned polling stations. The questionnaire is reproduced in Appendix A. The questionnaire included the question "Did biometric verification machine fail to function properly at any point in time?"[9] Possible responses were "Yes"/"No." We use this information to measure breakdowns of biometric verification machines. The structure of the question allows us

[7] The project experienced no issues with compliance in administering treatment.

[8] For details on the randomized saturation design used and the spillover impact of observers on fraud, see Asunka et al. (2015); Baird et al. (2014). We detail the design in Appendix B.

[9] The questionnaire also asked whether a biometric verification machine was present at the polling station. Ten polling stations in our sample did not have machines, and we drop these from the analysis.

to code every polling station in our sample (treated and control) for whether breakdown of biometric equipment occurred. We do not know if machines broke down repeatedly in the same polling place, how long breakdowns lasted, why they occurred, or what was done about them.

Enumerators gathered information on machine malfunction in treatment and control areas as follows. At treated stations, CODEO observers collected the information we analyze as part of their official assigned activities. Accordingly, at treated stations, data is a product of direct observation on the part of the data collector. At control stations, data was collected by enumerators who interviewed multiple people — party agents representing the two major political parties or presiding officers — after the polls closed. (Each political party is allowed to designate an official representative as a party observer; that individual is permitted to remain in the polling station for election day.) To avoid "observing" control stations, we could not send enumerators to control stations during the election process itself. Instead, using a data collection instrument identical to that used by CODEO observers, enumerators collected information from party agents after the close of the polls. Our enumerators were provided identical training as CODEO observers and were accredited by the Election Commission as observers. They were thereby permitted to enter polling places.

This variation in the data collection processes raises the concern that it may drive the observed causal relation that we report between election observers and machine failures. We have four reasons to believe our data is valid despite the differences in data collection between treatment and control stations.

First, reporting differences are likely to bias results *against* finding that rates of machine malfunction are lower at treated than control stations. CODEO observers are trained to document *all* irregularities that occur at their assigned stations, where they remain for the entire day. Official observers therefore seem more likely than party representatives to assiduously document events such as machine malfunction; in addition, the former record events in real time whereas our enumerators asked the latter persons to recollect events that had taken place during the preceding ten to twelve hours. We expect that CODEO observers would thereby record more violations of election integrity than party agents would report. Instead, our data report rates of machine breakdown that are twice as high in control stations as in those observed by CODEO.

Second, reporting differences cannot explain the result (presented below) that the extent of parliamentary electoral competition is strongly associated with machine breakdown. Observers are randomly assigned *within* constituencies, and all sampled constituencies have both treated and control polling stations in them. As a result, data gathered by enumerators at control stations should not be correlated with constituency-level variables. In addition, the relationship between electoral competition and machine breakdown is almost identical when we subset the sample into treated and control stations: thus, differences in data collection methods between treated and control stations do not affect this finding.

Third, in Appendix D, we verify the entire analysis using a reduced dataset drawn from only those control polling stations where the enumerators collected identical information from at least two different individuals. (In the main analysis reported in this paper, we include data from control polling stations that was collected from a single individual in instances where it proved impossible to collect data from a second person.) The two respondents were usually affiliated with different major political parties. We show that even using this more conservative dataset, the results reported in the paper continue to hold.

Fourth, in Appendix F, we document that spillover effects of election observers on the breakdown of biometric verification machines increases with the saturation of observers in the constituency. Spillover is measured by assessing differences in rates of breakdown *only at control polling places* in constituencies with different observer saturations. Data was collected at control polling stations by enumerators who all used identical data-collection methods. When we examine only spillover, as a result, the data is not affected by the differences in data collection methods that necessarily characterize treatment and control polling stations. If markers of election fraud rise with observer saturation, this provides indirect confirmation that the measure of fraud is valid.

For instance, election observers may reduce negligence and incompetence as well as malfeasance. However, observers are unlikely to displace poor electoral administration onto nearby polling stations. Therefore, we argue that evidence of spillover onto nearby polling stations also constitutes evidence of deliberate displacement of a certain fraud technology. Our finding of spillover thereby validates our data collection method.

During the course of the election, observer missions reported that they "found no reason to suspect that the breakdown of the biometric identification mechanism was deliberate" (Economic Community of West African States, 2012, p. 6). Such reports were necessarily drawn from polling stations where observers were sent. Our study collects data from *unobserved* polling stations in addition to those under observation, and our data are therefore more valid generally than reports that rely on information only collected at observed stations. We interpret out findings as strongly suggestive that the breakdown of biometric identification machines was in fact deliberate.

4.3 Measures of Election Fraud

We construct indicators of election fraud that rely on objective information gathered from sample polling places on election day. By law, ballots must be counted in public at each polling station after the polls close. This makes it possible to collect polling station level information before it is aggregated (and potentially tampered with) at higher levels.

We construct three measures of fraud, two of which — the *overvoting rate* and *ballot stuffing* — draw on measures created in Asunka et al. (2015). *Registry rigging* is original to this paper. Our first measure, the *overvoting rate*, is the number of votes cast in the presidential race that is above the number of voters officially registered at the polling station. We convert this measure into a share by dividing by the number of registered voters, taken from the Electoral Commission's (EC) official figures. Each voter is legally allowed to vote only at the polling station where they registered. Overvoting is a marker of potential fraud since it suggests that unregistered voters cast ballots, that double voting occurred, or that vote counts were artificially inflated in some other way.

The measure of overvoting that we construct uses data collected at our sample polling stations on the numbers of valid votes cast in relation to official Electoral Commission figures on the number of registered voters at each polling station. The latter figures were released prior to election day. The number of valid votes cast in each polling station is reported on an official form that is filled out at the close of day; we collected these figures in sample polling stations. The rate of overvoting in our $2,310$ polling stations ranges from 0.3 percent to more than 250 percent. Of the sample polling stations, $1,845$ reported vote totals that did not exceed the number of registered voters, and are therefore coded zero for overvoting.[10]

Our second measure of fraud is what we call *registry rigging*. The official number of registered voters reported by the Electoral Commission and the number of voters on the paper rolls at the electoral stations differed in many cases. Discrepancies may arise from the delivery of false voter rolls to the polling stations or from deliberate manipulation of the voter rolls by persons at the polling station.[11] The differences were unusually common in polling stations where we identify overvoting, and thus we expect that the local figures will be higher than the Electoral Commission figures in control stations in order to facilitate fraudulent excessive voting. Indeed, in control stations the local voter rolls are on average 21 voters larger than the Electoral Commission figures, while in treatment stations the local voter rolls are only 2 voters larger. The difference between these means has an associated p-value of 0.004 when accounting for clustered standard errors.

However, we are unsure of the exact mechanism that leads to variations between Electoral Commission figures and the local voter rolls. Thus, we code any numerical difference between Electoral Commission figures and those reported by the polling station as *registry rigging*. We

[10]Furthermore, one polling station in the Ho West constituency was coded as zero for overvoting even though turnout there appeared over 700 percent. A clear outlier in terms of turnout, this polling station received hundreds of voters from a near by polling station after the biometric machine broke down there. Not making this correction increases the magnitude of the treatment effect and shrinks the p-value; therefore the results of this paper are not driven by this decision.

[11]*Overvoting* may capture some of this fraudulent behavior, but often turnout will not exceed 100 percent.

code any difference between the two as a one; matching figures from the Electoral Commission and the local rolls are coded zero. In order to account for the possibility that small differences between the Electoral Commission figures and the figures on the paper registries are not indicative of the intent to commit fraud but instead are the product of minor administrative errors, we also demonstrate in the results section that our results are robust to a range of cutoffs for coding *registry rigging* as a one. We show that coding *any* discrepancy in the number of registered voters as *registry rigging* produces results similar to limiting the measure to cases where the figures differed by more than 50. Furthermore, we reproduce our analyses using the continuous measure of distance between the number of registered voters according to the local registry and the official Electoral Commission figure in Appendix G. Because the continuous nature of this variable allows intentional, administrative, and measurement errors to all inflate it, it exhibits high variation. As a result, the results reported in Appendix G are consistent with the rest of our findings but are less precisely estimated.

Registry rigging, while intimately related to *overvoting*, captures a slightly different mechanism. It highlights the willingness of local officials to change the voter registry rather than indicating a fraudulent outcome (namely, more ballots cast than registered voters). As a result, while 78 percent of polling stations with *overvoting* were also locations where there was *registry rigging*, only 15 percent of the locations where there was *registry rigging* exhibit *overvoting*. We could interpret this difference as suggesting more frequent intentions to commit fraud than we capture with our measure of overvoting.[12]

Our third fraud measure captures whether the presidential ballot box appears to have been stuffed. The *ballot stuffing* measure takes a value of one if more ballots were discovered in the ballot box than the number of voters known to have cast ballots and zero otherwise. The data were

[12] Importantly, both *overvoting* and *registry rigging* use the number of registered voters reported by the Electoral Commission as a benchmark. This number was fixed before the election took place and observers were randomly assigned to stations. Therefore, as a validation of both of these measures and this benchmark figure, we test for any treatment effect of the observers on the number of registered voters according to the Electoral Commission. The p-value for the difference in means is 0.99, validating this figure as a benchmark.

collected using the questionnaire; enumerators responded "Yes"/"No" to the question "Were more ballot papers found in the presidential ballot box than voters who cast ballots?" (See item CE on the questionnaire in Appendix A.) Because votes are counted at each polling station in public at the end of the day, enumerators had direct access to this information.

We analyze this suite of indicators separately because they capture different types of irregularities but represent a similar underlying pattern of electoral malfeasance: attempts to alter the electoral outcome through election day vote rigging. While overvoting may entail differences in the voter rolls (captured by registry rigging), they are weakly correlated ($r = 0.30$). Registry rigging may capture attempts to overvote that did not push turnout over 100 percent. Nor are overvoting and ballot stuffing correlated in our sample of polling stations ($r = 0.03$). These two types of irregularities almost never occurred in the same polling stations, appearing instead as substitute types of fraud. One possible explanation for this is that these two irregularities may have been committed by different types of individuals and in different ways. Overvoting may have occurred with the complicity of the presiding officer, when individual registered voters were permitted (or encouraged) to vote more than once, perhaps as party activists escorted them back into line after they had voted. Ballot stuffing, by contrast, may have occurred when the presiding officer was inattentive (either deliberately or when distracted), allowing others on the scene to add more ballots to the box.[13] The data reported below show roughly equivalent numbers of polling stations experienced overvoting and ballot stuffing in our sample.

The measures of election fraud we use are, strictly speaking, relevant exclusively to the presidential election. Our data collection did not include information that allows us to construct measures of fraud specific to the parliamentary races that were simultaneously underway. Our theory of election fraud posits that the extent of competitiveness — which in Ghana varies across

[13]These two types of irregularities were grouped together by the NPP when the party petitioned Ghana's Supreme Court to nullify the election results in a lengthy post-election court case. The NPP labeled both "overvoting." Although the petition was ultimately rejected, four of the nine Supreme Court justices ruled that the NPP's petition was valid, suggesting that our measures of fraud are broadly in line with what legal authorities in Ghana believe true.

constituencies for the parliamentary but not for the presidential races — affects the likelihood that political parties engage in fraud. We use the three measures of fraud in the presidential election just described to proxy generally for the extent of election fraud at the polling station. We assume that where incentives and opportunities were higher for political parties to commit election fraud in the parliamentary races, they also committed more fraud in the presidential race. We justify this with the reminder that votes for the presidency mattered equally regardless of the parliamentary constituency where they originated.

