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Revolt on the Nile: Economic Shocks, Religion and Political Influence

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Abstract

Can religious leaders use their popular influence to political ends? This paper explores this question using over 700 years of Nile flood data. Results show that deviant Nile floods reduced the dismissal probability of Egypt's highest-ranking religious authority by roughly one-half. Qualitative evidence suggests this decrease reflects an increase in political power stemming from famine-induced surges in the religious authority's control over popular support. Additional empirical results support this interpretation by linking the observed probability decrease to the number of individuals a religious authority could influence. The paper concludes that the results provide empirical support for theories suggesting religion as a determinant of institutional outcomes.

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Throughout history religious organizations often wielded political power. Existing, often informal, theories of the political and institutional effects of organized religion begin from the premise that religious leaders controlled popular support. Adam Smith (2009 [1776], p. 284) remarked that "[w]hen the authorized teachers of religion propagate [...] doctrines subversive of the authority of the sovereign, it is by violence only [...] that he can maintain his authority." Marx (1982 [1844], p. 42) echoed Smith's insights, implying that in equilibrium religious elites are coopted by the sovereign and discourage institutional change by preaching obedience.[1]

Recent research suggests that political freedom is correlated with a country's primary religious affiliation both historically and today (Lipset 1959, 1994; Barro 1999). The causal channels through which religion affects political outcomes, however, remain poorly understood.

This paper uses over 700 years of Nile flood data to investigate the extent to which religious leaders derived political influence (defined as monetary transfers from the military) from their control over popular support. In finding evidence consistent with such popularly-derived influence, it provides the first empirical evidence supporting the key premise of theories stressing the importance of religion in generating institutional outcomes.

To investigate this question, I gather the dismissal dates of medieval Egypt's highest ranking religious authority. Historians believe that this authority –known as the head judge– controlled popular support and used this control to extract concessions from the military elites who appointed him. Historical evidence suggests that during deviant Nile floods the head judge's control over popular support –and his political influence– temporarily increased. Empirical results are consistent with this narrative and show that deviant Nile floods reduced the probability of judge dismissal by roughly one-half.

This empirical result does not conclusively demonstrate that deviant Nile floods increased the political influence of the head judge by increasing his control over popular support. One alternative explanation is that the head judge was an irrelevant

[1] See also Montesquieu (1989 [1748], p. 61) and De Toqueville (1983 [1856] p. 152; 2003 [1840], pp. 111, 347).

bureaucrat and during periods of Nile-induced famine military authorities were less likely to dismiss any member of the bureaucracy. Another possible explanation is that deviant Nile floods made the sultan more superstitious and thus less willing to dismiss the religious authority.

I employ historical variation in popular adherence to the head judge's "denomination" (law school) to better understand the observed relationship between Nile flood levels and head judge dismissal. Results show that the negative relationship between deviant Nile floods and judge dismissal is stronger for judges that controlled more popular support. These findings cast doubt on alternative explanations and stress the importance of increases in popular support in generating the negative relationship between judge dismissal and deviant Nile floods.

The findings in this paper suggest the historical importance of religion (culture) in mobilizing popular support and determining coordinating equilibria (Greif 1994, 2006; Tabellini 2008, 2010). In this sense, the paper adds to a broader literature emphasizing the economic and political importance of religion and culture (Barro and McCleary 2003, 2005, 2006; Guiso et al. 2003, 2006; Iyigun 2008).

The results also provide the first empirical support for a literature stressing the political importance of religious leaders in the Islamic world.[2] This literature complements the discussion in North et al. (2009, p. 45) that suggests that religious elites historically used their popular influence to help maintain rent-extracting institutional equilibria.

Although the empirical results presented in this paper do not conclusively prove that religious elites stifled democratic change in medieval Egypt, they do show that "religion mattered" when such change would have been less costly due to economic shocks (Acemoglu and Robinson (2000a, 2001, 2006), Brückner and Ciccone (forthcoming)). This result suggests that better understanding the political role of religious leaders (perhaps as rent-extracting elites as in Acemoglu and Robinson (2000b, 2008)) may shed light on institutional outcomes in many areas of the world.

[2] Among a large literature see Lewis (1953), Gibb (1955a), Lapidus (1975), al-Sayyid-Marsot (1973) and Burke (1987). For negative correlations between democracy and the percentage of the population that is Muslim today see Barro (1999) and Fish (2002).

The remainder of the paper proceeds as follows. The first section briefly reviews the literature on the interplay between religion and politics and examines the political role of religion in pre-modern Islamic Egypt. The second section uses historical evidence to develop a simple conceptual framework relating deviant Nile floods to increased head judge influence. The third section describes the data. The fourth section documents the effect of Nile-induced famines on the probability of head judge dismissal. The fifth section investigates the plausibility of alternative explanations for the results. The sixth section concludes.

1 Religion, Politics and Islamic Egypt

Barro (1999) notes that despite evidence that religious affiliation is an important determinant of democracy "the theory of the interplay between religion and political structure is even less developed than other aspects of the theory of democracy." Baruch de Spinoza (1632-1677) –an influential enlightenment thinker– was an early proponent of one of the few existing frameworks that explores the political effects of organized religion. He has been paraphrased as arguing that "organized religion is nothing other than a political and social device instituted to serve the well-being of men [...Men use it] to astonish, terrify and elate the people and by this means manipulate them [...T]he inevitable result [of this] is oppression and despotism" (Israel 2001, pp. 701, 708-709).

Recent scholarship suggests that religious leaders can use their control over popular support to political ends. Barro and McCleary (2005) note that the government "might want to use religion as a cooperative force for controlling the citizenry." Gill (1998) argues that the state can use the popular influence of religious leaders to help them minimize the cost of ruling. Murphy and Shleifer (2004) view religious leaders as "brokers creating the networks [...] that bind members together [...and then] "rent out" their networks."

In the Islamic world, scholars have long viewed religious elites as a check on the absolute power of the sovereign. Al-Sayyid Marsot (1973, pp. 133-134) provides a clear exposition of this hypothesized function. She notes that in Muslim societies religious elites "had it in their power to rouse or placate public opinion [...] [i]t was through using the threat of rousing the mob that the 'ulamā' [religious elites] –when all else failed– could restrain the authorities, who recognized the dangers behind the threat."

Political rulers seem to have generally satisfied the demands of the religious elites to the extent necessary to prevent rebellion. Ibn Taymiyya –a well-known medieval thinker– provides one of the more striking expositions of this historical relationship. He notes that "the temporal princes, in close collaboration with the ulama, carry out their religious and political functions as the sharia directs and receive in return loyal obedience from the people."[3]

In Islamic Egypt, military elites served as the political rulers or sultans (henceforth I equate political rulers with military elites).[4] They appointed influential religious scholars to high-ranking judicial positions. Judicial appointees took care of the day-to-day workings of the legal system and worked to guarantee popular support for the incumbent regime (Lapidus 1984, p. 134; Petry 1981, pp. 232-240). In return, religious leaders developed sizeable fortunes which were directly linked to the number of individuals they could influence.[5] In addition to administering Islamic law and developing sizeable personal fortunes, influential ulama sought to protect their "constituents" from abuses. These abuses included confiscations and high levels of taxation.

