

Revolt on the Nile: Economic Shocks, Religion and Institutional Change

Eric Chaney*

September 11, 2010

Abstract

This paper uses over 700 years of Nile flood data to investigate the effect of economic shocks on political outcomes in pre-Modern Islamic Egypt. Results show that while deviant Nile floods increased political instability, these shocks decreased the likelihood of a change in the highest ranking religious post. Additional empirical evidence and the historical record suggest this latter result is indicative of an increase in the political power of the religious elites. This increase appears to have stemmed, in turn, from the combination of an increase in the number of potential rioters during economic downturns and the control of religious elites over popular coordination networks. The paper concludes that the results are consistent with theories that stress the importance of this control in determining the institutional evolution of Islamic Egypt.

*Harvard University. A previous version of this paper was circulated under the title “Sultans, the Shari’a and Seven Empty Ears: Economic Catastrophes, Church and State.” I thank CREI for hosting me while part of this project was carried out and William Caferro, Mahmoud al-Gamal, Claudia Goldin, Rick Hornbeck, Murat Igiyun, Cemal Kafadar, Asim Khwaja, Timur Kuran, Rachel McCleary, Carl Petry, James A. Robinson, Andrei Shleifer, James Stock, Joachim Voth and participants in various seminars for helpful conversations and suggestions. Alexander Ruzmaikin graciously shared the Nile data used in previous studies. The library staff at the Bibliothèque Nationale de France, Manuscrits Orientaux greatly facilitated the Nile data transcription. Any remaining errors are my own.

What leads to the emergence of growth-enhancing institutions? Recent research has stressed the importance of negative economic shocks. In a book and a series of influential articles, Acemoglu and Robinson (2001, 2006, 2008) develop a framework in which crises can facilitate the emergence of democracy. Empirical work by Brückner and Ciccone (2009) has found empirical support for this framework, showing that negative rainfall shocks are positively related to democratic transitions in sub-Saharan Africa.

Acemoglu and Robinson’s theoretical framework conditions on the existence of “civil society” which is assumed to have emerged as the “outcome of long-run historical processes” (2006, p. 31). Conditioning on the existence of popular coordination networks not controlled or coopted by incumbent elites assumes away the (historically rare) emergence of an important precondition for democracy (North et al. 2009, p. 45). Consequently, while such analyses have provided important insights into the final steps of the emergence of democracy, they seem unlikely to shed light on its ultimate roots.¹

This paper uses over 700 years of Nile flood data to examine how economic shocks affected political outcomes in the absence of a developed civil society. In so doing, it aims to shed light on the mechanisms that prevented economic shocks –that appear to have often spurred institutional change in the modern era– from leading to democratization in one pre-modern society. Results suggest that the monopoly of religious elites over popular coordination networks helped prevent such shocks from leading to substantial institutional changes.

Despite the fact that Nile shocks did not lead to substantial institutional changes, much of the empirical and historical evidence is consistent with the mechanisms highlighted in Acemoglu and Robinson (2001, 2006). Deviant Nile floods helped solve the collective action problem in medieval Egypt by making rioting individually optimal for a larger section of the populace (Grossman and Mendoza 2003).

For these groups of bread rioters to form a military threat to the incumbent political authorities, their behavior had to be coordinated. In pre-modern Egypt,

¹This point is recognized in Acemoglu and Robinson (2006, section 5.2).

religious elites controlled popular coordination networks (Lewis (1953)). The paper develops a simple theoretical framework that shows how Nile failures –by increasing the supply of potential rioters– made control over popular coordination networks more valuable in times of famine.

Although the head judge stood at the pinnacle of these coordination networks and could have helped orchestrate a rebellion against the incumbent elites this rarely appears to have occurred. Instead, the head judge seems to have preferred to pressure the military elites to reduce taxes and implement Islamic law more strictly.² He also extracted increased monetary payments and other “perks” for himself and other religious authorities. In return, he worked to ensure the riotous masses did not rise against the incumbent sultan. The theoretical framework suggests that the observed decreased probability of change of the head judge during deviant Nile floods is indicative of this increased level of transfers.

Despite purchasing the support of the religious elites, Nile-induced economic catastrophes led to an increase in the probability of a change of sultan.³ This result is consistent with previous studies (Miguel et al. (2004), Blattman and Miguel (2010) and Brückner and Ciccone (2010)), and with the theoretical framework developed in Chassang and Padró i Miquel (2009). These political changes led to a change in the identity of the extractive authority (and his coalition). They did not lead, however, to substantial changes in the institutional framework.

While it should be stressed that data limitations do not allow us to empirically pinpoint the causal channel through which Nile shocks affected the likelihood of change in the military and religious leadership, the empirical, historical and theoretical discussions are consistent with theories that stress the importance of the control of religious elites over popular coordination networks in determining the direction of institutional evolution (e.g. Lapidus 1984).

Inasmuch as this interpretation is correct, the results provide empirical support

²See Acemoglu et al. (2010) for a theoretical discussion of this behavior (in a principal-agent framework of the military).

³For the Sultan to wish to purchase the judge’s support the judge had to deliver some decrease in the probability of being overthrown, see section ().

for studies that stress the importance of “culture” (here religious beliefs) in determining both coordinating equilibria and institutional outcomes (Greif (1994, 2006), Tabellini (2008a, 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), North et al. (2009), Smith (1776, p. 385)). This interpretation of the results is also consistent, however, with the framework developed in Acemoglu and Robinson (2000, 2008) that stresses the importance of rent-extracting elites in maintaining suboptimal institutional arrangements.

The paper concludes by noting that if religious elites historically derived rents from their control over popular assembly –as suggested in this study (see also Murphy and Shleifer (2004))– these elites should have worked to generate beliefs that supported this control and to resist the emergence of alternative coordination networks (Chaney 2008, 2010). This observation suggests that future research investigating the role religious organizations played (and may continue to play) in resisting institutional changes both directly (by resisting the emergence of competing coordination networks) and indirectly (by creating and maintaining beliefs that are favorable to their interests) may provide important insights into the evolution of civil society, social capital and institutional outcomes.