4.4 Measuring Electoral Competition in the Parliamentary Elections

Our first hypothesis posits that electoral fraud will be concentrated in electorally competitive areas. Since Ghana's president is elected in a single nationwide district, the incentives for parties to win votes in the presidential contest are uniform across parliamentary constituencies. We therefore cannot test whether election competition affects election fraud at the level of the presidential race.[14] We instead test this hypothesis with data on electoral competition in constituency-level parliamentary elections. We label this variable *margin*.

The rationale behind margin is as follows. Political parties in Ghana, as elsewhere, seek to maximize seats in the legislature, as well as to win the presidency. If electoral competition creates incentives for fraud, we are likely to observe more fraud in electorally competitive parliamentary constituencies. Political parties in Ghana are organized hierarchically, with relatively independent constituency-level organizations guiding campaign operations (Osei, 2012). These constituency-level organizations are in the first instance creatures of the member of parliament. The degree of electoral competition in the parliamentary elections is therefore the primary influence shaping the incentives of constituency-level party organizations to commit fraud.

[14] The blocking variable for electoral competition is derived from the prior presidential race, and is therefore an invalid indicator of the incentives parties face to commit election fraud.

We create a continuous measure of the parliamentary vote margin to capture the degree of electoral competition in each constituency. Recall that the measure of electoral competition used in blocking was drawn from the prior (2008) *presidential* not *parliamentary* race. In Ghana, there is very little ticket splitting and a party's margin in the parliamentary race is almost identical to its constituency-level vote share for the presidency. For the NDC, the correlation in parliamentary and presidential vote shares across constituencies in 2012 is 0.98 and for the NPP it is 0.97. Although it hardly matters empirically whether we use the parliamentary margin or presidential vote share, our theory of incentives for fraud involves parliamentary races. We use results from the prior (2008) parliamentary elections in Ghana and calculate *margin* as the difference in the vote shares between the first- and second-place candidates in each constituency. Smaller values on the margin variable indicate higher levels of electoral competition, while higher values indicate the reverse. The average vote margin in the sampled constituencies is 0.31 percent and the median is 0.19. The constituencies in our sample display a large range of values on this variable, verifying that parliamentary competitiveness is highly variable. There are a noticeable number of constituencies in our sample where the margin in 2008 was close to zero, indicating extremely tight parliamentary races.

5 Results

Table 1 presents descriptive information about direct rates of machine breakdown and the three measures of electoral fraud in our experimental and blocking conditions. We report means and standard deviations. As the data presented in the first row documents, a quarter of the polling stations in our sample experienced machine breakdowns. The data reported in columns 2 and 3 provide preliminary evidence about the effects of election observers. Machine breakdown occurred at 17 percent of polling stations with a CODEO observer present but at 35 percent of those without an observer. This is a very large fraction of polling stations and implies an increase in the rate of breakdown of around 100 percent when an election observer was not present. The remaining columns present rates of machine breakdown in blocking environments: competitive and uncompetitive as well as urban and rural constituencies. We find that machines break down more frequently in electorally competitive constituencies: 28 percent of polling stations in competitive areas experience machine breakdown compared with 20 percent in uncompetitive constituencies. (To repeat, here competitiveness is a dichotomous blocking variable drawn from 2008 presidential not parliamentary election data; see above.) Rates of breakdown are also 3 percentage points higher in urban than in rural areas. The data describe an election in which biometric verification machines broke down more often when an election observer was not present, in competitive constituencies rather than party strongholds, and in urban rather than rural areas.

Table 1 about here.

The next three rows present the same information for the three indicators of fraud that we analyze. Registry rigging, which we analyze as a proxy for the intent to commit fraud, characterizes fully 18 percent of the full sample, and the rate is double at polling stations without an observer compared with those with an observer. However, objectively fraudulent outcomes — proxied by overvoting and ballot stuffing — was much less common, occuring at only 3 to 4 percent of polling stations. These too were more likely to occur in the absence of an election observer. Overvoting, ballot stuffing, and registry rigging were each more likely to occur in competitive than in stronghold constituencies and registry rigging is noticeably more common in urban than rural locations. The data on fraud is thus consistent with our hypotheses that fraud increases with election competition and when election observers are not present.

5.1 Experimental Results

We now present results of analyses that come directly from the experimental design. In Table 2, we report results when we examine the effect of electoral observers on machine malfunction and the three indicators of fraud. We present average treatment effects (ATE). We use OLS regression analysis in order to incorporate our blocking variables as covariates and display easily interpretable quantities.[15] (For details on the design and for parallel results that also incorporate spillover, see Appendix B.)

Table 2 about here.

For each outcome variable — machine *breakdown*, *overvoting rate*, *registry rigging*, and *ballot stuffing* — we report two specifications. The first column contains the unadjusted ATE effects while the second column adjusts for blocking covariates. Both columns report specifications that use robust standard errors clustered at the constituency level.[16] The results with or without the blocking covariates are substantively identical. Column 1 shows that election observers have a negative and statistically significant impact on machine breakdown. The size of the effect is unaltered when we incorporate blocking variables into the model, as shown in Column 2. Rates of machine breakdown are consistently less where an election observer is present. The estimated average treatment effect is very large, with observers reducing rates of machine breakdown by 18 percentage points (and by 11 percentage points when spillover is taken into consideration; see Table B.1 in Appendix B).

Similar to results reported in Asunka et al. (2015), columns 3 through 6 show that election observers have a negative and statistically significant impact on all three measures of election fraud. Columns 3 and 4 show that the rate of overvoting is 3.6 percentage points lower in observed polling stations and Columns 4 and 5 show that the prevalence of registry discrepancies is about 12 percentage points lower in observed polling stations.[17] Lastly, while observers have a negative

[15] In Appendix E, Table E.1, we report logistic regressions on the three dichotomous outcomes—*breakdown*, *rigging*, and *ballot stuffing*. Results are substantively unchanged.

[16] Using nonrobust standard errors yields the same results, although the p-values are smaller, the depressive effect of observers on ballot stuffing becomes significant, and the effect of competitive polling stations on markers of fraud is more clearly positive. This specification can be found in Appendix E, Table E.2.

[17] The reported operationalization of *registry rigging* defines any difference between the number of registered voters reported by the Electoral Commission and the rolls at the polling stations as intent to commit fraud. However, it is possible that some discrepancies arise due to simple transcription errors or minor modifications to the voter rolls. For that reason we recode *rigging* as one when the difference between the Electoral Commission and the polling station figures is greater than or equal to some cutoff, ranging from one, as it is now, to 500. For example, a cutoff of 100 would indicate that only when the two figures differ by greater than or equal to 100 do we indicate registry rigging.

impact on incidences of ballot stuffing, this result is not statistically significant. Overall, there is some evidence that election observers reduce fraud, and the size of the effect is particularly large for registry rigging.

The effect of election observers on biometric machine breakdown and the three markers of fraud is causally identified as a result of the random assignment of observers to polling stations. However, because we collected data on a wide variety of outcomes and have tested several of them, it is possible that the statistical significance reported above is an artifact of the number of specifications we have run. To ensure that our results are not due to multiple comparisons, we use a Holm correction to adjust the p-values. First, we collect over 43 outcomes from the survey instrument (replicated in Appendix A), including some of our own construction. Then we run OLS without blocking covariates and with robust clustered standard errors at the constituency level. Finally, we collect and order the p-values. The analysis requires that we inflate the p-values by dividing by the total number of comparisons made minus the rank of the p-value. In essence, this penalizes the most significant result the most, and the less significant results to a lesser degree. This method strictly dominates the simpler Bonferroni correction (Aickin and Gensler, 1996) when it comes to ensuring that the familywise error rate, or the probability of false discovery, is at most an acceptable level of error, usually specified as 0.05.

Figure 1 depicts the results of this correction. Highlighted on the y-axis are the key variables of interest and on the x-axis their associated p-value, both before and after correction. None of the results of our main analysis in Table 2 are changed and all remain significant at the 0.05 level.[18] Furthermore, the results are also robust to using the more stringent Bonferroni correction. For a full list of outcomes included for this correction, see Appendix H. This provides ample and

As reported in Figure G.1, the effect of observers on *rigging* is negative and statistically significant at the 0.05 level whether the cutoff for fraud versus administrative error is coded as any difference (1), to a large difference (357).

[18] We have added a dichotomous version of *overvoting* that is coded a one if *overvoting* is greater than 0, and a zero otherwise. I also include turnout to show that there is a negative treatment effect of observers on turnout, indicating that turnout was probably artificially inflated in control stations.

robust evidence of a causal depressive effect of election observers on biometric machine breakdown as well as the suite of fraud measures that we employ.

Figure 1 about here.

5.2 Non-Experimental Results

We now examine tests of our hypotheses related to electoral competition and party organization. In Column 2 of Table 2, we see that competitive constituencies are positively associated with machine breakdown. In our sample, polling stations in competitive constituencies are 7.8 percentage points more likely to experience machine breakdown than polling stations in party strongholds, which is how we conceptualize uncompetitive constituencies. Furthermore, the estimated effect of competitiveness on the three other markers of fraud is consistently positive although not statistically significant. However, the *competitive* blocking variable is dichotomous and constructed using the 2008 presidential election. We also created a continuous measure of competitiveness, *margin*, using the 2008 parliamentary election. This variable more accurately captures the incentives that parties face (we discuss this further in Section 4.4). Table 3 contains identical specifications to those reported in Table 2 but uses the continuous *margin* variable instead of the *competitive* blocking variable. Results are largely the same; an increase in the *margin* of victory is related to a decrease of fraud using any of the four indicators, including machine breakdown. *Margin* is now a statistically significant predictor of less *registry rigging*. The results reported in the table are consistent with the hypothesis that competitive constituencies provide incentives for parties to commit electoral fraud.

Overall, these results document that election observers have a causal effect in reducing the breakdown of biometric verification machines. We also find that where observers were present, there was significantly less tampering with the voter registry and a larger likelihood that the official EC figures on the numbers of voters corresponded to the paper registry on site. Our data do not allow us to conclusively spell out the causal mechanisms in play, but our results are consistent with the view that party activists deliberately altered the voter registry more often in polling stations without a CODEO observer and then deliberately interfered with the operation of the biometric identification machine. When the machine failed to function, voting continued, but on the basis of the rigged registry, resulting in overvoting rates above 100 percent.

6 Machine Malfunction and Fraud

There is no administrative or technical reason that election observers should have any significant impact on the operation of biometric verification machines. CODEO observers were not instructed in the use of the machines nor were they expected to ensure their operation; indeed, as we have already indicated, they were instructed not to touch or tamper with equipment in polling stations. The results thus imply that some substantial fraction of machine breakdown — apparently about half — was deliberately orchestrated when an election observer was not present.[19] This raises the question of whether machine breakdown was used strategically as an opportunity to commit election fraud — by encouraging voters to double vote, for instance. To explore this, we next turn to the effect of machine breakdown on the three markers of fraud.

Studying whether machine breakdown is a significant predictor of election fraud goes beyond the research design to explore important but unanticipated results. Our research was designed to study the impact of election observers on electoral integrity. Election observation was randomized, whereas machine breakdown was not. We cannot know with certainty whether associations that we observe between machine breakdown and other variables, such as proxies for election fraud, are genuinely causal. Nonetheless, our data provide the opportunity to explore and under-

[19]If the breakdown rate with no observer present is about 35 percent, as indicated by the value of the constant reported in columns 1 and 2 in Table 2, and the breakdown rate with an observer present is about 17 percent, then the absence of electoral observation about doubles the rate of breakdown. If we assume that all incidents of breakdown when observers were present were accidential, then the non-accidental frequency of breakdown is twice the random rate.

stand further the unanticipated finding that breakdowns of the biometric verification machines were systematically related to observer absence.