The head judge stood at the head of ulama networks in Islamic Egypt and could provide "massive popular backing" (Lapidus 1984, p. 134). One scholar of medieval Egypt has described the head judge as having "vast personal authority among the ulama" (Lapidus 1984, p. 136). Another notes that "[i]f the holders of any one

[3] Paraphrased in Gibb (1955b, p. 24)

[4] Throughout the remaining historical section I focus on the Mamluk period (both before and after the Ottoman invasion) due to source constraints. For the similarity of the institutional framework in earlier (Islamic) periods see Lapidus (1975).

[5] See Al-Sayyid Marsot (1972, p. 156), Al-Sayyid Marsot (1973, pp. 133-134) and Lapidus (1984, p. 141). One estimate puts at 70,000-80,000 the number of men that the most influential ulama could mobilize (Al-Sayyid Marsot 1972, p. 151).

office can be considered the voice of the ulama and the articulate representatives of the civilian sector, the chief justices can" (Petry 1981, p. 231). Given this fact, throughout the remainder of the paper I refer to the head judge and the ulama interchangeably.

2 Nile Floods and the Political Power of the Head Judge

The previous discussion suggests that concessions from the military to the head judge were a function of the number of individuals the head judge could influence. This section provides historical evidence that deviant Nile floods increased this number which in turn led to an increase in the judge's political influence.

2.1 The Nile Flood

Agriculture in the Nile basin was historically heavily dependent on the annual Nile flood. A complex system of dikes and irrigation networks helped harness the flood's agricultural potential, making Egyptian agricultural yields some of the highest in the pre-modern world.[6]

The Nile's annual flood usually began in earnest in July and had crested (at the latest) in October. Once the Nile began to subside in October, peasants across the basin sowed a wide variety of crops including wheat, barley, broad beans, chick-peas and lentils. Although other crops were grown and harvested on some land throughout the year (with the aid of waterwheels and other irrigation devices), the Nile flood irrigated the vast majority of crops. These crops were harvested in April and May.

Ethiopian monsoon runoff determined the size of the annual Nile flood. Recent research has linked variation in this monsoon runoff to sunspots (Ruzmaikin et al. 2006), suggesting the Nile's summer flood level can be considered exogenous. I

[6] This section draws on Cooper (1976), Frantz-Murphy (1986), Tsugitaka (1997). See also Borsch (2005, pp. 34-39) for a detailed discussion.

maintain this exogeneity assumption throughout the paper.

When the Nile's summer flood significantly deviated above or below its optimal level (these deviant episodes are henceforth referred to as Nile failures) agricultural output sharply dropped the following harvest.[7] While some Nile failures caused little more than passing shortages, large Nile deviations induced full-blown famines. More severe famines led to widespread unrest and armageddon-like conditions. Death rates during these episodes could reach rates of over 500 people a day in Cairo (Maqrizi 1997 [1441], IV, p. 376).[8]

The severity of a Nile shock primarily depended on the extent to which the Nile deviated from its optimal level. The historical record is somewhat ambiguous regarding the frequency of shocks severe enough to cause crises. One scholar suggests that such shocks occurred once every 8 years between 949 and 1233 CE (Hassan 2007) while another suggests these occurred every 17 years between 1600 and 1800 CE (Raymond 1973, pp. 81-106). These differences in the frequency of Nile-induced crises may have been driven by long-term variation in Nile flood cycles, improvements in agricultural technology or by differences in the precision with which the historical sources recorded such events.

2.2 Nile Failure, Popular Support and the Political Power of the Head Judge

A slow or excessively rapid Nile rise during the summer months unsettled the population. Food prices rose as individuals hoarded grain in preparation for shortages in the following year. Consequently, although the agricultural effects of a one-shot Nile failure did not obtain until harvest the following year the "treatment effect" of Nile failure began before the physical absence of foodstuffs occurred. If the Nile failed,

[7] Here (and below) I focus on Nile droughts for expositional clarity. See Raymond (1973, p. 83); Sabra (2000, pp. 152-153) or Petry (1994, p. 105) for evidence that excessive Nile floods had similar effects.

[8] Estimates of Cairo's population range between 500,000 and 600,000 in the 14^{th} century (Raymond 2002, p. 136).

prices of wheat could double or even quadruple. The price increases began at the first sign of an abnormally slow (rapid) rise of the Nile during the summer month prior to the Nile's crest (below I assume, following historical evidence, that evidence of Nile flood failure began to be revealed in July).

Grain prices decreased the following year if the Nile flood was adequate, although grain prices generally remained elevated until the harvest was collected in April/May of the following year (Maqrizi 1994 [1405], p. 51). In other words, the most severe effects of a one-shot Nile failure on grain prices appear to have lasted roughly from July of the solar year of the Nile failure (denote this year by t) through June of the following solar year (t+1). Grain prices remained abnormally high, however, through April/May of the solar year t+2 (when the harvest irrigated with the flood in year t+1 was collected).

As prices rose following a Nile failure, thousands assembled in search of grain. These groups rioted, sacked stores and attacked government officials.[9] One historian has summed up these riots by noting that "when hungry, [the people] were ready to rise even against powerful rulers" (Shoshan 1993, p. 58). During periods of Nile-induced bread riots, demonstrations blaming the incumbent sultan for the Nile's failure particularly alarmed the ruling coalition. The sultan's coalition (recall that I use the sultan to denote the head of the military) appears to have been wary of rival military factions using these rioters to aid a revolt.[10]

In order to prevent such a coordinated uprising, the sultan worked to purchase popular support by distributing food and importing grain. If riots continued despite food distribution (which often occurred due to insufficient stockpiles and imperfect storage technology), the sultan and his coalition could use military force to suppress the rioters, although they generally appear to have preferred to enlist the support of the ulama in their efforts to calm the populace (Raymond 1974, p. 420).

[9] For peasant assemblies and grain riots see Sabra (2000, pp. 136, 142, 155) and Shoshan (1980). For attacks on government officials see Perho (2001, p. 112) and Maqrizi (1405, p. 29).

[10] See Maqrizi (1997 [1441], IV, p. 368) ; Shoshan (1993, p. 53) and Taghri Birdi (1976 [1468], V, p. 120; VI, p. 63). See Grossman and Medoza (2003) for a theoretical discussion of how economic downturns can lead to popular unrest and "appropriative competition".

During the summer months, the ulama organized mass rain prayers and other processions to plead for divine aid to cause the Nile to flood.[11] If the summer ended in Nile failure, widespread famine and epidemic disease outbreaks followed. During the year "treated" by Nile failure one finds references to exceptionally large groups of individuals attending mosque services, rain prayers and congregating around influential members of the ulama. The ulama –who generally supported the incumbent sultan– seem to have used their increased influence to calm the masses.[12]

It is important to stress that the exact mechanism through which Nile failures increased popular support for members of the ulama (and consequently allowed them to quell riots) is unclear. Some historical passages stress the importance of religious beliefs (i.e. peasants viewed deviant Nile floods as divine punishment for sinful behavior and followed the religious elites in an attempt to garner God's mercy). Others suggest the pragmatic fact that sustained popular coordination to extract concessions from the sultan was impossible without ulama leadership.[13]

Regardless of the mechanism, the historical record suggests that the ulama used Nile-induced increases in popular support to extract greater concessions from the sultan. One historian, for example, notes that during periods of Nile failure "the sultan would bow to 'ulama' [...] pressure and enforce decrees against [...] prostitu-

[11] For an example of a rain prayer see Taghri Birdi (1976 [1468], III , pp. 77-78). For its use in calming bread riots see Taghri Birdi (1990 [1468], p. 234). For an example of a procession see Shoshan (1993, p. 62).