The remainder of the paper proceeds as follows. The first section briefly reviews political institutions in medieval Egypt. The second section uses the historical evidence to investigate how Nile failures affected the balance of political power and develops a simple theoretical framework. The third section empirically investigates the effect of Nile-induced famines on political outcomes. The fourth section weighs competing interpretations of the results. The fifth section provides a discussion and concludes.

1 Institutional Framework in Medieval Egypt

A large body of scholarship outlines a peculiar institutional arrangement that was historically common to much of the Islamic world.⁴ In this section we briefly explain the relevant features of the Egyptian variant of this institutional framework and then investigate the effect of civil wars on the balance of power.⁵

1.1 Men of the Sword (State)

During the Mamluk period (1250-1517 CE), Egyptian political institutions were primarily controlled by what were known as “men of the sword” (military elites which we henceforth identify with the state) and “men of the pen” (religious elites which we henceforth identify with the church).

Manumitted slaves composed the overwhelming majority of the “men of the sword.” This peculiar institution –in which foreign-born manumitted slaves had a virtual monopoly over coercive force– was common across the Islamic world. In Egypt, this institutional arrangement meant that individuals that had been enslaved at a young age in the Black or Caspian Sea areas composed the vast majority of the military elite.

Merchants transported these slaves (known in Arabic both before and after they were manumitted as mamluks) to Egypt and sold them to members of the existing military elite (who had previously been slaves themselves). After a member of the military elite purchased a slave the slave became part of his personal military retinue.

Following manumission, mamluks were free to rise in the military hierarchy. How far a given mamluk rose in this hierarchy (and how much wealth he was able to accumulate) appears to have depended on personal skill and connections to different

⁴For an introduction to this literature, see Crone (1980, 2004) and Pipes (1981). See also Coşgel et al. (2009).

⁵We focus on Mamluk Egypt (using evidence from both the pre-Ottoman and post-Ottoman periods) due to the scarcity of both primary and secondary literature for earlier eras (see Raymond (2002, p. 202), Raymond (1974, p. 429) and Al-Sayyid Marsot (1972, pp. 159-160) for the similarities of the pre and post-Ottoman mamluk frameworks).

mamluk factions (Irwin 1986b).

This relatively equal playing field led to constant competition between mamluk factions for control of the commanding heights of the military. The strongest mamluk faction (or coalition of factions) at any given period appointed the sultan. This sultan stood at the pinnacle of the military hierarchy and largely determined the distribution of Egypt's wealth across the military elites.

Once in power, a sultan assigned mamluks in his coalition the rights to collect revenues from "fiefs" (*iqṭa'āt*) as well as additional cash payments. Those in other mamluk coalitions also received monetary payments and fiefs, although these were substantially smaller than payments received by the sultan's coalition. This uneven allocation of resources meant that groups outside the governing coalition often rebelled against the incumbent sultan when the opportunity arose (Chassang and Padró i Miquel (2009)).

1.2 Men of the Pen (Church)

Guilds (*madhāhib*) of religious scholars (ulama) emerged as representatives of local populations from a relatively early date in many Muslim societies. They used their ability to control popular assembly and the threat of popular revolt as a tool to extract concessions from military elites (Lapidus 1984, p. 141, Al-Sayyid Marsot 1973, pp. 133-134).

In Egypt, military elites 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 addition to administering Islamic law and developing sizeable personal fortunes, influential ulama sought to protect their "constituents" (the native population) from mamluk abuses. These abuses included arbitrary confiscations of wealth and high levels of taxation.

Influential ulama also protected their guild's interests by resisting confiscation of guild property (e.g. *waqfs*) and by enlisting mamluk military support to weaken the

emergence of alternative coordination networks that could weaken their control over the populace (Lapidus 1984, pp. 131, 140; Al-Sayyid Marsot 1973).

1.2.1 The Head Judge, Judicial Rulings and Political Power

The head judge stood at the head of ulama –and popular– coordination networks. One scholar of Mamluk Egypt has described the head judge as having “vast personal authority among the ulama” (Lapidus 1984, p. 136). Another prominent scholar has summed up his role by noting that “[i]f the holders of any one 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 rest of the paper we often (somewhat loosely) refer to the head judge and the ulama interchangeably.

The sultan appointed and dismissed the head judge and was (in theory) subject to the head judge’s rulings as long as the head judge remained in office. While the sultan had an incentive to appoint a pliable “yes man” to the judiciary –and the historical record provides examples of such judges– such “yes men” were not likely to retain popular influence.⁶

Perhaps for this reason, in practice the sultan appears to have generally appointed head judges from a list of candidates presented by a council of ulama members, or to have appointed ulama figures with substantial popular followings.⁷

Once a head judge had been appointed, the mamluk elite appear to have been largely indifferent to the vast majority of his rulings. The mamluks took more interest, however, in judicial rulings that affected their well being. Attempts by the head judge to restrain mamluk confiscation of merchant property, *waqfs* or refusals to sanction additional taxes created tensions between the head judge and the military elites.

In general, the majority of head judges appear to have ruled against the sultan

⁶See Maqrizi (1441, VII, p. 450) and Petry (1981, p. 320).

⁷See Petry (1981, p. 315) and Maqrizi (1441, II, p. 228; III pp. 238-239; IV, p. 101) for the head judge being chosen by the ulama. See Maqrizi (1441, III, pp. 383, 384, 353) for the importance of a judge’s popular following.

(extracted concessions) to the extent they could do so without being dismissed. That is, if a head judge was in a weak position he would condone a wider range of infractions. If he found himself in a stronger position he would work to extract greater concessions (Al-Sayyid Marsot 1973).

Some judges, however, appear to have been especially “principled.” These judges insisted on higher level of concessions, and if the sultan did not meet their demands these judges resigned or ruled against the sultan and were dismissed. Such judges were remembered as heroes in the sources and appear to have enjoyed widespread popular influence even after their dismissal.⁸

This discussion suggests that a judge’s political influence was closely linked to his ability to successfully extract concessions from the mamluk elite. For this reason, we equate the amount of monetary concessions the sultan was willing to concede (both to the populace and the judge himself) as a measure of the head judge’s political influence (Al-Sayyid Marsot 1972, p. 156).