In Table 4, we report results of regressions that study the impact of election observers and machine malfunctions on our three measures of voter fraud. (These results do not take spillover into account but they do include potentially important control variables. The coefficients do not change in magnitude or statistical significance in any meaningful way if control variables are omitted.) In Column 1, we report OLS regression results for the overvoting rate and for its interaction with machine breakdown. In Columns 2 and 3, we do the same with logistic regressions for registry rigging and ballot stuffing, respectively.

Table 4 about here.

In all three specifications, the coefficient on machine breakdown is positively correlated with the indicator of fraud. This relationship is statistically significant for *registry rigging* and *ballot stuffing* although not for the rate of overvoting. Because this is an interactive model and the coefficient on *breakdown* is the effect in the absence of observers, machine breakdown appears to be strongly related to fraud when there is no election monitoring. Also, the coefficient on election observers is negative and statistically significant for the *overvoting* rate and for *rigging*. Therefore, even in the absence of machine breakdown, election observers appear to be important in the reduction of these activities. Furthermore, although none of the interactive effects are statistically distinguishable from zero, when we add them to the respective base *machine breakdown* term, the effect of machine breakdown on all three markers of fraud becomes statistically indistinguishable from zero. Analyzing machine breakdowns in observed polling stations would yield no statistically significant relationship with markers of fraud. Only by including data from unobserved stations does the relationship between breakdown and markers of fraud become apparent.

Jointly, these results demonstrate that both machine breakdown and election observers have important effects on electoral fraud in Ghana. Observers directly reduce fraud even when there is no machine breakdown, and they also seem to depress the strong relationship between machine breakdown and fraud.

To clarify these somewhat complex relationships, Figure 2 shows the same interactions graphically using bootstrapped means by group. The figure is broken into three panels, one for each measure of fraud. The y-axis is the proportion of polling stations with fraud for *rigging* and *ballot stuffing*; it is the mean level of overvoting for *overvoting rate*. The lighter line (with circles) corresponds to the control polling stations that were unobserved while the darker line (triangles) corresponds to the treatment — that is, to observed polling stations. In all three panels, the bootstrapped mean level of fraud for unobserved stations is above the mean level for observed stations, indicating that observers have a depressive effect on fraud independent of machine breakdown. Furthermore, the slope of the lighter lines is steeper in all three panels (although almost imperceptibly in the *overvoting rate* panel). This indicates that when machines break down, fraud becomes even more problematic in the absence of observers. For example, around 3 percent of all stations, whether observed or not, exhibit ballot stuffing when there is no machine breakdown. When there is machine breakdown, the percentage of stations exhibiting ballot stuffing jumps to around 12 percent when there is no observer but only to 5 percent when there is an observer at the station.

Figure 2 about here.

In summary, these results highlight that the worst outcomes consistently obtain when the biometric verification machine breaks down and no election observer is posted at the polling station. Election observers have independent effects in reducing fraud when there is a fully functional biometric identification machine. The breakdowns of biometric identification machines are important for fraud, and breakdowns are most strongly related to fraud in the absence of election observers.

Our experimental design allows us to state with confidence that the absence of election observers is causally related to machine breakdowns. Our results also show that machine breakdowns permitted much higher levels of election fraud to occur when a domestic election observer was not present than when one was present. These results underscore that machine breakdown is likely to have been deliberately induced, especially when no election observer was posted to the polling station, and also that persons on the scene took advantage of breakdowns to commit fraud, especially when an observer was not present.

7 Interpretations and Conclusions

This paper investigates the malfunction of biometric identification machines during Ghana's 2012 presidential and parliamentary elections. We document non-random patterns to breakdown. Using a randomized experiment, we find that biometric identification machines broke down significantly more often and at very high rates when an election observer was not present. These results suggest that the operation of biometric verification machines was in many instances deliberately induced. Our results also show that fraud was more prevalent where biometric identification machines failed to operate. Machine breakdowns appear to have been used strategically to increase overvoting and ballot stuffing. They occurred more frequently where registry rigging had laid the groundwork, since it more easily permitted voters to vote more than once or permitted persons not legally registered to vote. These processes resulted in turnout rates above 100 percent, which we capture with the measure of overvoting. We also find, consistent with a theory of fraud in the context of democratic political competition, that machines were significantly more likely to break down in constituencies that were more electorally competitive for the parliamentary seat. This corroborates that fraud increases with electoral pressures on political parties.

We can speculate about how machine breakdowns occurred and how this permitted election fraud to occur. There was a "natural" rate of breakdown, which appears to have been under 20 percent. This was the rate of breakdown when an election observer was present. It probably was chiefly due to battery exhaustion, where unfamiliarity with new equipment made it difficult to keep the machines operational. The additional breakdowns that took place when election observers were not present may have been deliberately induced by pilfering spare batteries, by exposing the machine to excessive heat or sunlight, or by rending any available backup machine non-operational. The occasional machine may have been stolen outright.[20] Breakdowns may also have been induced when presiding officers exhibited (perhaps strategically) unfamiliarity with the machines, despite the fact that temporary technical staff from the EC was supposed to be on site to keep the machines operating. Machine breakdowns could have led to confusion in the polling station, permitting ballot stuffing to occur as presiding officials were distracted trying to restore equipment. More frequently, it seems that breakdowns led some polling station officials to allow voting to continue, despite strict instructions from the EC to the contrary; this was extensively reported by the media even on election day.[21] In the quarter of polling stations without a CODEO observer and where the paper registry had been tampered with, this facilitated double voting and voting by unregistered individuals.

Aware of some of the problems that occurred in 2012, Ghana's Election Commission subsequently upgraded the biometric machines. The subsequent (2014) upgrade included programming the machines to warn when the batteries were running out.[22] Much of the fraud in the 2012 elections appears to have occurred when the batteries were exhausted and the machines froze up, making reprogramming the biometric verification machines a potentially successful prevention technique. The extent of electoral fraud that our research shows was associated with biometric machine failure in 2012 is unlikely to be repeated in the future.

Because biometric identification was used in every polling station in the December 2012 elections, we are unable to assess whether its introduction reduced electoral fraud. However, this is

[20] Reported in "Two Verification Machines Stolen in Tamale Central Constituency," Ghana Votes 2012, 15:58 December 8, 2012; available at `http://ghvotes2012.com/reports/view/133`, accessed October 16 , 2014.

[21] For instance, "Election 2012: Voting still ongoing despite 5:pm deadline," *radioxyzonline.com*, General News of Friday, 7 December 2012, `http://www.ghanaweb.com/GhanaHomePage/NewsArchive/Election-2012-Voting-still-ongoing-despite-5-pm-deadline-258814` and "Nadowli-Kaleo electoral officers defy EC's 'no verification, no vote' rule," *myjoyonline.com*, Politics of Friday, 7 December 2012, `http://politics.myjoyonline.com/pages/news/201212/98388.php`.

[22] "EC Upgrades Biometric Verification Machines," *GhanaWeb*, 5 April 2014, `http://www.ghanaweb.com/GhanaHomePage/NewsArchive/artikel.php?ID=305315`.

likely to be the case. The fact that twice as many biometric identification machines did not operate uninterruptedly during the election in polling stations without observers suggests that malfunction was deliberately induced. Why would this occur if not to commit election fraud? The utility of functioning biometric identification machines in fraud prevention provides the incentive for individuals to sabotage their operation when no election observer is present. If biometric identification machines did not reduce fraud, we would not observe a non-random pattern of breakdown or a significant association of machine breakdown and election fraud. However, this inference goes beyond what our research was designed to investigate.

Our study cautions that biometric technology is susceptible to manipulation, especially in an initial large scale rollout and even in a genuinely competitive democracy. In this context, breakdown may be deliberately induced when machines are not monitored by neutral, trained election observers. The overall legal and political environment is sufficiently relaxed that political party operatives apparently feel free to take advantage of unmonitored voting to tamper with new and imperfectly designed equipment. These results carry general implications for the use of biometric identification technology. Introduction of such equipment reduces fraud, even if we cannot estimate how much fraud is prevented. However, it remains important to use the technology under the watchful eyes of independent, non-partisan and neutral observers who have no interest in perpetuating fraud and who are professionally committed to the practices of good governance. There is no technical fix to election fraud.

References

Aickin, Mikel and Helen Gensler. 1996. "Adjusting for Multiple Testing when Reporting Research Results: The Bonferroni vs Holm Methods." *American Journal of Public Health* 86(5):726–28.

Asunka, Joseph, Sarah Brierley, Miriam A. Golden, Eric Kramon and George Ofosu. 2014. "Protecting the Polls: The Effect of Observers on Election Fraud." Unpublished paper.

Asunka, Joseph, Sarah Brierley, Miriam A. Golden, Eric Kramon and George Ofosu. 2015. "Protecting the Polls: The Effect of Observers on Election Fraud." Unpublished paper.

Bader, Max. 2013. "Do New Voting Technologies Prevent Fraud? Evidence from Russia." *Journal of Election Technology and Systems* 2(1):1–8.

Baird, Sarah, Aislinn Bohren, Craig McIntosh and Berk Özler. 2014. Designing Experiments to Measure Spillover Effects. Policy Research Working Paper, Development Research Group, Poverty and Inequality Team, 6824. The World Bank Washington, D.C.: .

Baland, Jean-Marie and James A. Robinson. 2008. "Land and Power: Theory and Evidence from Chile." *American Economic Review* 98(5):1737–65.

Birch, Sarah. 2007. "Electoral Systems and Election Misconduct." *Comparative Political Studies* 40(12):1533–56.

Callen, Michael and James D. Long. 2015. "Institutional Corruption and Election Fraud: Evidence from a Field Experiment in Afghanistan." *American Economic Review* 105(1):354–81.

Coalition of Domestic Election Observers. 2012. "Manual for CODEO Constituency Supervisors. December 7, 2012 Presidential and Parliamentary Elections." Accra, Ghana: Training manual, CDD-Ghana.

Coalition of Domestic Election Observers. 2013. "Final Report on Ghana's 2012 Presidential and Parliamentary Elections." Accra, Ghana: CDD-Ghana.

Cox, Gary W. and J. Morgan Kousser. 1981. "Turnout and Rural Corruption: New York as a Test Case." *American Journal of Political Science* 25(4):646–63.

Darkwa, Linda. 2013. "Ghana's Elections 2012: Some Observations.".
URL: *http://forums.ssrc.org/kujenga-amani/2013/08/15/ghanas-elections-2012-some-observations/fn-468-5*

Economic Community of West African States. 2012. "Observation Mission: Ghana 2012, Preliminary Declaration.".

Enikolopov, Ruben, Vasily Korovkin, Maria Petrova, Konstantin Sonin and Alexei Zakharov. 2013. "Field Experiment Estimate of Electoral Fraud in Russian Parliamentary Elections." *Proceedings of the National Academy of Sciences* 110(2):448–52.

Fearon, James D. 2011. "Self-Enforcing Democracy." *The Quarterly Journal of Economics* 126(4):1661–1708.

Fridy, Kevin. 2007. "The Elephant, Umbrella, and Quarrelling Cocks: Disaggregating Partisanship in Ghana's Fourth Republic." *African Affairs* 106(423):281–305.

Gelb, Alan and Caroline Decker. 2012. "Cash at Your Fingertips: Biometric Technology for Transfers in Developing Countries." *Review of Policy Research* 29(1):91–117.

Gelb, Alan and Julia Clark. 2013. Identification for Development: The Biometrics Revolution. Working Paper 315. Center for Global Development, Washington, D.C.: .

Gerber, Alan and Donald Green. 2012. *Field Experiments: Design, Analysis, and Interpretation*. New York: W.W. Norton.

Hyde, Susan D. 2007. "The Observer Effect in International Politics: Evidence From a Natural Experiment." *World Politics* 60(1):37–63.

Hyde, Susan D. 2010. "Experimenting in Democracy: International Observers and the 2004 Pesidential Elections in Indonesia." *Perspectives on Politics* 8(2):511–27.