[12] For an example of abnormally large mosque attendance see Taghri Birdi (1976 [1468], p. 233). For public readings of Bukhari (a famous religious text) to calm the suffering populace after the Nile had failed see Maqrizi (1997 [1441], IV, p. 366). For large crowds congregating around the head judge see Maqrizi (1997 [1441], VI, p. 100).

[13] For studies linking economic shocks to increases in religious intensity see McCann (1999) or Chen (2010). Among a large literature stressing the coordinating importance of religious authorities in the Islamic world see Lewis (1953) or al-Sayyid Marsot (1973). For an example of a judge aiding coordination across city quarters see Lapidus (1984, p. 166). For coordination in the Friday sermon and at mosques and educational centers see Al-Sayyid Marsot (1972, p. 153; 1973, p. 133) and Raymond (1974, p. 432). For the coordinating effects of *fatwas* (legal opinions) see Maqrizi (1441, VI, pp. 12, 227); Taghri Birdi (1468, I, pp. 88-91), Lapidus (1984, pp. 152-153) and Tyan (1960, pp. 116, 424).

tion, hashish eating, beer drinking, the wearing of immodest or over-luxurious dress [or] Christian and Jewish functionaries lording it over Muslims" (Irwin 1986, p. 50). The fact that these measures were more likely to be enforced during periods of Nile failure suggest that religious elites had greater bargaining power during such periods.

The primary sources also indicate that religious leaders were better able to extract monetary concessions and other perquisites from the military during deviant Nile episodes.[14] Religious authorities passed some of these concessions on to the populace, routinely calling for "the lifting of unjust taxes and reimbursement of those taxed" (Jabarti 1994 [1822], III, p. 403) in exchange for their continued support during Nile failures.

2.3 Conceptual Framework

The historical evidence suggests that deviant Nile floods increased popular support for the head judge. The intuition for how an increase in popular support can lead to an increase in the political influence of the head judge (which, recall, I equate with increased monetary transfers to the judiciary) is straightforward. An increase in popular support for the head judge means that the threat of popular revolt becomes more dangerous to the incumbent sultan (higher probability of success). Consequently, the incumbent sultan has to transfer greater resources to the head judge (who might pass some of these on to the populace) in order to prevent him from sanctioning a revolt.[15]

In the empirical section I use the judge dismissal probability as a proxy for these

[14] For examples of increased monetary payments to the ulama following a Nile failure see Maqrizi (1997 [1441], IV, p. 269) and Taghri Birdi (1976 [1468], p. 233). For an example of increased perquisites see the effect of Nile failure on the ability of the ulama to ride horses in Taghri Birdi (1990 [1468], pp. 220, 238).

[15] The assumption of a static framework will not alter these qualitative implications as long as the judge cannot (or will not) change the existing institutional structure. Since there are only isolated and short-lived examples of religious authorities establishing their own political entities I ignore this possibility. See Acemoglu et al. (2010) for a related theoretical framework and the conclusion for a brief discussion.

increased monetary transfers. To understand the relationship between the two, denote the monetary transfers from the sultan to the judge by $Y(\sigma(Nile), Nile)$ where $\sigma(Nile)$ denotes popular support and $Nile$ is an index measuring the Nile's deviation from its optimal level. Write the judge's outside option (if he doesn't sanction a revolt) as $\theta(Nile)$. The judge will be dismissed (or quit) if $\mathbf{1}(Y(\sigma) < \theta)$ where $\mathbf{1}$ denotes the indicator function equal to one if the argument in parentheses is true and I assume that if indifferent the judge remains in power.

I allow for heterogeneity in σ and θ across judges. For each level of Nile flood the probability of dismissal is given by $\Pr(Y(\sigma, Nile) < \theta)$. As long as the Nile-induced changes in the levels of the judge's outside option and his σ-held-constant monetary offer from the sultan are roughly equal (which seems a plausible assumption), increases in the Nile's deviation should decrease the probability of judge dismissal by increasing Y (through σ) relative to θ.

3 The Data

3.1 Head Judge Changes

Ibn Hajar (1998 [1449]) provides the month and year of head judge changes. These data are given by hijri months and years. Hijri years are lunar years consisting of 354 days (355 days in a lunar leap year) and have twelve months which alternate between 29 and 30 days. The first day of the first hijri year corresponds to the solar date July 16^{th} 622 CE (solar year is henceforth used to denote CE years), the day the Prophet Muhammad made his *Hijra* or migration from Mecca to Medina. Since the lunar year or AH year (henceforth both notations are used to denote hijri years) is approximately 11 days shorter than the solar year, the first day of the lunar year slowly "cycles backwards" through the solar year.

The relationship between lunar and solar years can been seen in figure one. The brackets denote the solar years 1000-1015 CE. The vertical lines denote the first day of each lunar year. The solar date corresponding to the start of each lunar year is given above the highest horizontal line. Lunar years run from vertical line to vertical line and are numbered in the row marked lunar year. Inspection of figure one shows that the vertical lines occur earlier in the solar year as time goes on. This is a graphical representation of the backwards cycling of the lunar year through the solar year. Consequently, the lunar months have no calendar regularity. This has important implications for the correct assignment of the Nile flood data as discussed below.

Although Ibn Hajar's data are thought to be generally reliable (Escovitz 1984, p. 5), information regarding how a head judge left power is not available for the majority of the head judges. For expositional ease I refer to these changes as dismissals throughout the text regardless of whether the judge died in office, was dismissed or quit. In practice, the missing information on how a judge was released does not threaten the empirical strategy below since I assume that the Nile flood level is exogenous.[16]

Of the 245 judge changes reported by Ibn Hajar on the interval [20, 10^{th} month of 842 AH] the year of dismissal was available (or could be imputed) for 239 changes (98%) and the year and month of dismissal was available for 209 changes (85%).

Missing dismissal dates were imputed as follows. Ibn Hajar (1998 [1449], pp. 4-21) provides a poem that lists Egypt's judges in chronological order.[17] When a judge's dismissal date was missing, I replaced this missing date with the appointment date of the judge that chronologically followed him in the poem. When the appointment month/year of the following judge was also missing, the dismissal month/year was left blank. Judge changes missing the month but containing the year of change were assigned the month 6.

When there was more than one head judge after 1265 CE I included the dismissal

[16]One might worry that deviant Nile floods increased the probability of a judge dying in office. Since in practice I find a negative relationship between deviant Nile floods and head judge dismissal such an effect would bias the results towards zero. In addition, it should be noted that the historical record contains many example both of the head judge constraining the sultan's behavior (e.g. Ibn Hajar 1998 [1449], pp. 68, 240) and attempting to constrain the sultan and being dismissed or quitting when the sultan refused to comply (e.g. Ibn Hajar 1998 [1449], pp. 231, 392).

[17]A spreadsheet documenting the construction of this data set is available upon request.

date of the Shafii judge in the main series (the Shafii school was the most influential in Egypt during the Mamluk era).[18] After 1265 CE I created 3 additional series for the head judges of the three other law schools in an identical manner to those for the Shafii school.

Since the head judge data do not completely cover the hijri year 842, I discard it from the sample. The data set consequently contains 239 judge dismissals on the interval [20,841 AH].

3.2 Assigning Lunar Months to Solar Months

Although the head judge change data is given by lunar months and years, Nile floods followed the solar calendar (see section 2.1 for a discussion of the Nile's seasonal flood pattern). To correctly assign each Nile flood to lunar months it treated I developed a mapping from lunar months/years to solar months/years using the tables provided in Freeman-Grenville (1995).[19] Their conversion tables assume that the 12 months of the lunar year alternate between 30 and 29 days. In addition, they give lunar leap years on pages 18-72.