1.3 Civil Wars and The Head Judge’s Bargaining Power

The historical record suggests that the head judge could better constrain the mamluk elites during periods of civil war. This increased influence appears to have been due to the fact that “in Mamluk civil wars, the support of the ulama [...] was often of decisive importance” (Lapidus 1984, p. 134). The ulama’s importance during periods of civil strife, in turn, stemmed from their control over popular coordination networks.

If successfully mobilized, the masses served as effective auxiliaries to mamluk regulars. The historical record contains examples of the common people armed with rocks and slings successfully stopping the advances of mamluk soldiers.⁹ In one period of civil strife, a mamluk leader offered monetary payments to members of the

⁸For examples of such “principled” judges see Taghri Birdi (1468, V, pp. 79, 109); Maqrizi (1441, II, p. 293); Taghri Birdi (1468b, p. 72).

⁹See, for example, Taghri Birdi (1468, I, pp. 74-75). For examples of the military role of the populace see Maqrizi (1441 VI pp. 41, 176, 232, 233) and Lapidus (1984, p. 164).

populace and mamluks who joined their cause. The pay offered suggests that this leader considered ten commoners equivalent to one mamluk regular (Taghri Birdi 1468, V, p. 34).

In order to obtain popular support, mamluk factions offered monetary payments (and/or a share of the plunder after victory) and competed for ulama support during periods of civil upheaval.

The ulama in general and the head judge in particular had various means to mobilize the populace.¹⁰ Regardless of the method used, one prominent scholar of the Mamluk period has described the ulama as capable of providing “massive popular support” (Lapidus 1984, p. 134).¹¹

Since popular support during civil wars could mean the difference between victory and defeat, religious scholars emerged as important players in civil conflicts. Contemporary chronicles during the Mamluk period provide examples of high ranking members of the ulama (including the head judge) using their power to extract greater concessions from the mamluk elite during periods of political instability.¹²

2 Nile Shocks and the Balance of Power

The previous discussion suggests that the head judge was able to extract increased concessions from the mamluk elite during periods of political strife. Given the growing literature linking political instability to economic downturns, it seems plausible that negative economic shocks led to both political instability and an increase in the

¹⁰For an example of a judge aiding coordination across city quarters see Lapidus (1984, p. 166). For coordination in the Friday sermon (*khuṭba*) and at prominent 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).

¹¹One estimate puts at 70,000-80,000 the number of men that the most influential ulama could mobilize (Al-Sayyid Marsot 1972, p. 151). For additional evidence of the effectiveness of the ulama in mobilizing popular support see Maqrizi (1441, VI, p. 231; VII, p. 419) and Taghri Birdi (1468, V, pp. 74-75).

¹²For examples see Taghri Birdi (1468, I, pp. 30-31) and Nielsen (1985, pp. 131-132).

religious elites' bargaining position.

This section uses the historical record to investigate this hypothesis and develops a simple model based on the historical evidence. We begin, however, by briefly investigating the importance of the Nile's annual flood for Egypt's pre-modern economy.

2.1 Determinants of the Nile Flood, Egyptian Agriculture and Nile Failures

2.1.1 The Annual Nile Flood

The Nile's annual flood usually began in earnest in July and had crested (at the latest) in October. Ethiopian monsoon runoff determined the size of this summer flood. Recent research has linked variation in this monsoon runoff to sunspots (Ruzmaikin, Feynman and Yung (2006)), suggesting the Nile's summer flood level was exogenous.

2.1.2 Agriculture in The Nile Basin

Agriculture in the Nile basin was heavily dependent on the annual Nile flood. A complex system of dikes and irrigation networks helped harness the Nile flood's agricultural potential, making Egyptian agricultural yields some of the highest in the pre-modern world.¹³

Once the Nile began to recede 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.

2.1.3 Economic Effects of Deviant Floods

Economic output sharply dropped when the Nile flood significantly deviated above or below its optimal level (these deviant episodes are henceforth referred to as Nile

¹³This section draws on Cooper (1976), Frantz-Murphy (1986), Tsugitaka (1997). See also Borsch (2005, pp. 34-39) for a detailed discussion.

failures).¹⁴

If the Nile rose during the summer months at a “deviant” rate, prices rapidly increased. 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 1441, IV, p. 376). During one particularly severe famine, a chronicler noted that parents ate their own children or sold them into slavery (Maqrizi 1405, p. 41)

The severity of a Nile shock primarily depended on the extent to which the Nile-flood deviated from its optimal flood level. Deviations severe enough to cause crises appear in the historical records roughly once every 17 years between 1600 and 1800 CE (Raymond 1973, pp. 81-106) and once every 8 years between 949 and 1233 CE (Hassan 2007).

2.2 Historical Examples of Nile-Induced Political Instability

Chroniclers, historians and archaeologists have linked civil wars and the collapse of political regimes to Nile failures. The earliest (to the best of my knowledge) known example occurs around 2200 BCE, when a series of Nile failures is thought to have led to civil war and the collapse of centralized government in ancient Egypt (Hassan 1997). Early examples from the Islamic period include uprisings after low Niles in 902 CE and 967 CE which led to the collapse of two dynasties.¹⁵

As the historical sources become more abundant, one often finds contemporaries linking Nile failures with political instability. Taghri Birdi’s (1468, II, p. 80) description of events in the year 1403 CE is representative of this perceived connection. He states that

“[d]uring this year there was a vast extent of uninundated land in Egypt,

¹⁴Here (and below) we 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.

¹⁵See ‘Abd al-Latif (1231, p. 48) and Bianquis (1998, pp. 117-118).

and extreme scarcity resulted, followed by the plague. And this year was the beginning of a series of events and trials in which most of Egypt and its provinces were ruined, not only because of the failure of the inundation but also because of the lack of harmony in the government.”