Hyde, Susan D. 2011. *The Pseudo-Democrat's Dilemma: Why Election Observation Became an International Norm*. Cornell University Press.

Ichino, Naomi and Matthias Schündeln. 2012. "Deterring or Displacing Electoral Irregularities? Spillover Effects of Observers in a Randomized Field Experiment in Ghana." *Journal of Politics* 74(1):292–307.

Jain, Anil, Lin Hong and Sharath Pankanti. 2000. "Biometric Identification." *Communications of the Association for Computing Machinery (ACM)* 43(2):90–98.
URL: *http://doi.acm.org/10.1145/328236.328110*

Keefer, Philip. 2002. DPI2000: Database of Political Institutions: Changes and Variable Definitions. Technical report The World Bank Washington, D.C.: .

Kelley, Judith G. 2012. *Monitoring Democracy: When International Election Observation Works, and Why It Often Fails*. Princeton: Princeton University Press.

Lehoucq, Fabrice Edouard. 2002. *Stuffing the Ballot Box: Fraud, Electoral Reform, and Democratization in Costa Rica*. New York: Cambridge University Press.

Magaloni, Beatriz. 2006. *Voting for Autocracy: Hegemonic Party Survival and Its Demise in Mexico*. New York: Cambridge University Press.

Mares, Isabela. 2015. *From Open Secrets to Secret Ballots: The Adoption of Electoral Reforms Protecting Voters Against Intimidation*. New York: Cambridge University Press.

Molina, Iván and Fabrice Edouard Lehoucq. 1999. "Political Competition and Electoral Fraud: A Latin American Case Study." *Journal of Interdisciplinary History* 30(2):199–234.

Morrison, Minion K.C. and Jae Woo Hong. 2006. "Ghana's Political Parties: How Ethno-Regional Variations Sustain the National Two-Party System." *Journal of Modern African Studies* 44(4):623–47.

Muralidharan, Karthik, Paul Niehaus and Sandip Sukhtankar. 2014. Payments Infrastructure and the Performance of Public Programs: Evidence from Biometric Smartcards in India. Working Paper. 19999, National Bureau of Economic Research Boston: .

Oduro, Franklin. 2012. Preventing Electoral Violence: Lessons from Ghana. In *Voting in Fear*, ed. Dorina A. Bekoe. Washington, D.C.: United States Institute of Peace.

Osei, Anja. 2012. *Party-Voter Linkage in Africa: Ghana and Senegal in Comparative Perspective*. Wisebaden: Springer.

Piccolino, Giulia. 2015. "Infrastructural State Capacity for Democratization? Voter Registration and Identification in Côte d'Ivoire and Ghana Compared." *Democratization* 22.

Przeworski, Adam. 2008. Self-Enforcing Democracy. In *Oxford Handbook of Political Economy*, ed. Barry R. Weingast and Donald Wittman. Oxford Handbooks of Political Science. New York: Oxford University Press.

Simpser, Alberto. 2013. *Why Governments and Parties Manipulate Elections: Theory, Practice, and Implications*. New York: Cambridge University Press.

Sjoberg, Fredrik M. 2012. "Making Voters Count: Evidence from Field Experiments about the Efficacy of Domestic Election Observation." Unpublished paper.

Sjoberg, Fredrik M. 2014. "Autocratic Adaptation: The Strategic Use of Transparency and the Persistence of Election Fraud." *Electoral Studies* 33(ß):233–45.

Ziblatt, Daniel. 2009. "Shaping Democratic Practice and the Causes of Electoral Fraud: The Case of Nineteenth-Century Germany." *American Political Science Review* 103(1):1–21.

Table 1: Descriptive Statistics of Machine Breakdown and Measures of Fraud

	(1) Full Sample	(2) Treatment	(3) Control	(4) Competitive	(5) Stronghold	(6) Urban	(7) Rural
Machine breakdown	0.234	0.172	0.354	0.276	0.201	0.249	0.216
	(0.423)	(0.378)	(0.479)	(0.447)	(0.401)	(0.433)	(0.412)
Overvoting rate	0.027	0.015	0.051	0.035	0.022	0.024	0.032
	(0.194)	(0.152)	(0.255)	(0.210)	(0.182)	(0.180)	(0.209)
Registry rigging	0.177	0.134	0.255	0.198	0.163	0.192	0.161
	(0.382)	(0.340)	(0.436)	(0.399)	(0.369)	(0.394)	(0.368)
Ballot stuffing	0.043	0.032	0.062	0.056	0.033	0.043	0.042
	(0.202)	(0.175)	(0.242)	(0.230)	(0.179)	(0.203)	(0.201)
Observations	2047	1281	766	864	1183	1081	966

Notes: Standard deviations in parentheses. Ten polling stations without biometric verification machines removed from sample. Polling stations where enumerators recorded different responses from two party officials on relevant variables are dropped. In Appendix D, Table D.1 we report the same table but only include observations where enumerators recorded identical answers from *both* party officials.

Table 2: Average Treatment Effects of Election Observers on Machine Breakdown and Fraud

	Breakdown		Overvoting rate		Registry rigging		Ballot stuffing	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Election observer	−0.182***	−0.181***	−0.036***	−0.037***	−0.122***	−0.121***	−0.031	−0.031
	(0.037)	(0.038)	(0.010)	(0.010)	(0.025)	(0.026)	(0.027)	(0.028)
Competitive		0.078*		0.013		0.039		0.023
		(0.039)		(0.009)		(0.023)		(0.019)
Urban		0.030		−0.008		0.026		0.001
		(0.036)		(0.009)		(0.022)		(0.018)
Constant	0.354***	0.304***	0.051***	0.050***	0.255***	0.224***	0.062*	0.052
	(0.035)	(0.039)	(0.010)	(0.012)	(0.025)	(0.028)	(0.026)	(0.027)
Observations	1,888	1,888	1,864	1,864	1,973	1,973	1,987	1,987
R^2	0.042	0.051	0.008	0.009	0.023	0.027	0.005	0.009

Notes: *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$. OLS with robust standard errors clustered by constituency in parentheses. Ten polling stations without biometric verification machines removed from sample of machine breakdown. Polling stations where enumerators recorded different responses from two party officials on relevant variables are dropped. In Appendix D, Table D.2 we report the same table but only include observations where enumerators recorded identical answers from *both* party officials. Logistic models for dichotomous outcome variables are reported in Appendix E, Table E.1. Results are unchanged in both alternative specifications.

Table 3: Effect of Election Observers and Competitiveness on Machine Breakdown and Fraud

	Breakdown	Overvoting rate	Registry rigging	Ballot stuffing
	(1)	(2)	(3)	(4)
Election observer	-0.176^{***}	-0.036^{***}	-0.118^{***}	-0.030
	(0.038)	(0.010)	(0.025)	(0.027)
Urban	0.024	-0.009	0.024	-0.001
	(0.036)	(0.009)	(0.022)	(0.020)
Margin	-0.157^{**}	-0.012	-0.088^{*}	-0.035
	(0.058)	(0.017)	(0.038)	(0.023)
Constant	0.386^{***}	0.060^{***}	0.268^{***}	0.073
	(0.052)	(0.013)	(0.028)	(0.039)
Observations	1,888	1,864	1,973	1,987
R^2	0.053	0.009	0.028	0.008

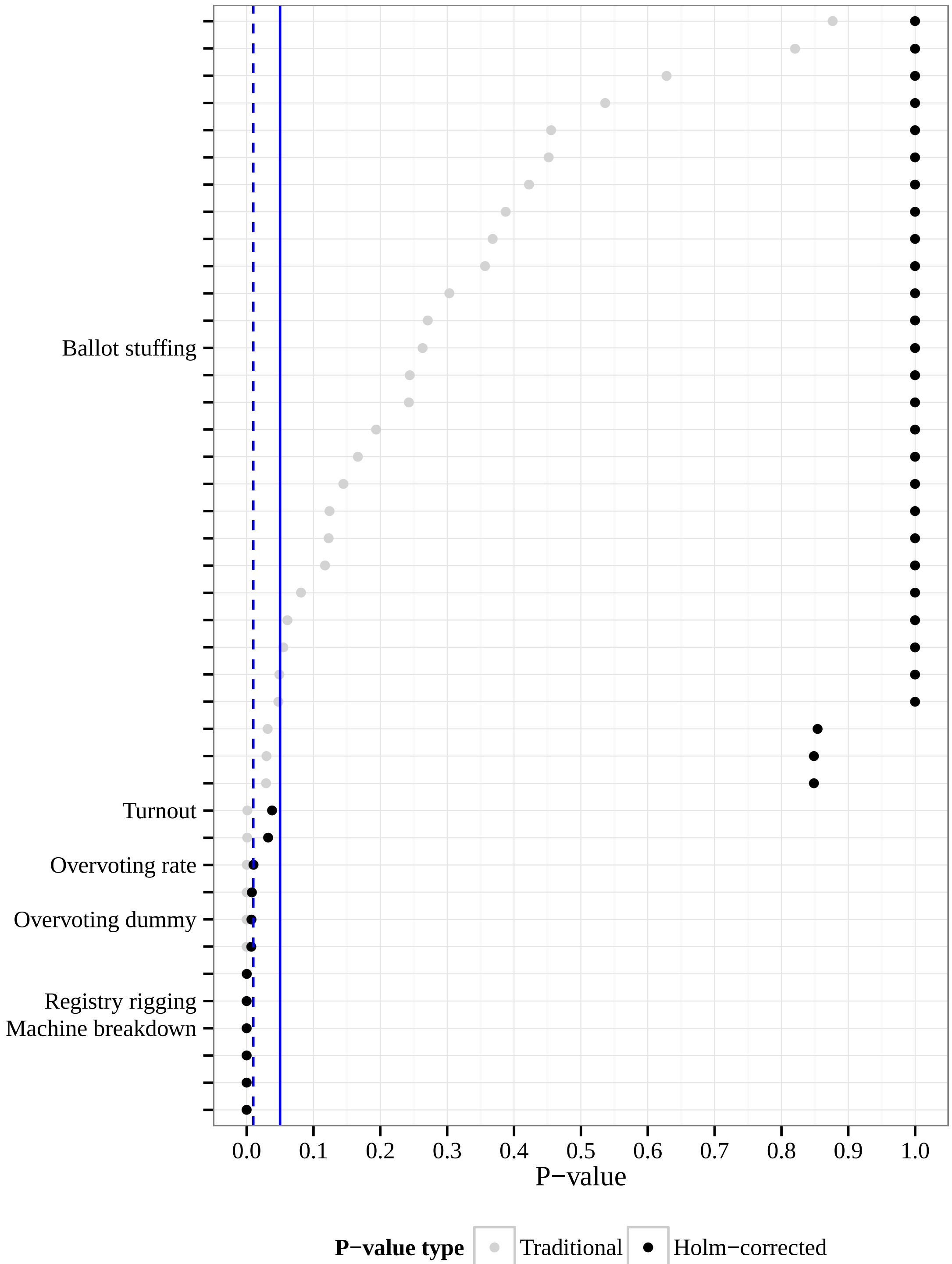
Notes: *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$. OLS with robust standard errors clustered by constituency in parentheses. Ten polling stations without biometric verification machines removed from sample of machine breakdown. Polling stations where enumerators recorded different responses from two party officials on relevant variables are dropped. In Appendix D, Table D.3 we report the same table but only include observations where enumerators recorded identical answers from *both* party officials. The results are substantively the same.