To create the mapping between the lunar and solar months I first calculated the percentage of each lunar month occupied by a given solar month. I then assigned a lunar month to a solar month if the solar month occupied 50% or more (15 days or more) of the lunar month. When the lunar month was evenly divided between two solar months I used the earlier of the two solar months. Since the solar year is longer than the lunar year, sometimes 2 different lunar months are assigned to one solar month (that is, one solar month occupied 50% or more of two lunar months).

[18] There was also more than one head judge briefly under the Fatimids. During the Fatimid period I included the Ismaili (Shia) head judge since the head judges were generally Ismaili under the Fatimids.

[19] I use the Julian Calendar as a proxy for the solar (tropical) calendar for simplicity, while recognizing that this calendar slowly diverged from the solar calendar. By 1582 this calendar had diverged from the tropical calendar by 10 days.

3.3 Nile Flood Data

In the empirical section, I use the maximum Nile flood level each year to construct a metric of Nile-induced economic shocks. Egyptian political leaders were interested in gathering this maximum level and other flood statistics to both estimate agricultural tax receipts (Cooper 1976) and forecast future flood levels (Petry 1994, p. 105). To this end, they constructed Nilometers.

The Nilometer on the island of Rauda (Cairo) was among Egypt's most elaborate.[20] This Nilometer was staffed by a guardian who provided daily measurements to government officials. Although the guardian's original records are lost, two historians in the 15^{th} century compiled copies of the Nile's historical minimum and maximum levels.

The historians Ibn al-Hijazi and Taghri Birdi provide two separate sets of Nile flood data. Hijazi's (1470) statistics cover the interval [1,873] AH, whereas Taghri Birdi's statistics span the years [20,855] AH.[21] Both data sets appear to be copies of the original records kept by the guardian of the Nilometer on the island of Rauda. The authors give the yearly maximum and minimum level of the Nile flood by lunar year.

Scholars agree that these data provide credible estimates of the true Nile flood levels and Hijazi's data have been extensively used in the climatology literature. The data, however, contain two sources of measurement error. First, both data sets have transcription errors. I show in the appendix that this source of error attenuates the coefficients of interest under plausible assumptions. Second, both authors assigned the yearly Nile flood maxima and minima to lunar years. The assignment of the flood levels by lunar year introduces an additional source of measurement error if left uncorrected.

Figure one highlights the problems introduced by the assignment of Nile floods to lunar years. To better understand these problems, consider the flood that occurred in the year 1008 CE. Hijazi recorded this flood level as having occurred in the year

[20] This section draws on Popper (1951).

[21] Taghri Birdi's data are drawn from Sami (1916, introduction, pp. 4-9).

398 AH (the solar year flood recorded by Hijazi in each lunar year is given in the final row of figure one). The year 398 AH spanned the interval [17, September 1007; 4, September 1008]. Recall, however, that information regarding the maximum Nile flood level began to be revealed in July (see section 2.1). Consequently, if I assigned the flood recorded by Hijazi in 398 AH to that lunar year, only the lunar dates corresponding to the solar interval [1, July 1008; 4, September 1008] would be correctly assigned. I would spuriously assign to the remainder of dates in the lunar year 398 the flood that occurred in 1008 CE when in reality these dates were treated by the Nile flood that occurred in 1007 CE.

To further complicate matters, neither Hijazi nor Taghri Birdi appear to have necessarily recorded Nile floods in the lunar year in which the maximum flood level occurred. Hijazi seems to have assigned solar year floods to lunar years by convention. The mapping between the flood levels recorded by lunar years and the CE year in which the flood actually occurred is given in Toussoun (1925).

Although there is enough information to construct such a mapping for Hijazi's data, it is not possible to determine which solar year flood Taghri Birdi recorded in each lunar year.[22] For this reason I use Hijazi's data throughout the remainder of the paper. I show in the appendix, however, that merging Taghri Birdi's flood data by lunar year yields qualitatively similar results (when the lagged flood value is used).

Equipped with Hijazi's flood data assigned to CE years, I merged it to the head judge data set as follows. I defined a Nile year to run from July through June of the solar year (since these were approximately the dates treated by each Nile flood level). I then assigned the Nile flood from CE year t to the lunar months in the interval [July, t; June, t+1]. Taghri Birdi's flood data was merged by lunar years without correction.

For most of the empirical section, I use the Nile year as the unit of observation.

[22]The mapping from lunar to solar years is made possible in Hijazi's data by the fact that he skips every 34 lunar year. Taghri Birdi's data does not following such a pattern, making the exact mapping between lunar and solar years unclear. See Popper (1951, pp. 123-149) for a detailed discussion.

Collapsing the monthly data down to the Nile year level was straightforward. Note that for Taghri Birdi's data, the flood level assigned to each Nile year in regressions at the Nile year level is the weighted average of the flood level recorded in the lunar years contained in that Nile year. The appendix provides details regarding the number of observations at the yearly and monthly levels.

The original data are given in cubits and fingers. I used the mapping provided by Popper (1951, pp. 104-105, table 1) to convert cubits and fingers to meters above sea-level.

Figure two presents the recorded yearly Nile flood maximums and minimums as reported by Hijazi (upper graph) and Taghri Birdi (lower graph). The inferior horizontal axis marks lunar years, and the superior horizontal axis gives the corresponding CE year (the ticked solar years were assigned using the solar year corresponding to the start of the lunar year). The left hand vertical axis details the flood level in meters above sea level and the right hand vertical axis measures the flood level in cubits and fingers. On the right hand axis only the level of 16 cubits ("plenitude") is ticked. This level was originally (after the Muslim conquest) considered the optimal flood level.

Examination of figure two reveals that the Nile flood level slowly trended upwards over time. Sediment accumulation slowly caused both the rise of the Nile bed and the surrounding land (Popper 1951, pp. 241-247; Borsch 2000). For this reason, throughout the empirical section I consider the "real" Nile flood deviation by examining its deviation from a time trend.[23]

4 Nile Floods and Judge Dismissal

I begin by examining the relationship between head judge dismissal and Nile flood deviations (recall that for the remainder of the main text I use Hijazi's data as explained above) using the Nile year as the unit of observation. Figure three provides the non-parametric estimate of the relationship between head judge dismissal and

[23] I show in the data appendix that the results are robust to alternative residual calculations.

the deviation of the Nile floods from a linear trend. Vertical lines mark the upper and lower cutoffs defining the top 10% of Nile flood deviations. The negative relationship is striking and suggests that Nile flood deviations affected the probability of judge dismissal.

To investigate this relationship formally, I create a dummy variable $Famine_t$ equal to one if the Nile flood residual from a linear trend is in the upper 5% or lower 5% of the flood distribution.[24] Although under plausible assumptions a continuous metric –such as the square of the flood residuals– has the advantage of yielding consistent results when instrumenting for one series with the other, in practice these results are less robust and powerful than the "extreme value" specification used throughout the paper (although such results are often significant at conventional levels). Moreover, the "extreme value" specification used closely corresponds with historical and empirical evidence that only deviant Nile floods significantly empowered the head judge (i.e. the true functional relationship is closer to a step function than a parabola).