2.3 Historical Examples of Nile-Induced Religious Influence

Although historians have generally stressed that the ulama’s political power increased during periods of political instability few have explicitly noted the relationship between Nile failures and increased ulama bargaining power.¹⁶ The historical record, however, suggests that during Nile failures the ulama were better able to extract 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 [...] prostitution, 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 strict enforcement of these and other measures suggest that the religious elites had greater bargaining power during Nile failures.¹⁷

Observations by contemporaries also suggest that the religious elites were more able to extract monetary concessions and other perks during deviant Nile episodes.¹⁸ Some concessions appear to have been institutionalized, with the ulama routinely calling for “the lifting of unjust taxes and reimbursement of those taxed, repentance and renunciation of sins” (Jabarti 1822, p. 403) in exchange for their continued support during Nile failures.

¹⁶For exceptions see Raymond (1974, p. 430) and Tucker (1981). For a discussion of an increase of Nile-induced political influence of religious elites in the pre-Islamic era see Hassan (1997, p. 13).

¹⁷Why the strict implementation of the Shari’a led to higher payoffs for the religious authority, however, is often less clear.

¹⁸For examples of increased monetary payments to the ulama following a Nile failure see Maqrizi (1441, IV, p. 269) and Taghri Birdi (1468b, p. 233). For an example of increased “perks” see the effect of Nile failure on the ability of the ulama to ride horses in Taghri Birdi (1468b, pp. 220, 238).

2.4 A Timeline of Nile Failure

2.4.1 “Impact” Year

The historical evidence suggests that Nile failures both increased political instability and the ulama’s bargaining power. This subsection uses additional historical evidence to provide a rough timeline of the events in Cairo that followed Nile failure.

A slow or excessively rapid Nile rise during the summer months unsettled the population. Prices of foodstuff rose as individuals hoarded grain in preparation for shortages in the following year. If the Nile failed, prices of wheat could double or even quadruple.

As prices rose, thousands of people assembled in search of grain. These groups rioted, sacked stores and attacked government officials.¹⁹ 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.²⁰ The sultan’s coalition appear to have been wary of rival factions using these rioters to aid a revolt.²¹

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 seems to have often been 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).

During the summer months, the ulama organized rain prayers and other processions to plead for divine aid to cause the Nile to flood.²² If the summer ended

¹⁹For 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).

²⁰See Maqrizi (1441, IV, p. 368) ; Shoshan (1993, p. 53).

²¹See Taghri Birdi (1468, V, p. 120; VI, p. 63).

²²For an example of a rain prayer see Taghri Birdi (1468, pp. 77-78). For its use in calming

in a Nile failure, widespread famine and epidemic disease outbreaks often followed. During the year “treated” by Nile failure one finds references to exceptionally large groups of individuals attending mosque services and congregating around influential members of the ulama. The ulama –who generally supported the incumbent sultan– seem to have used their influence to calm the masses.²³

The ability of the ulama to calm the populace appears to be reflected in the absence of explicit references to Nile-induced bread rioters aiding rival mamluk factions to overthrow the incumbent sultan in the historical sources. Indeed, the theoretical discussion below suggests that the head judge should never support a rebellion in equilibrium.

These facts suggest that any observed relationship between Nile failures and changes in the sultanate are not directly driven by head judge-sponsored popular revolt. Rather it appears that Nile failures often led military factions to revolt regardless of ulama support for such rebellions.²⁴ Although the support of the religious scholars could strengthen the probability a rebellion would succeed, the lack of such support did not necessarily mean that such rebellions were condemned to failure.

In sum, the historical record suggests that the ulama were politically influential due to their control over popular coordination networks. Nile failures increased this influence by i. making civil war more likely and thus the value of a given level popular support more valuable²⁵ and ii. increasing the supply of individuals the head judge could provide as military auxiliaries.

bread riots see Taghri Birdi (1468b, p. 234). For an example of a procession see Shoshan (1993, p. 62). It should be noted that the mechanisms through which these gatherings diffused the danger of revolt are unclear.

²³For an example of abnormally large mosque attendance see Taghri Birdi (1468b, p. 233). For public readings of Bukhari (a famous religious text) to calm the suffering populace after Nile had failed see Maqrizi (1441, IV, p. 366). For large crowds congregating around the head judge see Maqrizi (1441, VI, p. 100).

²⁴See Sanders (1994, p. 3) or Lev (1991, pp. 14, 76).

²⁵For a theoretical discussion of why the incumbent sultan could not buy off rebellious factions see Chassang and Padró i Miquel (2009).

2.4.2 Following Year

A brief note on duration of the effect of a one-shot Nile failure. It should be stressed that the timing of the Nile “treatment effect” began before the physical absence of foodstuffs occurred (since immediately following the Nile failure the stock of foodstuffs was the same it would have been had the Nile not failed). The immediate rise in prices was due to precautionary hoarding by individuals and speculators.

Similarly, if the Nile flooded normally the next year, grain prices usually fell when the Nile flooded. Despite this fact, the available historical evidence suggests that grain prices generally remained elevated until the harvest was collected in April/May of the following year (Maqrizi 1405, p. 51).

If the next year’s flood (two years after the failure) was relatively normal as well, the Nile-induced crisis ended. Thus a one-shot Nile failure seems to have affected grain prices for roughly two years following its occurrence.

2.5 Simple Theoretical Framework

The previous discussion suggests that Nile failures imperiled the incumbent sultan’s hold on power by i. increasing the probability rival military factions would rise in rebellion and ii. increasing the percentage of the populace that was willing to rise in popular revolt. In this section we focus on the second effect of Nile failures and treat the first effect in a reduced-form manner (for a theoretical discussion of the first effect see Chassang and Padró i Miquel (2009)).

Recall that the evidence suggests that the sultan appointed the head judge to help control the local population. The historical record suggests that during periods of Nile failure the head judge was able to extract more from the incumbent sultan than during “normal” periods. This increased bargaining power appears to have stemmed from both an increase in the probability of a military revolt and from an increase in the members of the populace who were willing to riot.