Table 4: Interactive Effect of Machine Breakdown and Election Observers on Fraud

	Overvoting rate	Registry rigging	Ballot stuffing
	OLS	*OLS*	*logistic*
	(1)	(2)	(3)
Machine breakdown	0.027	0.102*	1.102**
	(0.023)	(0.044)	(0.350)
Election observer	−0.024**	−0.093**	−0.432
	(0.009)	(0.033)	(0.513)
Competitive	0.012	0.044	0.490
	(0.009)	(0.023)	(0.369)
Urban	−0.004	0.024	−0.039
	(0.009)	(0.022)	(0.394)
Breakdown X observer	−0.009	−0.098	−0.487
	(0.029)	(0.050)	(0.479)
Constant	0.033**	0.190***	−3.357***
	(0.010)	(0.033)	(0.453)
Observations	1,745	1,830	1,848

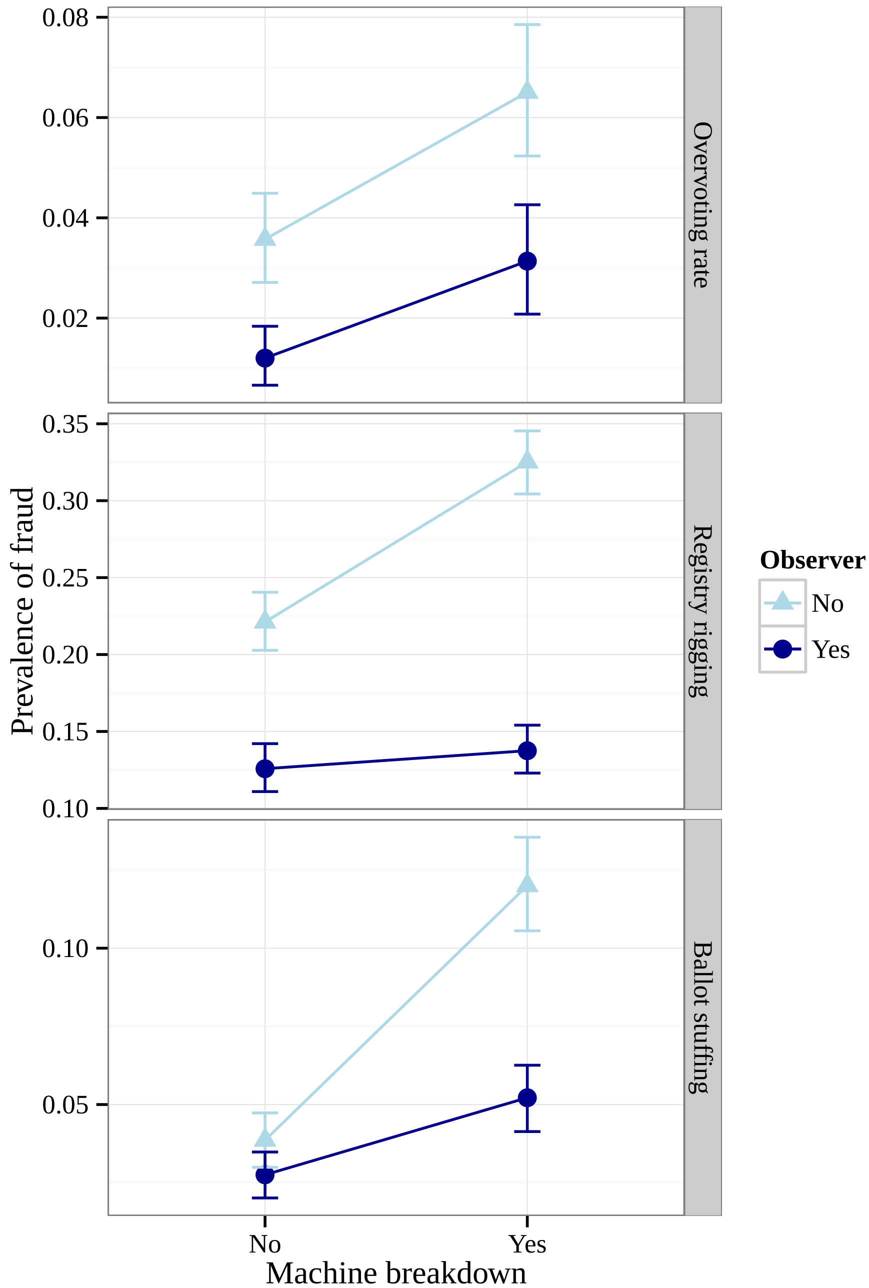
Notes: *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$. OLS in Column 1 and logistic regression in Columns 2 and 3, with robust standard errors clustered by constituency in parentheses. Ten polling stations without biometric verification machines removed from sample of machine breakdown. Polling stations where enumerators recorded different responses from two party officials on relevant variables are dropped. In Appendix D, Table D.4 we report the same table but only include observations where enumerators recorded identical answers from *both* party officials. There is very little change, although the effects on overvoting grow smaller and the effect of machine breakdown on rigging is no longer significant.

Figure 1: Holm Corrected P-Values



Note: Listed on the y-axis are the four focal outcomes, as well as turnout and a dummy variable for overvoting (1 if it exists, 0 otherwise). The dashed vertical line is at 0.01 and the solid horizontal line is at 0.05. The full list of outcome variables can be found in Table H.1.

Figure 2: Bootstrapped Mean Levels of Fraud by Machine Breakdown and Observer



Note: Machine breakdown is on the x-axis and the different colors and shapes indicate different observer statuses. On the y-axis are mean levels of fraud; this is the mean level of overvoting for *overvoting rate* and the proportion of polling stations with indicators of fraud for *registry rigging* and *ballot stuffing*. Standard errors and mean values computed using 1,000 bootstrapped samples.

A Appendices

A Survey Instrument

Figure A.1: Data Collection Instrument Used in Sampled Polling Stations

CODEO (UCLA) OBSERVER CHECKLIST – 07 December 2012 Elections

Enumerator Name		**Constituency**	AFIGYA SEKYERE EAST
Region	ASHANTI	**Electoral Area**	AMANGOASE
Polling Station Name	WIAMOASE SAL ARMY JHS	**Polling Station Code**	F353001

ARRIVAL

AA Were any election officials present upon arrival? Yes (1) / No (2)

SETUP

AB At what time did voting commence? By 7:15 (1) / 7:16 to 8:00 (2) / 8:01 to 10:00 (3) / After 10:00 (4) / Never Opened (5)

AC Were you permitted to observe? Yes (1) / No (2)

AD Was the polling station set up so that voters could mark their ballots in secret? Yes (1) / No (2)

AE Was the polling station accessible to persons with disabilities and the elderly? Yes (1) / No (2)

AF Was a polling agent present for NDC? Yes (1) / No (2)

AG Was a polling agent present for NPP? Yes (1) / No (2)

AH Which other political party agents were present? (*Tick one or more*) None (0) / CPP (1) / GFP (2) / NDP (3) / GCPP (4) / PNC (5) / PPP (6) / UFP (7) / URP (8) / INDP (9)

AJ Were security personnel present? Yes (1) / No (2)

AK Which items, if any, were missing (*Tick one or more*) None (0) / Ballot Box (1) / Ballot Paper (2) / Voters' Register (3) / Indelible Ink (4) / Voting Screen (5) / Validating Stamp (6) / Endorsing Ink (7) / Ink Pad (8) / Tactile Ballot (9)

AM Did the polling station have a biometric verification machine? Yes (1) / No (2)

AN Number of names on the voters register? *(Enter zero if no voters register)* [| | |]

AP Number of names on the proxy voters list? *(Enter zero if no proxy register)* [| | |]

AQ Number of presidential ballot papers? *(Enter zero if none)* [| | |]

AR Were the presidential and parliamentary ballot boxes shown to be empty, sealed and placed in public view? Yes (1) / No (2)

VOTING

BA Were people's biometric registration information verified? Yes (1) / No (2)

BB Did biometric verification machine fail to function properly at any point in time? Yes (1) / No (2)

BC Were people's fingers marked with indelible ink before voting? Yes (1) / No (2)

BD Were ballot papers stamped with the validating stamp before being issued? Yes (1) / No (2)

BE Were any unauthorised person permitted to remain in the polling station during voting? Yes (1) / No (2)

BF Did anyone attempt to harass or intimidate voters or polling officials during voting? Yes (1) / No (2)

(For Questions BG, BH, BJ, BK and BM: None = 0, Few = 1 to 5, Some = 6 to 15 and Many = 16 or more)

BG How many people with Voter ID Cards were not permitted to vote? None (0) / Few (1) / Some (2) / Many (3)

BH How many people were permitted to vote without voter ID cards? None (0) / Few (1) / Some (2) / Many (3)

BJ How many people were permitted to vote whose names did not appear on the voters' register? None (0) / Few (1) / Some (2) / Many (3)

BK How many people were permitted to vote whose biometric details did not match? None (0) / Few (1) / Some (2) / Many (3)

BM How many people were assisted to vote (blind, disabled, elderly, etc)? None (0) / Few (1) / Some (2) / Many (3)

BN Were assisted voters allowed to have a person of their own choice to assist them to vote? Yes (0) / No (1) / No Assisted Voters (3)

BP Overall, how would you describe any problems that may have occurred during the voting process? Major (1) / Minor (2) / None (3)

CLOSING & COUNTING

CA How many people were in queue at 5:00 pm? None (0) / Few (1) / Some (2) / Many (3)

CB	Was everyone who was in the queue at 5:00 pm permitted to vote?		Yes (1)	No (2)
CC	Was anyone who arrived at the polling station after 5:00 pm permitted to vote?	Yes (1)	No (2)	No One Arrived After 5pm (3)
CD	Did anyone attempt to harass or intimidate polling officials during counting?		Yes (1)	No (2)
CE	Were more ballot papers found in the presidential ballot box than voters who cast ballots?		Yes (1)	No (2)
CF	Did any polling agent request a recount of the presidential ballots?		Yes (1)	No (2)
CG	Did an NDC polling agent sign the declaration of results for the presidential election?	Yes (1)	No (2)	No NDC Agent Present (3)
CH	Did an NPP polling agent sign the declaration of results for the presidential election?	Yes (1)	No (2)	No NPP Agent Present (3)
CJ	Did any other polling agent present sign the declaration of results for the presidential election?	Yes (1)	No (2)	No Other Agents Present (3)
CK	Do you agree with the vote count for the presidential election?		Yes (1)	No (2)
CM	Did all polling agents present sign the declaration of results for the parliamentary election?		Yes (1)	No (2)
CN	Do you agree with the vote count for the parliamentary election?		Yes (1)	No (2)

PRESIDENTIAL VOTE COUNT

DA	Spoilt ballot papers		**DH**	UFP (Akwasi Addai Odike)	
DB	Rejected ballot papers		**DJ**	PNC (Ayariga Hassan)	
DC	Total Valid Votes		**DK**	CPP (Michael Abu Sakara Forster)	
DD	NDC (John Dramani Mahama)		**DM**	INDP (Jacob Osei Yeboah)	
DE	GCPP (Henry Hebert Lartey)				
DF	NPP (Nana Addo Dankwa Akufo-Addo)				
DG	PPP (Papa Kwesi Ndoum)				

Who was interview

- ☐ 1) Party Agent (specify)………………………………………………….
- ☐ 2) EC Official
- ☐ 3) Security Personnel

Enumerator First Name ______ Surname ______ Arrival Time ______ Departure Time ______ Signature ______

B Details of the Experimental Design

We implement a "randomized saturation" experimental design (Baird et al., 2014). The advantage of the randomized saturation design is that it allows us to estimate the causal effect of election observers while including in the estimates their potential "spillover" effects. Spillover effects occur when the treatment status of one unit impacts outcomes at other units (Gerber and Green, 2012): in our case, when the deployment of an observer to one polling station influences election integrity at other polling stations (because the observer "pushes" election fraud to unobserved polling stations).