The baseline regression is the linear probability model of the form:

$$Judge_{td} = \alpha_d + \beta Famine_{td} + \varepsilon_{td} \tag{1}$$

where t indexes Nile years and α_d denote decade dummies.[25] The variable $Judge_{td}$ is a scaled dummy variable (to facilitate presentation) equal to one hundred if the head judge at the start of Nile year t is dismissed on the interval (t,t+1). This type of specification is closely related to duration models and particularly suits the empirical setting (see Lancaster 1990, pp. 10-13).

OLS estimates of (1) are reported in table one. The first panel uses the Nile maximum to calculate the dummy variable $Famine_{td}$. In this panel, the first column omits covariates whereas the second column includes decade dummy variables. In

[24] The 10% cutoff was chosen using the historical evidence that deviant Nile floods occurred approximately every 8 years for a subset of the period covered by the data. As I show in the appendix, alternative cutoffs yield similar results.

[25] Probit or logit specifications yield qualitatively similar results throughout the paper and are consequently omitted.

both specifications, the estimated relationship is negative and statistically significant. Newey-West standard errors with 7 lags are reported in parentheses. Results in table two add two leads and lags to equation (1) and show that the effect of deviant Nile floods on judge dismissal is concentrated in the "impact" year.

Columns (3) and (4) of table one report the result using the disaggregated data at the lunar month level. Here the dependent variable is equal to one hundred if the incumbent judge at the start of lunar month h is dismissed on the interval (h,h+1). The third column again omits covariates while the fourth column includes solar year and month dummies. The point estimates are again statistically significant (Newey-West standard errors with 17 lags are reported in parentheses).

In the second panel, I use the Nile minimum to construct a placebo $Famine_{td}$. Rainfall in the Nile's equatorial catchment area (which includes Western Kenya, Uganda, Rwanda, Burundi, the Central African Republic, the Republic of Congo and the Democratic Republic of Congo) determined this minimum (as opposed to the Ethiopian monsoon runoff which determined the maximum). The Nile's yearly minimum and maximum levels were imperfectly correlated and often did not move in sync (Hassan 2007).

These data allow me to construct the placebo $Famine_{td}$ equal to one if the Nile flood minimum was in the top 5% or lower 5% of the minimum flood distribution. Since the Nile flood maximum determined agricultural productivity whereas the Nile minimum had no effect on this productivity, I expect the Nile flood minimum to not be related to head judge dismissals. Results in panel two of table one are consistent with this prediction and show that the Nile flood minimum was not related to head judge dismissals.[26]

The estimated magnitudes of the relationship between deviant Nile floods and head judge dismissal are both statistically significant and economically meaningful. The smaller (in absolute value) point estimates in columns one and three suggest that deviant Nile floods decreased the yearly probability of dismissal by approximately 9

[26] The drop in the number of observations is due to missing data in Hijazi's Nile minimum series. Limiting both series to years in which both the Nile maximum and minimum are given by Hijazi yields similar results.

percentage points and the monthly probability of dismissal by roughly one percentage point (or using the binomial approximation by approximately 12 percentage points over a lunar year). Since the monthly probability of judge dismissal is 2.2 percentage points and the yearly probability is 21 percentage points this suggests that deviant Nile floods reduced the probability of judge dismissal by roughly one-half.

5 Judge Dismissal, Popular Support and Political Influence

Although the results in the previous section demonstrate a negative relationship between deviant Nile floods and head judge dismissal, the causal path generating this result remains unclear. The historical evidence presented in the second section suggests a causal path that can be summarized schematically as follows: deviant Nile$\rightarrow\uparrow$popular support$\rightarrow\uparrow$political influence$\rightarrow\downarrow$probability of dismissal. Alternative causal paths, however, are consistent with the observed reduced form relationship.

This section addresses such concerns by using historical variation in the maximum number of individuals a head judge could influence. I use three sources of variation in popular adherence to the head judge's "denomination" (school of law). First, I observe that during the Fatimid dynasty (969-1169 CE) both the ruling dynasty and the head judge were Shia (with a few isolated exceptions) whereas the overwhelming majority of Egypt's Muslim population was Sunni. Second, I note that the Egyptian population slowly converted to Islam, giving the head judge an increasingly large "constituency." Third, I use the fact that after 1265 CE the military appointed four head judges. These four head judges represented the four main Sunni law schools (Shafii, Maliki, Hanafi and Hanbali), each of which had different levels of adherence among Egyptian Muslims.

The reasoning behind the empirical strategy using these sources of variation can be understood as follows. Recall that the proposed causal path can be written as deviant Nile$\rightarrow\uparrow$popular support$\rightarrow\downarrow$probability of dismissal. Suppose the extreme case in which no one in the populace shares the head judge's religious affiliation.

Then I would not expect deviant Nile floods to have an effect on judge dismissal since during periods of Nile famines the populace would presumably rally behind other (possibly religious) leaders. Similarly, if different head judges have different "stocks" of potential adherents I expect the head judge with the larger stock to experience a larger decrease in the probability of dismissal than judges with smaller stocks.[27]

Table three presents results using these three sources of variation. The first column presents a regression identical to (1) adding the interaction term $Famine_t * Shia_t$, where the variable $Shia_t$ is equal to one if the head judge was Shia. Column (2) includes the term $Famine_t * PercentMuslim_t$ where $PercentMuslim_t$ is the percentage of the population that is Muslim in each year as given in Bulliet (1979). The F-statistic and corresponding p-value testing the hypothesis that both interaction terms are zero is given in the row labeled F-Stat.

Results in column (2) are consistent with the proposed causal path and suggest that deviant Nile floods increased judge dismissal when the head judge was Shia. For all other head judges (who were Sunni like the overwhelming majority of Egypt's Muslim population), the results suggest that the effect of Nile failures on judge dismissal became increasingly negative as the population converted to Islam.

Column (3) limits the sample to after 1265 CE, and reports results running regression (1) for the Shafii, Maliki, Hanafi and Hanbali head judges using a seemingly unrelated regression framework. Although statistics of the distribution of Egypt's Muslims across the four law schools during this period do not exist, there is broad scholarly agreement that the Egyptian population was "mainly Shāfi'ī" (Nielsen 1984, p. 172) during the period covered by the data after 1265 CE. This popular influence meant that the Shafii head judge was the "highest ranking" of the four head judges (Escovitz 1984, p. 25) and led one medieval observer to note that any sultan who did not adhere to the Shafii law school was "quickly ousted or killed" (cited in Jackson 1996, p. 33). Escovitz (1984, p. 25-27) suggests that after the Shafii judge the Maliki judge was the most influential, followed by the Hanafi and the Hanbali judges.

[27]Here I implicitly assume that the percentage of the head judge's potential stock of popular support that actively supports him during "normal" times is constant across time and law school.

The coefficient for the Shafii head judge is given in the row marked $Famine_t$ in column (3) of table three. Those for the Maliki, Hanafi and Hanbali head judges are provided in the fourth, fifth and sixth rows. The F-statistic testing the equality of the coefficients with its corresponding p-value is again given in the row labeled F-Stat. Results show that Nile failures were associated with statistically significant decreases in the probability of dismissal of the Shafii and Maliki head judges (who seem to have been those who had the greatest popular influence). The data reject the null-hypothesis that Nile-induced famines had similar effects on the probability of dismissal of all the head judges.