This section investigates this intuition using a static, finite game of perfect information.²⁶ The timing of events within a period is as follows: first the Nile plays

²⁶A dynamic setup introduces complexity without altering the basic results. More precisely,

and determines a flood level which in turn determines incomes that period. After observing the state of the Nile the sultan determines how much to pay the head judge. Finally, the judge decides –given the state of nature and the sultan’s offer– whether or not to sanction a revolt. At the end of the period taxes are collected and payoffs are realized.

Nile floods determine the variable $Y_t \in [Y^{Fail}, Y^{Goldilocks}]$, $Y^{Goldilocks} > Y^{Fail} > 0$, which in turn determines the distribution of incomes in that year. We assume that incomes are distributed uniformly on the interval $[0, Y_t]$ (we subsequently drop the subscript t). For the remainder of the theoretical section we maintain the assumption that Nile failures are one-sided.²⁷

Payoffs are as follows. If the judge sanctions a revolt and it succeeds, he gets a fixed fraction $\rho \in (0, 1)$ of the money brought in by taxes (which are levied at the exogenous rate τ) in that period.²⁸ If he sanctions the revolt and it fails he gets nothing.²⁹

If the judge does not support the rebellion he gets $\max(P_J, \bar{w}_J(Y))$ with probability 1 (regardless of whether the incumbent sultan retains power) where the quantity P_J is determined by the sultan and \bar{w}_J is the judge’s outside option. We assume that $\bar{w}_J(Y) = \gamma\rho\tau\frac{Y}{2}$, $\gamma \in (0, 1)$, or that the judge’s outside option is proportional to total economic production but is less than what he would get if he sanctioned a revolt and it succeeded. The parameter γ is a measure of the judge’s outside options.

It is important to stress that we assume (following the historical record) that if

the qualitative implications presented generally hold in a dynamic framework as long as the judge does not find it optimal to change the existing institutional structure. See Lapidus (1984, p. 153) for a discussion of why medieval religious elites did not aim to change the existing structure and Acemoglu and Robinson (2006) for a model of institutional change in periods of economic crises.

²⁷The theoretical implications are easily generalized to the two-sided case as discussed in section 3.2.1.

²⁸A more general framework would endogenize the tax rate. Since this considerably complicates the analysis without fundamentally altering the mechanism generating increased judicial power we abstract from the tax rate for simplicity.

²⁹For examples of ulama and judges supporting a rebel and being punished for their support see Taghri Birdi (1468, I, pp. 91, 123; II, p. 148).

the sultan is deposed by a rebellious faction and the judge did not sanction that rebellion the incumbent judge gets the same payment he would have received had the incumbent sultan not been deposed.³⁰

To better understand this point, recall that the incumbent head judge stood at the pinnacle of ulama coordination networks. In other words, he had been chosen by the previous sultan because of his influence with the ulama and the populace. We assume that this head judge was uniquely qualified until his dismissal or death. Following a successful rebellion, then, the new sultan faced the same problem the previous sultan had faced, and could not do better than keeping the previous head judge.

If the judge supports the rebellion it succeeds with probability $h[f(Y), J = 1] > h[f(Y), J = 0]$ $h_1 \geq 0$. Here $f(Y)$ represents the fraction of the population that is willing to heed the judge's call to revolt, which is a function of income. We assume that $f' < 0$.³¹ $J \in \{0, 1\}$ is equal to 1 if the judge sanctions revolt and 0 else. We often use the shorthand $h[f(Y), J] \equiv h(J)$, $h_1[f(Y), J]f' \equiv h'(J) \leq 0$ where h_1 is the partial derivative of h with respect to $f(Y)$.

Note that we allow for the possibility that the probability of a successful rebellion may increase despite the judge's support of the incumbent sultan. In practice, as noted above, this increase in probability appears to have been due to military factions deciding to revolt in periods of famines independent of the head judge's decision.³²

The sultan gets $\tau \frac{Y}{2} - P_J$ if he remains in power and 0 if he is deposed. We can

³⁰In general, it appears that the head judge was not punished for supporting the incumbent sultan even if he was deposed. See Lapidus (1984, pp. 131-132) for a discussion and Taghri Birdi (1468, I, pp. 67, 97, 173) for examples of head judges retaining their positions after a revolt despite the fact they did not support the revolt.

³¹See Grossman and Mendoza (2003) for the effect of famines on the supply of individuals willing to revolt and Acemoglu and Robinson (2006) for a discussion of how economic downturns help solve collective action problems.

³²This also raises the possibility that the incumbent sultan could divert resources away from the judge and towards the opposing military faction to prevent revolt. Analysis in Chassang and Padró i Miquel (2009) suggests it may have been impossible for the sultan to buy off rebellious factions during Nile downturns.

write the sultan's expected payoff as $V^S(Y, J, P_J) = (1 - h(J))[\tau \frac{Y}{2} - P_J]$. The judge receives on expectation $V^J(Y, J, P_J) = Jh(J)(\rho\tau \frac{Y}{2}) + (1 - J) \max(P_J, \bar{w}_J)$.

In addition, we make the following three assumptions:

Assumption 1: the function h and the parameter γ are such that $\exists Y \in (Y^{Fail}, Y^{Goldilocks})$ for which $h(Y, 1) = \gamma$. Denote this value of Y by \bar{Y} .

Assumption 2: $h_1(f(\bar{Y}), 1) > 0$

Assumption 3: $h(1) \frac{1-\rho}{1-h(1)\rho} \geq h(0) \forall Y < \bar{Y}$ ³³

The first assumption ensures that the judge will consider supporting a revolt for some Y and not for others on the interval $[Y^{Fail}, Y^{Goldilocks}]$. The second assumption ensures that \bar{Y} is unique and the third assumption that the sultan will always purchase the judge's support on the interval $Y < \bar{Y}$.³⁴ It is clear that the sultan can always afford to purchase the judge's support.