The design involves a two-stage randomization process: in our case, first at the constituency level and then at the polling station level. In the first stage, we assign constituencies to an observer "saturation" treatment. Saturation is defined as the proportion of polling stations within a constituency that is monitored by observers. In the second stage, we randomly assign observers to polling stations within the sample of constituencies.

In the first stage, we randomly assign each constituency to one of three saturations: *low*, *medium*, and *high*. In the low condition, observers are deployed to 30 percent of sample polling stations in the constituency. In the medium condition, we treat 50 percent of sample polling stations. In the high condition, we treat 80 percent of sample polling stations.[23] In the second stage of our randomization process, we randomly assign individual polling stations to treated (observed) or control (unobserved) status. The proportion of polling stations randomly assigned to treatment within a constituency is determined by the randomly assigned saturation level in the first stage. The approach yields a 3×2 experimental design. In total, we send observers to $1,292$ polling stations across 60 constituencies in the sample.

[23] In other research (Asunka et al., 2014), we seek to identify the spillover effects of observers on fraud in polling stations that are not under observation. The estimation of spillover effects relies on comparisons of control units in each of the three constituency level conditions. Since by definition there are relatively few control stations in the higher saturation constituencies, we assign the constituency treatments with a probability of 20 percent for the low condition and 40 percent for the medium and high conditions. This increases the statistical power to detect spillover effects. Such spillovers are not the focus of the present study.

In our experimental framework, potential outcomes are determined by the polling station's treatment status and the treatment condition of each station's constituency. Potential outcomes can be written as follows:

$$Y_{ij}(T_{ij}, S_j) \tag{B.1}$$

where Y_{ij} is one of the indices of election integrity (such as ballot stuffing or overvoting) at polling station i in constituency j. T_{ij} indicates treatment status at polling station i in constituency j ($T_{ij} = 1$ if an observer is present, and 0 otherwise). The constituency level treatment status is indicated by S_j, where $S_j = s$ and $s \in \{low, medium, high\}$.

To account for spillover in our estimation of causal effects, we compare outcomes in treated polling stations to outcomes in control polling stations in the low saturation constituencies. Since the saturation of treatment in the low condition constituencies is relatively low, the control polling stations in the low condition constituencies are less likely to be affected by spillover effects. Comparing outcomes in treated polling stations only to these low condition control stations should therefore generate less biased estimates of observers' causal effects.[24] To estimate the average treatment effect of election observers, we therefore define a dummy variable, W_{ij}, which takes a value of 1 if the unit is a control polling station located in one of the medium and high saturation constituencies (following Baird et al., 2014). To estimate the average treatment effect, we estimate the following regression model:

$$Y_{ij} = \beta_0 + \beta_1 T_{ij} + \beta_2 W_{ij} + \varepsilon_{ij} \tag{B.2}$$

[24]Ideally, we would have implemented the study with "pure" control polling stations. Pure control units are untreated units that are not susceptible to spillover effects because there are no treated units in the same constituency (or local area). In our study, no control units were assigned to this pure control status. This decision was driven solely by practical considerations. Given CODEO's mission, which is to deter electoral malfeasance and enhance the quality of elections across the country, we were unable to create constituencies in which no observers were present. It is an important part of CODEO's mission to be present in all regions and constituencies of the country, in part so that the organization maintains credibility as an impartial observer. Therefore, we use control stations in low saturation constituency as our main comparison set.

Here, β_1 provides the estimate of the average treatment effect. It compares outcomes in all treated polling stations to outcomes in control stations in the low saturation constituencies. We cluster standard errors by constituency to account for the fact that the cluster-level treatments are assigned at that level.

In Table 2, we reported average treatment effects. In Table B.1 we report results of the same regressions including spillover effects.

Table B.1: Average Treatment Effects of Election Observers on Machine Breakdown and Fraud, Incorporating Spillover

	Breakdown		Overvoting rate		Registry rigging		Ballot stuffing	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Election observer	−0.113*	−0.109*	−0.026	−0.028	−0.087*	−0.084*	−0.005	−0.005
	(0.048)	(0.052)	(0.015)	(0.015)	(0.040)	(0.039)	(0.026)	(0.028)
Competitive		0.078*		0.013		0.039		0.023
		(0.037)		(0.009)		(0.023)		(0.019)
Urban		0.034		−0.008		0.029		0.003
		(0.034)		(0.009)		(0.023)		(0.017)
Spillover	0.095	0.099	0.014	0.012	0.048	0.051	0.035	0.035
	(0.062)	(0.065)	(0.019)	(0.018)	(0.050)	(0.049)	(0.042)	(0.041)
Constant	0.285***	0.230***	0.041**	0.041**	0.221***	0.186***	0.036	0.025
	(0.044)	(0.054)	(0.015)	(0.016)	(0.039)	(0.045)	(0.025)	(0.027)
Observations	1,888	1,888	1,864	1,864	1,973	1,973	1,987	1,987
R^2	0.045	0.054	0.008	0.010	0.024	0.028	0.007	0.011

Notes: *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$. OLS with robust standard errors clustered by constituency in parentheses. Eleven polling stations without biometric verification machines removed from sample of machine breakdown. Polling stations where enumerators recorded different responses from two party officials on relevant variables are dropped.

C Covariate Balance Tests

In this section, we present data showing balance on various dimensions for treated and control polling stations. We use data from a household survey we conducted in the communities near observed and unobserved polling places during the two days following the elections.[25] As part of the survey, we gathered data on voting behavior in the prior 2008 election as well as measures of socio-economic conditions and ethnic self-identification.

Table C.1 presents means in control and observed communities on a number of pre-election covariates. It also presents the difference in these means and the p-value of a two-tailed difference-of-means test. The first section of the table shows that the partisan voting histories of residents near observed and unobserved polling are comparable. In both sets of communities, about 35 percent report voting for the NPP in the 2008 presidential election, while about 43 percent report voting for the NDC, whose candidate was the winner of that election. The remaining sections of the table examine measures of education, poverty and well-being, and ethnicity. Observed and control polling stations are also similar along these dimensions. The data presented in the table shows that the communities surrounding our observed and control polling stations are comparable across a range of political, ethnic and and socio-economic characteristics that could potentially affect the level of election fraud.

[25] We surveyed over 6,000 Ghanaians. Ideally, we would have randomly sampled individuals from the official voter register. Because this was not available, we employed the random sampling techniques used across Africa by the Afrobarometer public opinion survey. Our enumerators visited each of our approximately 2,000 sampled polling place and then selected four households using a random walk technique.

Table C.1: Polling Station (Unit) Level Covariate Balance

	Mean Treatment	Mean Control	Difference	P-Value
NPP Presidential Vote 2008	0.359	0.368	-0.009	0.562
NDC Presidential Vote 2008	0.425	0.426	-0.000	0.975
NPP Parliamentary Vote 2008	0.359	0.391	-0.032	0.034
NDC Parliamentary Vote 2008	0.408	0.401	0.008	0.614
Poverty index	0.956	0.981	-0.025	0.151
Electricity	1.117	1.156	-0.039	0.104
Medicine	0.896	0.886	0.010	0.659
Sufficient Food	0.840	0.879	-0.039	0.106
Cash Income	0.970	1.002	-0.031	0.143
No Formal Schooling	0.145	0.145	0.000	0.987
Completed Primary Schooling	0.716	0.698	0.018	0.206
Post Primary Schooling	0.543	0.522	0.021	0.184
Formal House	0.181	0.177	0.004	0.737
Concrete Permanent House	0.427	0.416	0.011	0.463
Concrete and Mud House	0.218	0.219	-0.001	0.952
Mud House	0.168	0.181	-0.014	0.242
Akan	0.685	0.699	-0.013	0.350
Ga	0.021	0.018	0.002	0.614
Ewe	0.220	0.203	0.016	0.201
Other, Refuse, or Don't Know	0.074	0.079	-0.005	0.546

Notes: P-values calculated from two-tailed difference-of-means tests. Poverty index constructed by adding responses to the following items and dividing by the total number of items: How often did you go without the following in the past year, where the items are cash income; sufficient food; medicine; and electricity. Responses were: *Never* (0), *Occasionally* (1), and *Most of the time* (2).

D Data Collection and Robustness

In this section, we describe features of the data collection and analysis that led us to undertake specific robustness checks. We present the results of the robustness checks and verify that the results reported in the body of the paper remain unchanged.

Data was collected on election day from sampled polling stations by enumerators using the questionnaire that appears in Appendix A. In treated areas, enumerators acted as election observers for the whole of the day. These observer/enumerators remained in a single randomly selected polling station through the vote count. They recorded the information reported and analyzed here by observing events at the polling station as well as the vote count. Due to logistical challenges and because we wanted to avoid treating control stations by sending enumerators to observe activities throughout the course of election day, other enumerators were assigned to visit three to four control polling stations after the polls had closed at 17:00 and, using identical questionnaires, to collect the same information. They were instructed to collect information from two persons, ideally the two official representatives of the major political parties in each polling place. These representatives typically gather similar information to report to central party offices. If enumerators could not speak with a party representative because the person was unavailable, enumerators were instructed to collect the information from the presiding officer. Members of both groups of enumerators received identical training, were officially designated CODEO election observers, and received appropriate identification materials that permitted them entry into polling stations.

The analysis reported in this paper relies on four pieces of information collected by enumerators: (1) the number of rejected ballots; (2) the number of valid votes; (3) whether more ballot papers were found in the presidential ballot box than had been cast; and (4) whether at any point during the data the biometric verification machine malfunctioned. In addition, we use data supplied by the Election Commission on the number of registered voters at each polling station.

The analysis reported in the main body of the paper uses all observations where enumerators only were able to collect data from one party official as well as all observations where the enumerator was able to reach both party officials and the answers were identical along the variables of interest. This means the main analysis drops only observations where the party officials explicitly disagreed. In the robustness tests presented below, we drop observations that fail to meet one of two criteria: the enumerator collected the information through direct observation (i.e. the polling station was a treated unit) or the enumerator collected identical information from two separate respondents. Thus, observations with only one party official's responses are no longer included.

Table D.1 and Table D.2 replicate the main analyses from the results Section using this smaller dataset. All the results remain stable.

Table D.1: Descriptive Statistics of Machine Breakdown and Measures of Fraud, Smaller Dataset

	(1) Full Sample	(2) Treatment	(3) Control	(4) Competitive	(5) Stronghold	(6) Urban	(7) Rural
Machine breakdown	0.223	0.172	0.335	0.264	0.192	0.238	0.206
	(0.416)	(0.378)	(0.472)	(0.441)	(0.394)	(0.426)	(0.404)
Overvoting rate	0.025	0.015	0.045	0.029	0.021	0.021	0.028
	(0.185)	(0.152)	(0.242)	(0.188)	(0.184)	(0.171)	(0.200)
Registry rigging	0.172	0.134	0.248	0.190	0.159	0.185	0.157
	(0.377)	(0.340)	(0.432)	(0.392)	(0.366)	(0.389)	(0.364)
Ballot stuffing	0.041	0.032	0.060	0.053	0.033	0.043	0.039
	(0.199)	(0.175)	(0.238)	(0.224)	(0.178)	(0.203)	(0.194)
Observations	1988	1281	707	831	1157	1051	937

Notes: Standard deviations in parentheses. Ten polling stations without biometric verification machines removed from sample. Polling stations where enumerators recorded different responses from two party officials on relevant variables or responses from only one party official are dropped.