When taken in unison, these results cast doubt on alternative explanations for the results. One alternative explanation is that the sultan was more superstitious during famines and this increased superstition made him less likely to dismiss the head judge. The results render this explanation implausible since the head of the military was always Muslim yet the effect of Nile failures on judge dismissal increases as the percent of the population that was Muslim increases. Additionally, the head judge and the military were both Shia under the Fatimids, yet the negative relationship between Nile famines and judge dismissal does not hold.

Results also render unlikely the scenario in which the results are simply a reflection of a decrease in the probability of dismissal of all government staff during deviant Nile floods. If this were the case, the effect of Nile failures on judge dismissal should not vary based on the judge's law school. Results in column (3) of table three are not consistent with this scenario.

6 Conclusion

A distinguished line of scholars have stressed that religious leaders can derive political influence from their control over popular support. Results in this paper are consistent with such scholarship. Deviant Nile floods decreased the dismissal probability of Egypt's highest ranking religious authority by roughly one-half. Historical evidence suggests that this result is indicative of increased political power stemming from an increase in popular support for the religious authority.

To better understand the extent to which the statistical relationship reflects this historical narrative I used three sources of variation in the head judge's popular support. Results using these sources of variation cast doubt on alternative explanations for the decrease in the dismissal probability.

While data limitations do not allow an investigation of the mechanism leading from deviant Nile floods to increased popular support for the religious authorities, the evidence does suggest (in a reduced-form manner) that Nile-induced economic downturns helped temporarily solve the collective action problem. Acemoglu and Robinson (2000a, 2001, 2006) have argued that such periods can provide a democratic "window of opportunity."

Egypt did not democratize during periods of famine. Religious leaders instead appear to have used Nile-induced increases in popular support to extract increased concessions for both themselves and the populace. This result is consistent with historical evidence that religious leaders protected their positions by discouraging "revolutionary developments" (Lapidus 1984, p. 153) and suggests that future research investigating the political role of religious leaders (perhaps as rent-extracting elites as in Acemoglu and Robinson (2000b, 2008)) may shed light on institutional outcomes in many areas of the world.

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7 Appendix

7.1 Bias Introduced by Measurement Error

Without loss of generality consider the regression at the Nile year level without covariates:

$$Judge_t = \beta_0 + \beta_1 Famine_t^* + \varepsilon_t$$

where $Judge_t$ is a dummy variable equal to one if the incumbent judge at time t is dismissed on the interval (t,t+1) and $Famine_t^*$ is a dummy variable equal to one if the correctly measured Nile flood is in the top 5% or the lower 5% of the flood distribution. I assume that all necessary moments exist.

I observe $DevNile_t = DevNile_t^* + \nu_t$ and $Famine_t = \mathbf{1}(DevNile_t \leq c_5) + \mathbf{1}(DevNile_t \geq c_{95})$ where c_5 is the lower 5% cutoff of the observed Nile flood distribution and c_{95} denotes the cutoff for the upper 5% of this distribution. Assuming that $E[\varepsilon_t|Famine_t] = E[\varepsilon_t]$ (a sufficient condition for this is the joint independence of $DevNile_t^*, \nu_t$ and ε_t) standard arguments imply that the coefficient $\hat{\beta}_1$ converges in probability to $\beta_1[\Pr(Famine_t^* = 1|Famine_t = 1) - \Pr(Famine_t^* = 1|Famine_t = 0)]$. Using Bayes' rule this can be written as $\beta_1[\frac{10}{9}\Pr(Famine_t = 1|Famine_t^* = 1) - \frac{1}{9}]$. Consequently, $\hat{\beta}_1$ will converge to an attenuated constant that has the same sign as β_1 as long as $\Pr(Famine_t = 1|Famine_t^* = 1) \geq 0.10$.

7.2 Number of Observations

I used the intersection of all three data sets (judge changes and the two Nile flood data sets) which span the interval [20, 841 AH]. Since the year 841 AH ended on June 23, 1438 CE, the data set contains 797 Nile years [641,1437]. In other words, the data cover the interval [July, 641; June, 1438 CE].

When regressions are run at the lunar level there are 9857 observations. This number can be understood as follows. If I ran the regressions at the solar month level I would have 797*12=9564 observations. There are 293 solar years containing 13 lunar months and the total number of monthly observations at the lunar month level is 9564+293=9857.

7.3 Robustness Checks, Measurement Error and Placebo

Table four presents estimates of equation (1) including decades dummies and the interaction term $Famine_t * Shia_t$ (and are thus comparable to those reported in column (1) of table three). The first panel of table four varies the famine cutoff used in equation (1). The first row uses the top 5% of flood deviations and the second row uses the top 10% of flood deviations calculated using dynasty-specific cutoffs. Although statistical significance varies by cutoff, results are significant at conventional levels. The second panel details the results using residuals calculated from an AR(10) and a moving average with 10 lags.[28] These results show that the negative relationship between Nile famines and judge dismissal is robust to the way in which the Nile residuals are calculated.

Panel three provides the results using Taghri Birdi's data to calculate the variable $Famine_t$. Recall that Taghri Birdi's data cannot be correctly assigned to solar years. The results in panel three, however, show that Taghri Birdi's lagged data produces statistically significant results, whereas the placebo calculated using the minimum level is statistically insignificant.[29]

[28] Lag length for the autoregression was chosen using the Schwarz criteria with maximum lag length set to 20.

[29] The coefficient on the "contemporaneous" flood (assigned by lunar years) is statistically insignificant.

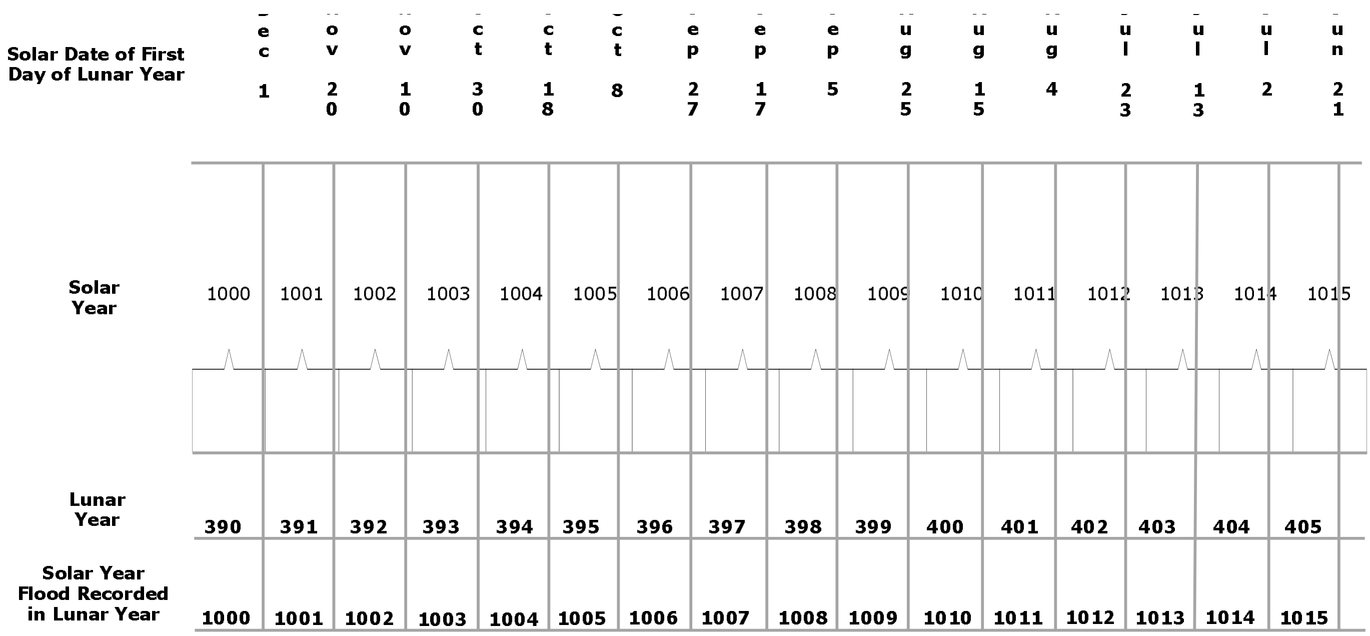

Figure 1: **Lunar and Solar Years**

Brackets denote solar years. Vertical lines mark the first day of the lunar year denoted to the right. The solar year of the Nile flood Hijazi assigned to each lunar year is provided in the final row.