With these assumptions³⁵ we can state the following:

Proposition 1

Let $s_S = \{P_J(Y)\}$, $P_J(Y) \in [0, \tau \frac{Y}{2}]$ be the salary offered by the sultan to the judge. Denote the decision by the judge whether or not to endorse a revolt by $s_J = \{J(P_J, Y)\}$, $J(P_J, Y) \in \{0, 1\}$. In addition, let assumptions 1-3 hold. Then there exists a subgame perfect equilibrium $\{s_S, s_J\}$ in the game defined above in which:

- i. If $Y \in [\bar{Y}, Y^{Goldilocks}]$ then $P_J(Y) = 0$, $J(P_J, Y) = 0 \forall P_J$
- ii. If $Y \in [Y^{Fail}, \bar{Y})$ then $P_J(Y) = h(1)(\rho\tau \frac{Y}{2})$, $J(P_J, Y) = 0$ if $P_J(Y) \geq h(1)(\rho\tau \frac{Y}{2})$. Off the equilibrium path $J(P_J, Y) = 1$ if $P_J(Y) < h(1)(\rho\tau \frac{Y}{2})$.

Proof: see appendix

In equilibrium, the judge will never support a rebellion. On the interval $[\bar{Y}, Y^{Goldilocks}]$ the judge gets his outside option ($\bar{w}_J(Y)$) and nothing from the sultan.

³³Here we assume that if indifferent the sultan purchases the judge's support.

³⁴If this third assumption doesn't hold, then for some levels of income the judge may support the rebellion because he does not have sufficient control over the probability of a successful revolt to convince the sultan to purchase his support. While this is theoretically possible the fact that incumbent judges rarely supported revolts suggest that this possibility can be safely ignored.

³⁵In addition we assume that if indifferent the judge does not sanction a revolt.

On the interval $[Y^{Fail}, \bar{Y})$ the judge gets $h(1)(\rho\tau\frac{Y}{2}) > \gamma\rho\tau\frac{Y}{2} \equiv \bar{w}_J$. On this interval, the judge's share of the total amount of the treasury $h(1)\rho$ (weakly) increases as incomes fall.

The probability the judge is deposed (we assume that if he is paid nothing he is either deposed by the sultan, quits or he rules against him and is dismissed) is one on the interval $[\bar{Y}, Y^{Goldilocks}]$ and 0 on the interval $[Y^{Fail}, \bar{Y})$.

On expectation the sultan receives $[1 - h(0)]\tau\frac{Y}{2}$ on the interval $[\bar{Y}, Y^{Goldilocks}]$ and $[1 - h(0)](\tau\frac{Y}{2} - h(1)\rho\tau\frac{Y}{2})$ on the interval $[Y^{Fail}, \bar{Y})$. The probability the sultan is changed is given by $h(0) \forall Y$.

2.5.1 Judge Heterogeneity

The previous discussion implies that a plot of the probability of a judge's dismissal against the Nile's level should take the form of a step function with this probability equalling 1 on the interval $[\bar{Y}, Y^{Goldilocks}]$ and 0 on the interval $[Y^{Fail}, \bar{Y})$. A cursory examination shows that the data do not conform to this pattern.

Judge heterogeneity is one possible explanation for this observed difference. Indeed, there is overwhelming evidence in the historical sources of heterogeneity in a given judge's personal "rectitude."

We model differences in judge rectitude by introducing heterogeneity in γ . We interpret a higher γ (outside option) as designating a more "principled" judge, in other words, one who prefers to rule against the sultan and be dismissed for a greater range of Nile floods. Only when this "principled" judge is able to extract large concessions from the sultan (these concessions can be interpreted as having the sultan enforce the Shari'a more strictly) will he accept the sultan's offer of payment.³⁶

Since \bar{Y} is defined by the equality $h(\bar{Y}, 1) = \gamma$ introducing heterogeneity in γ also introduces heterogeneity in \bar{Y} . This heterogeneity defines a cdf $F(Y) \equiv \Pr(\bar{Y} \leq Y)$. In other words, for a given Nile flood level Y , $F(Y)$ tells us the percentage of all judges who will not consider supporting a rebellion. If the sultan dismisses these judges at the flood level Y , they will not sanction a revolt (because their outside

³⁶See footnote 8 for evidence that such judges existed.

option at this flood level is too high). Consequently, these judges are dismissed at flood level Y .

Conversely, $1 - F(Y) = \Pr(\bar{Y} > Y)$ gives the percentage of judges who will consider supporting a rebellion at Y (because their outside option is lower). They are bought off by the sultan at this flood level (note that we are abstracting from heterogeneity in the functional form of h and/or correlations between h and γ for simplicity). We assume that some judges will always be bought off ($1 - F(Y^{Goldilocks}) > 0$). In addition, we assume that the cdf F is independent of the Nile flood level.

3 The Effect of Nile Failures on Political Outcomes: Empirical Evidence

The historical record and theoretical considerations suggest that religious authorities in general and the head judge in particular gained political power during periods of Nile-induced economic downturn. The remainder of the paper uses over 700 years of Nile flood data to empirically test this hypothesis. This section presents the bulk of the empirical evidence and section 4 provides a discussion and weighs competing explanations. We begin with a brief overview of the data sources.

3.1 The Data

3.1.1 Nile Flood Data

Egyptian rulers constructed Nilometers to measure the Nile flood level. These Nilometers provided data which was used to both estimate tax receipts (Cooper 1976) and to forecast the flood level in future years (Petry 1994, p. 105).

The Nilometer on the island of Rauda (Cairo) was among Egypt's most elaborate.³⁷ This Nilometer was staffed by a "guardian" who provided detailed records on the Nile flood level to government officials. Although the guardian's original records

³⁷For a detailed description of the Rauda Nilometer see Popper (1951).

are lost, two historians in the 15th century compiled copies of the Nile’s historical flood levels (Popper 1951, p. 156).

The first copy of these records are provided by Taghri Birdi. Hijazi provides the second set of statistics. A detailed description of these data is provided in the data appendix.