Table D.2: Average Treatment Effects of Election Observers on Machine Breakdown and Fraud, Smaller Dataset

	Breakdown		Overvoting rate		Registry rigging		Ballot stuffing	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Election observer	-0.163^{***}	-0.163^{***}	-0.030^{**}	-0.031^{**}	-0.115^{***}	-0.114^{***}	-0.029	-0.029
	(0.040)	(0.041)	(0.011)	(0.011)	(0.025)	(0.025)	(0.029)	(0.030)
Competitive		0.076		0.008		0.035		0.022
		(0.039)		(0.009)		(0.023)		(0.020)
Urban		0.028		-0.008		0.024		0.004
		(0.035)		(0.009)		(0.022)		(0.019)
Constant	0.335^{***}	0.288^{***}	0.045^{***}	0.047^{***}	0.248^{***}	0.221^{***}	0.060^{*}	0.050
	(0.037)	(0.041)	(0.010)	(0.012)	(0.025)	(0.029)	(0.028)	(0.029)
Observations	1,814	1,814	1,786	1,786	1,896	1,896	1,895	1,895
R^2	0.033	0.042	0.006	0.007	0.021	0.024	0.005	0.008

Notes: *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$. OLS with robust standard errors clustered by constituency in parentheses. Ten polling stations without biometric verification machines removed from sample of machine breakdown. Polling stations where enumerators recorded different responses from two party officials on relevant variables or responses from only one party official are dropped.

Table D.3: Effect of Election Observers and Competitiveness on Machine Breakdown and Fraud, Smaller Dataset

	Breakdown	Overvoting rate	Registry rigging	Ballot stuffing
	(1)	(2)	(3)	(4)
Election Observer	-0.157^{***}	-0.030^{**}	-0.111^{***}	-0.028
	(0.041)	(0.011)	(0.025)	(0.029)
Urban	0.023	-0.009	0.022	0.002
	(0.035)	(0.009)	(0.022)	(0.020)
Margin	-0.159^{**}	-0.005	-0.082^{*}	-0.035
	(0.056)	(0.017)	(0.039)	(0.024)
Constant	0.368^{***}	0.052^{***}	0.261^{***}	0.069
	(0.054)	(0.014)	(0.028)	(0.042)
Observations	1,814	1,786	1,896	1,895
R^2	0.045	0.006	0.025	0.007

Notes: *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$. OLS with robust standard errors clustered by constituency in parentheses. Ten polling stations without biometric verification machines removed from sample of machine breakdown. Polling stations where enumerators recorded different responses from two party officials on relevant variables or responses from only one party official are dropped.

Table D.4: Interactive Effect of Machine Breakdown and Election Observers on Fraud, Smaller Dataset

	Overvoting rate	Registry rigging	Ballot stuffing
	OLS	*logistic*	*logistic*
	(1)	(2)	(3)
Machine breakdown	0.001	0.388	1.290***
	(0.020)	(0.235)	(0.333)
Election observer	−0.025*	−0.674**	−0.342
	(0.010)	(0.206)	(0.564)
Competitive	0.007	0.302	0.500
	(0.010)	(0.164)	(0.392)
Urban	−0.004	0.158	−0.001
	(0.009)	(0.161)	(0.418)
Breakdown X observer	0.018	−0.341	−0.680
	(0.027)	(0.345)	(0.458)
Constant	0.036***	−1.472***	−3.470***
	(0.011)	(0.228)	(0.508)
Observations	1,676	1,759	1,766

Notes: *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$. OLS in Column 1 and logistic regression in Columns 2 and 3, with robust standard errors clustered by constituency in parentheses. Ten polling stations without biometric verification machines removed from sample of machine breakdown. Polling stations where enumerators recorded different responses from two party officials on relevant variables or responses from only one party official are dropped.

E Alternative Specifications of Average Treatment Effects

Table E.1: Average Treatment Effects of Election Observers on Machine Breakdown and Fraud, Logistic Models

	Breakdown		Registry rigging		Ballot stuffing	
	(1)	(2)	(3)	(4)	(5)	(6)
Election observer	-0.971^{***}	-0.974^{***}	-0.798^{***}	-0.796^{***}	-0.711	-0.720
	(0.188)	(0.194)	(0.146)	(0.149)	(0.496)	(0.512)
Competitive		0.452^{*}		0.273		0.561
		(0.212)		(0.163)		(0.402)
Urban		0.180		0.189		0.037
		(0.211)		(0.160)		(0.437)
Constant	-0.600^{***}	-0.903^{***}	-1.071^{***}	-1.295^{***}	-2.711^{***}	-2.997^{***}
	(0.153)	(0.199)	(0.130)	(0.175)	(0.440)	(0.494)
Observations	1,888	1,888	1,973	1,973	1,987	1,987
Akaike Inf. Crit.	1,981.043	1,967.207	1,803.952	1,800.830	695.955	693.672

Notes: *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$. Logistic regression with robust standard errors clustered by constituency in parentheses. Ten polling stations without biometric verification machines removed from sample of machine breakdown. Polling stations where enumerators recorded different responses from two party officials are dropped.

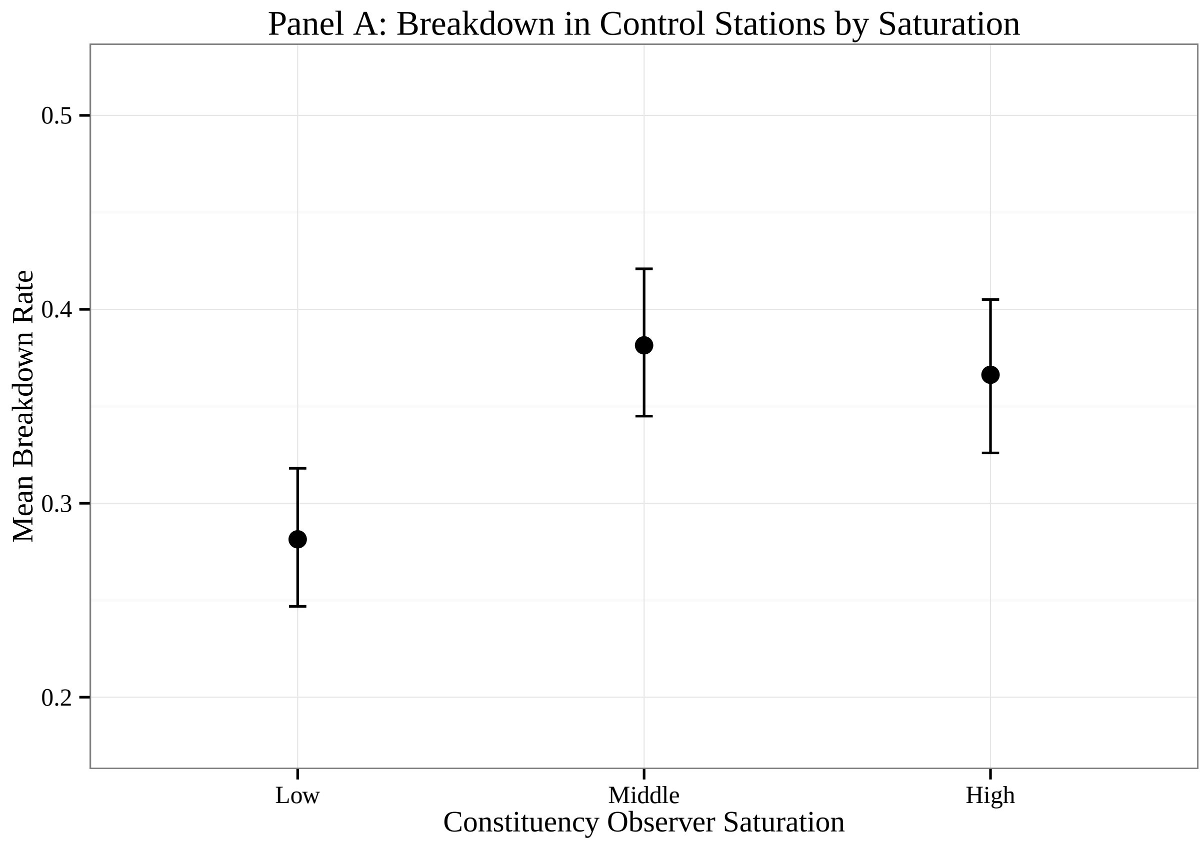
Table E.2: Average Treatment Effects of Election Observers on Machine Breakdown and Fraud, Non-Robust Standard Errors

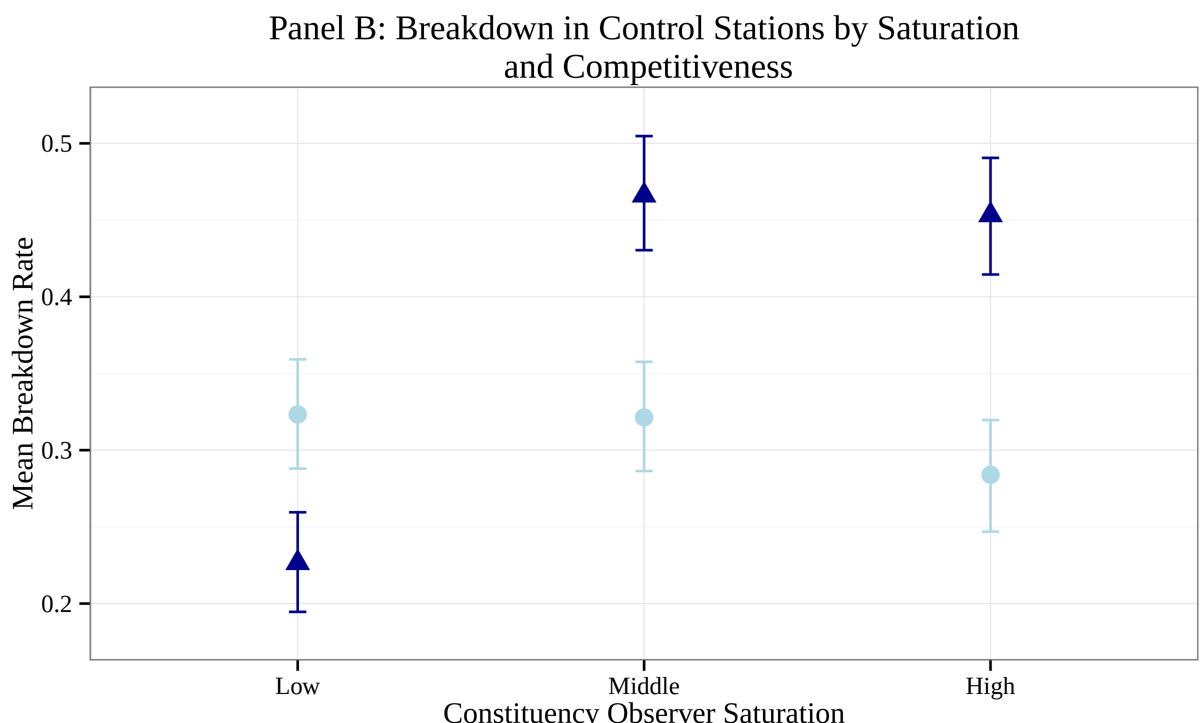
	Breakdown		Overvoting rate		Registry rigging		Ballot stuffing	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Election observer	-0.182^{***}	-0.181^{***}	-0.036^{***}	-0.037^{***}	-0.122^{***}	-0.121^{***}	-0.031^{**}	-0.031^{**}
	(0.020)	(0.020)	(0.009)	(0.009)	(0.018)	(0.018)	(0.009)	(0.009)
Competitive		0.078^{***}		0.013		0.039^{*}		0.023^{*}
		(0.019)		(0.009)		(0.017)		(0.009)
Urban		0.030		-0.008		0.026		0.001
		(0.019)		(0.009)		(0.017)		(0.009)
Constant	0.354^{***}	0.304^{***}	0.051^{***}	0.050^{***}	0.255^{***}	0.224^{***}	0.062^{***}	0.052^{***}
	(0.016)	(0.022)	(0.008)	(0.010)	(0.014)	(0.019)	(0.008)	(0.010)
Observations	1,888	1,888	1,864	1,864	1,973	1,973	1,987	1,987
R^2	0.042	0.051	0.008	0.009	0.023	0.027	0.005	0.009

Notes: *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$. OLS with non-robust standard errors. Ten polling stations without biometric verification machines removed from sample of machine breakdown. Polling stations where enumerators recorded different responses from two party officials are dropped.