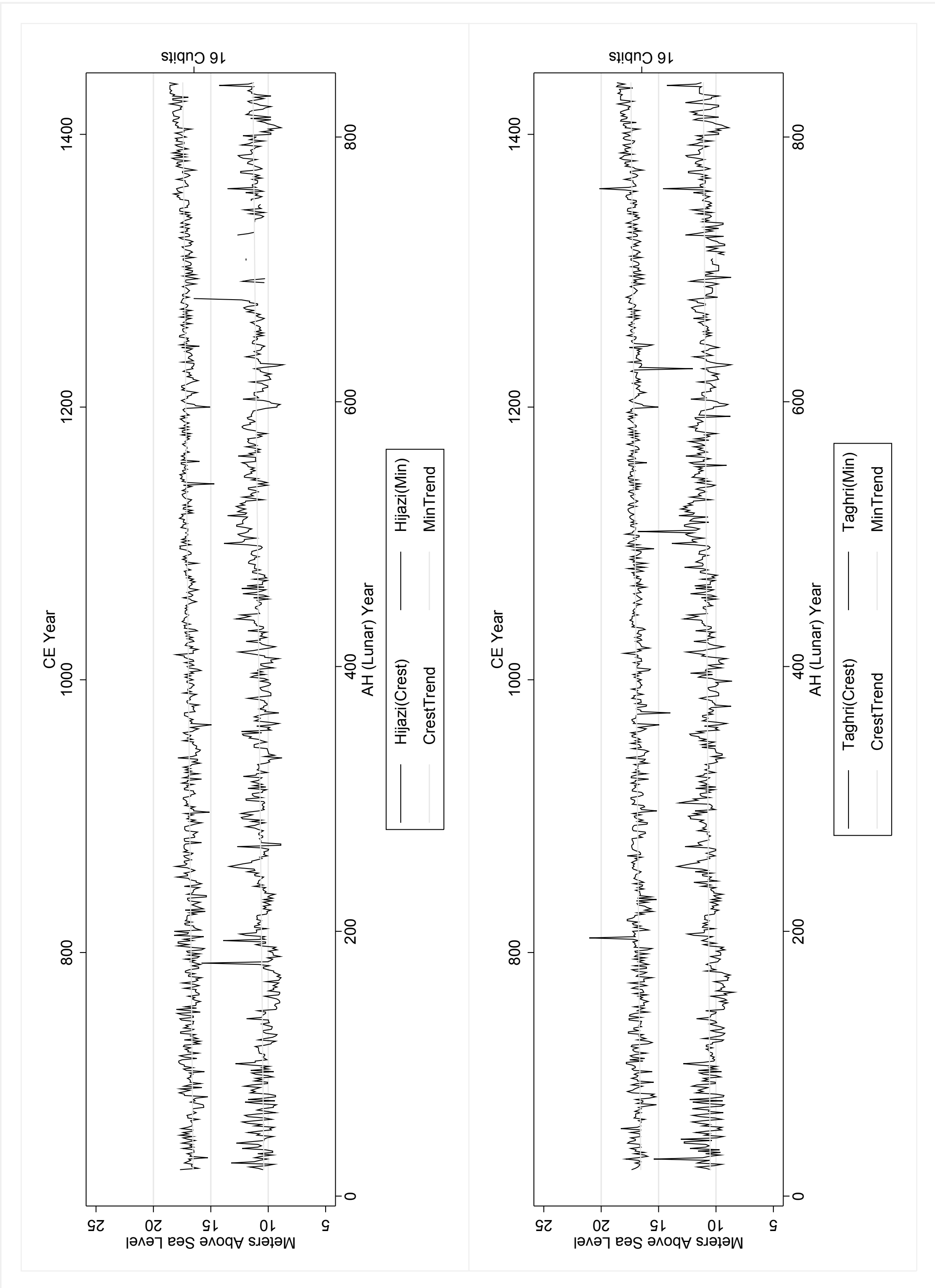

Figure 2: **Maximum and Minimum Nile Flood Levels**
Sixteen Cubits (16.47 meters) marks “Plenitude”