The recorded maximums of the Nile flood as recorded by Hijazi (black line) and Taghri Birdi (light grey line) are detailed in figure 1. The inferior x axis marks hijri (lunar) years (for a detailed explanation of hijri years see the data appendix), and the superior x axis gives the corresponding CE year. The left hand y axis details the flood level in meters above sea level and the right hand 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 1 shows that the Nile flood level slowly trended upwards over time. This was caused by the rise of the Nile bed (and the surrounding lands) due to sediment accumulation (Popper 1951, pp. 241-247; Borsch (2000)). Figure 1 provides the fitted value of the Nile’s trend (dotted line) as well as the fitted value of an AR(10).³⁸

Table 1 provides summary statistics. The first row provides statistics on Hijazi’s flood data. The Nile flood was on average 16.99 meters above sea level over the period covered by the data. The minimum flood was 14.70 meters above sea level, while the maximum measured flood was 18.60 meters above sea level. The maximum flood level had a standard deviation of 0.58 meters. Finally, the data cover 822 lunar years.

Statistics in columns (5)-(9) in the first row provide the mean level of Hijazi’s flood level by dynasty. The remainder of the first panel of table one uses an identical format to present statistics for the Nile flood as measured by Taghri Birdi and the squared deviation of Nile floods from a linear trend (which will be our preferred measure of Nile shocks).

³⁸Lag length was selected using the Schwarz criteria with maximum lag length set to 20.

These statistics show that although Taghri Birdi and Hijazi’s series track one another, there are non-trivial divergences between the two. These divergence stem from scribal error (Popper 1951, p. 152) and confusion in the occurrence of “skip years” due to the backwards cycling of the hijri year through the solar year.

3.1.2 Rulers and Head Judges

The month and year of changes in the political authorities were taken from Sami (1916). The month and year of changes in the office of head judge come from Ibn Hajar’s (1449) *Raf’u al-Iṣr ’an Quḍāt Miṣr* (The Lifting of Difficulties Surrounding Egypt’s Judges). This book details the biographies of Egypt’s head judges from the Muslim conquest (640 CE) through 843 AH (1438 CE).³⁹ The biographies are thought to be reliable with the exception of those for the earliest judges (Escovitz 1984, p. 5). Additional details can be found in the data appendix.

Throughout the empirical section, we use a unit of time (lunar year or lunar month) as the unit of observation. We then construct $Judge_t$ equal to one if the incumbent judge at the start of the time period is no longer in power at the end of the period. That is, we let t index time period and $Judge_t$ be a dummy equal to one if the incumbent judge at t is deposed (recall that dismissal in our framework can mean either that the sultan deposed the judge or he quit) on the interval $(t, t+1)$. We construct a similar metric for sultans.

The second panel of table 1 shows that on average 19% (22%) of sultans (judges) who started a given lunar year in power were no longer in power at the end of that year. The Fatimid dynasty was the most stable when measured by political turnover, whereas the Ayyubid dynasty was the most stable for head judges.

³⁹We will henceforth denote hijri years by the abbreviation AH.

3.2 Functionalizing the Theory and Empirical Results by Year and Month

3.2.1 Functionalizing the Theory

The theoretical discussion in section 2.5 implies that $E(Judge_t|Nile_t = Y_t) = F(Y_t)$, or the percentage of judges that are dismissed at flood level Y_t is equal to the percentage of judges that the sultan does not find optimal to buy off because they are too “principled.”

For simplicity in the theoretical section we abstracted from death in office. In reality, however, most judges died in office (Escovitz 1984, p. 228). If we assume that a (constant) proportion α of all judges die in office, then $E(Judge_t|Nile_t = Y_t) = \alpha + (1 - \alpha)F(Y_t)$.⁴⁰ In other words, the percentage of judges who started a year in office but are no longer in office at the end of the year is equal to the percentage of incumbent judges who die in office (α) plus the percentage of “principled” judges who live long enough to be dismissed ($(1 - \alpha)F(Y_t)$).

Although in the theoretical framework we considered the Nile failure index Y_t in which a higher Y_t denoted higher incomes, in the empirical section we will often use the metric $DevNile_t^2$, in which a higher value of $DevNile_t^2$ denotes lower incomes. To relate the two frameworks we assume (without loss of generality) that $DevNile_t^2 = 0 \rightarrow Nile_t = Y^{Goldilocks}$ and $\max(DevNile_t^2) \rightarrow Nile_t = Y^{Fail}$ and then define a bijective mapping $g()$ from $(Y^{Fail}, Y^{Goldilocks})$ onto $(0, \max(DevNile_t^2))$ such that $\forall Y_t \in (Y^{Fail}, Y^{Goldilocks})$ and $DevNile_t^2 \in (0, \max(DevNile_t^2))$: $DevNile_t^2 = g(Y_t)$.

Thus, we can write $E(Judge_t|DevNile_t^2) = \alpha + (1 - \alpha)[1 - F(\zeta(DevNile_t^2))]$ where $\zeta \equiv g^{-1}$. Equipped with this mapping, we can interpret the non-parametric fits provided in Figure 2 in light of the theoretical framework.

Figure 2 presents the nonparametric fit of $Judge_t$ against the Nile flood residuals.⁴¹ The two concave parabolas give the fitted values of $Judge_t$ against Hijazi’s and Taghri’s residuals.

⁴⁰An increased likelihood of judge death during Nile failures would act to attenuate the estimated coefficients since in practice we find that Nile failures resulted in fewer judge dismissals.

⁴¹We use a lowess smoother with bandwidth 0.8.

To interpret these fits in the framework of the model, recall that we interpret a residual of 0 as $Y^{Goldilocks}$. The percentage of incumbent judges who did not retain power at this flood level is estimated to be roughly 23%. Thus, $0.23 = \alpha + (1 - \alpha)F(Y^{Goldilocks})$.

In addition, recall that we interpret $\max(DevNile_t^2) = Y^{Fail}$. The tails of the parabola are not equal for Hijazi’s and Taghri’s data (and the extreme fitted values are driven by a few outliers). It seems, nonetheless, that approximately $0.10 = \alpha + (1 - \alpha)F(Y^{Fail})$.