F Estimates of Spillover of Machine Breakdown onto Control Polling Stations

Figure F.1: Spillover of Machine Breakdown onto Control Polling Stations





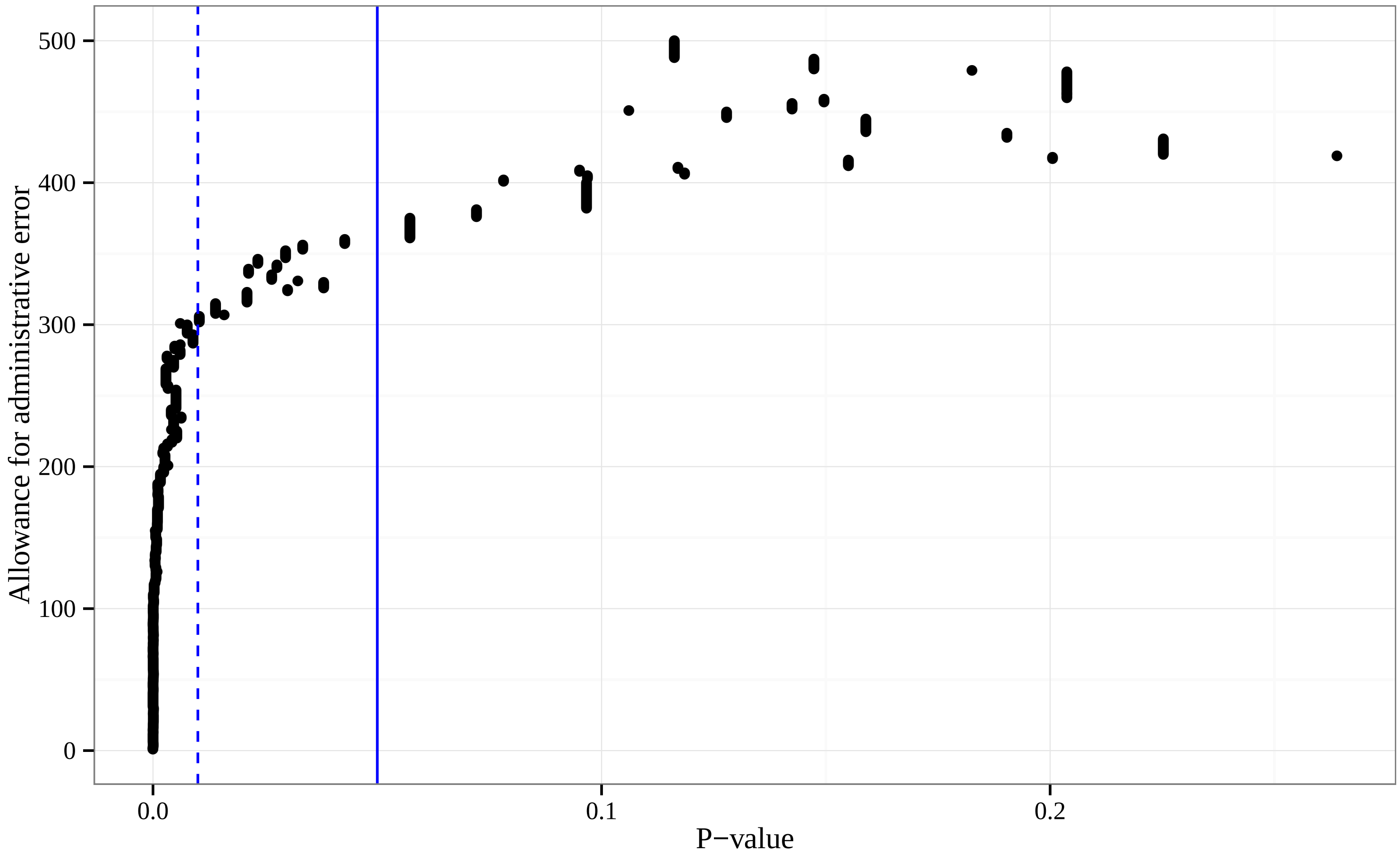
G Cutoffs for Registry Rigging and Registry Difference

Figure G.1 demonstrates that *registry rigging* is robust to different cutoffs that allow for administrative error. Table G.1 replicates the regressions in Table 2 and Table 4 using a continuous rather than discrete measure of registry rigging. The measure *registry difference* is continuous from -923 to 1314, with a large number of values at 0 where the registry number matched the official EC number. The measure is constructed by subtracting the Electoral Commission figures from the number of registered voters according to the local rolls. Positive numbers indicate the number on the local rolls was larger than the Electoral Commission figure. In two polling stations the local rolls showed figures greater than 8000. These appear to be simple transcription errors. In seven polling stations the local roll numbers were not available. These polling stations are all dropped.[26]

The results in Table G.1 show that control stations had significant positive values of *registry difference* while observers reduced that value to almost 0. This would support the story that registry rigging was deliberately done to inflate the voter rolls. Furthermore, although the standard errors are quite large, the second column is consistent with the story that registry rigging to inflate the rolls was encouraged by machine breakdown, although that relationship disappears in the presence of an observer.

[26]Their inclusion only strengthens our findings, but it is inappropriate to include them as they are clear outliers driven by erroneous data collection that drive the regressions below

Figure G.1: Allowance for Administrative Discrepancies When Constructing *Registry Rigging*



Notes: This plot demonstrates the p-values for unequal variance t-tests for a range of cutoffs for the rigging variable. The y-axis describes the allowance for administrative error and the x-axis is the p-value of the ATE effect of observers on registry rigging. The dashed vertical line is at 0.01 and the solid horizontal line is at 0.05. As we move along the y-axis, we only code a polling station with registry rigging if the difference between the number of registered voters according to the Electoral Commission and the local figure at the polling station is greater than or equal to the value of the y-axis — the cutoff. The treatment effect of observers remains significantly negative until the cutoff is 357, meaning until we treat only discrepancies *greater* than or equal to 357 as registry rigging, observers have a significant depressive effect on registry rigging.

Table G.1: Effect of Observers and Machine Breakdown on Registry Difference

	Registry Difference	
	(1)	(2)
Machine breakdown		25.410
		(16.768)
Election observer	−19.651**	−14.302*
	(6.784)	(5.712)
Competitive	2.725	2.621
	(5.690)	(5.671)
Urban	−3.786	−3.126
	(5.471)	(5.636)
Breakdown X observer		−24.981
		(15.768)
Constant	22.329**	16.166**
	(7.159)	(6.052)
Observations	1,973	1,830
R^2	0.008	0.014

Notes: *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$. OLS with non-robust standard errors. Ten polling stations without biometric verification machines removed from sample of machine breakdown. Polling stations where enumerators recorded different responses from two party officials are dropped.

H Holm Correction

For a brief introduction and overview of the Holm correction, see Aickin and Gensler (1996). It is very easily implemented in `R` using the `p.adjust` function. In the table below, we report the average treatment effect of election observers on a host of outcome variables. We include the effect size, the traditional p-value, the Holm corrected p-value, and the Bonferroni corrected p-value. Notice that the key treatment effects that were originally significant remain significant even using the stricter Bonferroni correction.

Table H.1: Effect Sizes and Corrected P-Values of 43 Outcomes

Variable	Treatment	Control	Difference	P-Value	Holm Adj.	Bonferroni Adj.
Time voting commenced (Early[1] - Late[5])	1.547	1.282	0.265	0.000	0.000	0.000
Station set up to ensure ballot secrecy (0/1)	0.837	0.958	-0.121	0.000	0.000	0.000
No. of voters assisted (None[0] - Many[4])	1.368	1.073	0.294	0.000	0.000	0.000
Machine breakdown (0/1)	0.123	0.304	-0.181	0.000	0.000	0.000
Registry rigging (0/1)	0.104	0.224	-0.121	0.000	0.000	0.000
Election official present (0/1)	0.785	0.908	-0.123	0.000	0.000	0.000
Was station accessible to elderly/disabled (0/1)	0.944	0.978	-0.033	0.000	0.007	0.008
Overvoting dummy (0/1)	0.021	0.064	-0.044	0.000	0.007	0.009
Security personnel present (0/1)	0.824	0.881	-0.058	0.000	0.008	0.010
Overvoting rate	0.014	0.050	-0.037	0.000	0.010	0.013
Election materials missing (0/1)	0.074	0.030	0.044	0.001	0.032	0.043
Turnout	82.333	87.463	-5.130	0.001	0.038	0.052
Voters w/ no ID permitted to vote (None[0] - Many[3])	0.669	0.536	0.133	0.029	0.849	1.000
Harrassment or intimidation of voters (0/1)	0.043	0.113	-0.070	0.030	0.849	1.000
Voters w/out bio matches allowed to vote (None[0] - Many[3])	0.049	0.155	-0.106	0.032	0.854	1.000
Other party agents sign pres. results (0/1)	1.472	1.375	0.097	0.048	1.000	1.000
Voters biometric registration verified (0/1)	0.991	0.968	0.023	0.049	1.000	1.000
Voter not on register allowed to vote (None[0] - Many[3])	0.032	0.136	-0.104	0.055	1.000	1.000
NDC agent present (0/1)	0.995	0.986	0.009	0.061	1.000	1.000
Unauthorized persons at station (0/1)	0.060	0.103	-0.043	0.081	1.000	1.000
Voters queued at 5pm allowed to vote (0/1)	0.785	0.828	-0.043	0.117	1.000	1.000
NDC agent sign pres. results (Yes[1], No[2], Not Present[3])	1.023	1.046	-0.022	0.123	1.000	1.000
Allowed voters arriving after 5 (Yes[1], No[2], NA[3])	2.579	2.477	0.102	0.124	1.000	1.000
Agents agree on parl. results (0/1)	1.000	0.979	0.021	0.145	1.000	1.000
Voters marked with ink (0/1)	0.983	0.960	0.023	0.167	1.000	1.000
Agents agree on pres. results (0/1)	0.996	0.976	0.020	0.194	1.000	1.000
Count of intimidation events	0.024	0.050	-0.026	0.243	1.000	1.000
Party agent allowed to observe (0/1)	0.995	0.999	-0.004	0.244	1.000	1.000
Ballot stuffing (0/1)	0.021	0.052	-0.031	0.263	1.000	1.000
Overall problems (Major[1], Minor[2], None[3])	2.696	2.772	-0.076	0.271	1.000	1.000
Ballot papers stamped by EC (0/1)	0.988	0.976	0.011	0.303	1.000	1.000
No. of voters on proxy list	9.989	6.430	3.559	0.357	1.000	1.000
Empty ballot boxes displayed pre-voting (0/1)	0.998	1.000	-0.002	0.368	1.000	1.000
Voters queued at 5pm (0/1)	0.656	0.729	-0.074	0.387	1.000	1.000
NPP votes	157.835	167.464	-9.630	0.422	1.000	1.000
Voters w/ ID not permitted to vote (None[0] - Many[3])	0.281	0.316	-0.036	0.452	1.000	1.000
NDC votes	239.369	247.220	-7.851	0.456	1.000	1.000
Party agents sign parl. results (0/1)	0.986	0.978	0.008	0.536	1.000	1.000
NPP agent sign pres. results (Yes[1], No[2], Not Present[3])	1.022	1.026	-0.005	0.628	1.000	1.000
NPP agent present (0/1)	0.992	0.993	-0.001	0.820	1.000	1.000
Request for recount (0/1)	0.078	0.082	-0.005	0.877	1.000	1.000