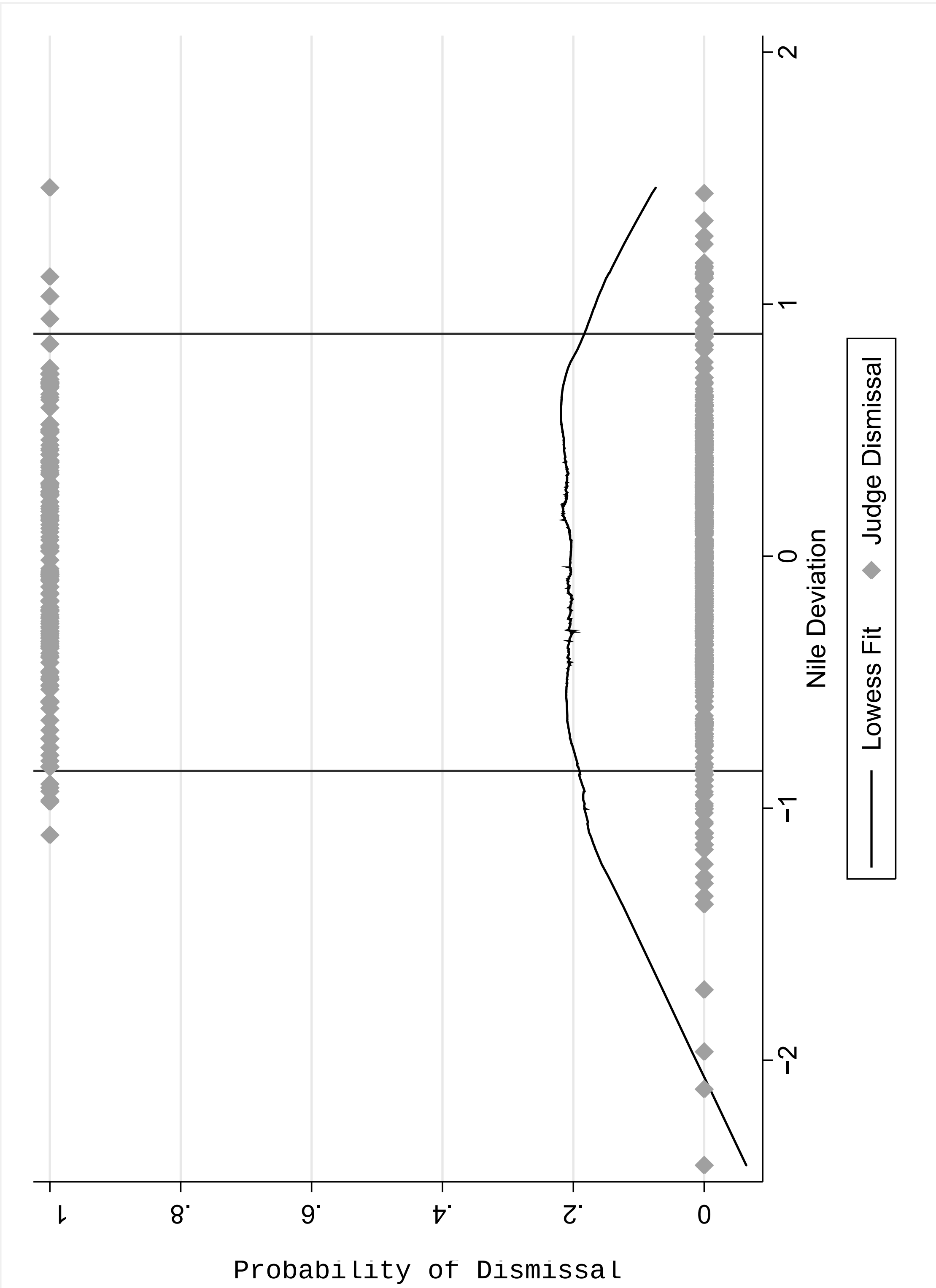

Figure 3: **Nile Variation and Probability of Dismissal**
Graph details (raw) non-parametric relationship between changes in the judgeship and the Nile maximum's deviation from a linear trend as reported by Hijazi. Vertical lines mark the top 5% and lower 5% of the maximum flood distribution.

Table 1: **Flood Deviations and Judge Dismissal**

	=100 if judge at t was dismissed on (t,t+1)			
	Nile Flood Year		Lunar Month	
	(1)	**(2)**	**(3)**	**(4)**
Panel 1: Nile Max.				
$Famine_{NileYear}$	-9.12**	-15.50***	-1.13***	-1.71**
	(4.34)	(5.75)	(0.42)	(0.70)
N	797	797	9857	9857
Panel 2: Placebo (Nile Min.)				
$Famine_{NileYear}$	5.69	6.63	0.41	0.45
	(5.29)	(5.41)	(0.55)	(0.76)
N	750	750	9275	9275
Decade Dummies?	No	Yes	No	No
Solar Year Dummies?	No	No	No	Yes
Solar Month Dummies?	No	No	No	Yes

Notes: estimates of equation (1) reported in panel 1. The dependent variable is 100* a dummy variable equal to one if the incumbent judge at time t was dismissed on the interval (t,t+1). t is measured by Nile flood years ([July,June] of the solar calendar) in columns (1) and (2) and by lunar month in columns (3) and (4). $Famine_{NileYear}$ is a dummy variable equal to one if the Nile flood was in the upper 5% or lower 5% of the flood distribution. Panel 2 constructs the variable $Famine_{NileYear}$ using the minimum Nile level. This variable is equal to one if the minimum level was in the upper 5% or lower 5% of the minimum flood distribution. Coefficients are reported with Newey-West standard errors with 7 lags (Nile year) and 17 lags (lunar month) in parentheses in panel 1. Robust standard errors are presented in panel 2 due to gaps in the minimum flood data. ***,**and *indicate significance at the 1%, 5% and 10% levels.

Table 2: **Timing of the Effect**

	(1)	**(2)**
$Famine_{t+2}$	4.16	-2.16
	(4.74)	(5.01)
$Famine_{t+1}$	1.67	-4.20
	(4.74)	(5.50)
$Famine_{t}$	-9.86**	-14.83**
	(4.52)	(6.10)
$Famine_{t-1}$	5.28	1.76
	(5.11)	(5.33)
$Famine_{t-2}$	2.92	0.66
	(4.74)	(5.65)
Decade Dummies?	No	Yes
N	793	793

Notes: The dependent variable is 100* a dummy variable equal to one if the incumbent judge at the start of Nile year t was dismissed on the interval (t,t+1). $Famine_t$ is a dummy variable equal to one if the Nile flood was in the upper 5% or lower 5% of the flood distribution. Coefficients are reported with Newey-West standard errors with 7 lags in parentheses. ***,**and *indicate significance at the 1%, 5% and 10% levels.

Table 3: **Popular Support and Judge Dismissal**

	=100 if incumbent judge was dismissed on (t,t+1)		
	(1)	**(2)**	**(3)**
$Famine_t$	-18.14***	-0.04	-21.97***
	(6.19)	(10.68)	(6.08)
$Famine_t * Shia_t$	20.91	37.90**	
	(14.50)	(15.13)	
$Famine_t * PercentMuslim_t$		-37.43***	
		(14.25)	
$MalikiFamine_t$			-15.79***
			(2.97)
$HanafiFamine_t$			8.55
			(10.17)
$HanbaliFamine_t$			-3.55
			(5.39)
$F - Stat$		5.19***	2.69**
$[p - value]$		[0.01]	[0.04]
Decade Dummies?	Yes	Yes	Yes
Sample	All	All	Post 1265
N	797	797	172
Estimation	OLS	OLS	SUR

Notes: The dependent variable is 100* a dummy variable equal to one if the incumbent judge at the start of the Nile year t was dismissed on the interval (t,t+1). $Shia_t$ is a dummy variable equal to one if the head judge was Shia. $PercentMuslim_t$ is the percent of the Egyptian population in year t that was Muslim (taken from Bulliet 1979). Results in column (3) are from a seemingly unrelated regression estimation of equation (1) run separately for judges of the four Sunni law schools. The coefficient for the Shafii head judge is reported in the row labeled $Famine_t$. The entries in the row $F - Stat$ provide the test statistic and p-value testing the hypothesis that both interaction terms are equal to zero in column (2) and testing the hypothesis that the four head judge coefficients are equal in (3). Coefficients are reported with Newey-West standard errors with 7 lags in parentheses in columns (1) and (2) and SUR-robust standard errors in column (3). ***,**and *indicate significance at the 1%, 5% and 10% levels.

Table 4: **Robustness Checks**

	Coef.	**SE**	**N**
Panel 1: Cutoff			
Top 5%	-19.83***	4.37	797
Top 10%, Dynasty	-10.53*	5.94	797
Panel 2: Alternative Residuals			
$AR(10)$	-11.68**	5.41	787
$MA(10)$	-8.68*	4.96	796
Panel 3: Taghri Birdi			
Top 10% (lag)	-13.03***	4.90	796
Top 10% (lag, min.)	-1.00	5.21	794

Notes: estimates of equation (1) reported including decade dummies and the interaction term $Famine_t * Shia_t$ in all specifications (and are thus comparable to those reported in column (1) of table three). The dependent variable is 100* a dummy variable equal to one if the incumbent judge at the start of the Nile year t was dismissed on the interval (t,t+1). The first panel varies the cutoff for $Famine_t$ using the top 5% of Nile flood deviations in the first row and the top 10% of Nile floods calculated using dynasty-specific cutoffs in the second. The second panel calculates residuals using an autoregression with 10 lags and a moving average with 10 lags. The third panel uses Taghri Birdi's (uncorrected) data to calculate the variable $Famine_t$ using both the maximum (first entry) and the minimum. Coefficients are reported with Newey-West standard errors with 7 lags in parentheses with the exception of those in the second row of panel 3 where robust standard errors are reported due to gaps in the data. ***,**and *indicate significance at the 1%, 5% and 10% levels.