Consequently, $0.13 = (1 - \alpha)[F(Y^{Goldilocks}) - F(Y^{Fail})]$. If we are willing to assume that during severe Nile failures no judge is dismissed ($F(Y^{Fail}) = 0$) then $\alpha = 0.10$ and $F(Y^{Goldilocks}) = 0.14$. In other words, roughly 14% of all judges were principled to one degree or another. These judges only remained in office during Nile failures, since during “good times” the sultan did not find it optimal to meet their more rigid demands.

Regression Framework In the empirical section we often consider the coefficient β_1 in the regression:

$$Judge_t = \beta_0 + \beta_1 DevNile_t^2 + \varepsilon_t \tag{1}$$

β_1 can be interpreted as the slope of the linear approximation to the conditional expectation function $E[Judge_t | DevNile_t^2] = \alpha + (1 - \alpha)F(\zeta(DevNile_t^2))$. Since the theoretical discussion implies $\frac{d}{dDevNile_t^2} E[Judge_t | DevNile_t^2] \leq 0$ we expect $\beta_1 < 0$.

We will use regressions of the form (1) throughout the empirical section. That is, we examine how the hazard (probability of dismissal) on the interval (t,t+1) of the incumbent judge at time t relates to a Nile failure over at least part of the interval. This type of specification is closely related to standard duration models⁴² and is particularly suited to our empirical and theoretical setting.⁴³

⁴²For a theoretical justification see Lancaster (1990, pp. 10-13) and assume the Nile flood level at time t is not related to the probability of dismissal in previous time periods.

⁴³In addition to the difficulty of handling measurement error in non-linear frameworks, the use of across-judge variation obviates the exogeneity assumption needed for duration models with time

Finally, a brief note on the distribution of judges. While it seems plausible to assume that this distribution is not related to the Nile level, the existence of any incumbent “principled” judges may seem counterintuitive despite the fact that this claim is consistent with the historical record. In other words, these judges should have been dismissed immediately after appointment (or not accepted appointment at all). In practice “principled” judges may have survived their initial appointment because political/economic turmoil in previous periods strengthened their position or because they had recently been appointed and had not yet had the opportunity to be dismissed.

3.2.2 Judges

Lunar Year

OLS Results from regression of the form (1) are presented in table 2.⁴⁴ In panel 1, column (1) presents the results using the untransformed Nile deviation calculated using Hijazi’s data.⁴⁵ If the effect of Nile failure on judge dismissal was symmetric we would expect this coefficient to be 0. Results in column (2) present results using the square of Hijazi’s residual. Results in column (3) add dynasty dummies (see table 1 for an enumeration of the dynasties) and a time trend. Results from a specification identical to that in column (3) but substituting the absolute value of Hijazi’s residual for the squared deviation are presented in column (4). Column (5) presents results from an identical specification using a dummy variable equal to one if Hijazi’s residuals are in the top 2.5% or lowest 2.5% of the residual distribution. The point estimates suggest that a meter increase in the Nile flood’s deviation (roughly two standard deviations) was associated with between a 3 and a 4 percentage point decrease in the probability that the incumbent judge was dismissed in that lunar

varying covariates which does not hold in our context (Lancaster 1990, p. 28).

⁴⁴Throughout the empirical section, we use robust standard errors or errors clustered by lunar or Nile year. These standard errors are similar to those calculated using HAC standard errors.

⁴⁵Residuals throughout the empirical section are calculated using a linear time trend. The results, however, are robust to a variety of specifications. See section 4.2.1 for a discussion.

year.

Results in panel 2 use an identical format to present the results obtained using Nile deviations calculated with Taghri Birdi's data. These results suggest Taghri Birdi's data suffer from more severe measurement error than Hijazi's.

In sum, while the point estimates presented in table 2 are consistent with the theoretical prediction, these point estimates are not generally significant at conventional levels.

IV Since both Nile data sets are measured with error, it might seem a straightforward exercise to instrument for one time series with the other to obtain consistent estimates. In practice, however, the use of IV has two problems in our context.

First, since Nile shocks appear to have been roughly symmetric we need to take a non-linear transformation of the original residuals. It is shown in the appendix that under a few plausible assumptions IV is consistent when instrumenting for the square of one residual with the square of the other.

Second, a portion of the measurement error appears to come from misassignment of Nile floods to lunar years (see the data appendix for a detailed discussion). To the extent that the mapping from solar to lunar years was similar in both data sets, IV will only eliminate measurement error stemming from transcription error. The effects of the misassignment of Nile floods will remain.

The instrumental variable results are presented for the specifications which can be shown to be consistent in table 4. Results for judge changes are presented in panel 1. The first two columns present the results instrumenting for Hijazi's residuals with Taghri Birdi's (column 1) and vice versa (column 2). The following two columns do the same with squared residuals. The final two columns add dynasty dummies and a time trend.

The last row in panel 1 presents the first stage F-statistics. Although there are no theoretical guidelines (to the best of my knowledge) for weak-instruments in non-linear frameworks, the results in columns (1) and (2) show that Hijazi's and Taghri's residuals are strongly correlated.

In general, the IV point estimates are substantially larger (in absolute value) than

their OLS counterparts. Results instrumenting for Hijazi’s data are statistically significant at the 10% level, although those instrumenting for Taghri Birdi’s data remain insignificant. The point estimates suggest that a meter increase in the Nile flood’s deviation was associated with between a 6 and an 18 percentage point decrease in the probability that the incumbent judge was dismissed in that lunar year.

Lunar Month Since the use of the available instrument does not likely solve the error introduced by misassignment of Nile floods to lunar month, this section investigates the results reassigning Nile floods to each lunar month (we only present results using Hijazi’s data because we do not possess a mapping between lunar and solar years for Taghri’s data). In other words, we investigate the coefficient β_1 in the regression

$$Judge_{mt} = \beta_0 + \beta_1 DevNile_t^2 + \varepsilon_t \quad (2)$$

where t indexes years, m indexes months and $Judge_{mt}$ is a dummy variable equal to one if the incumbent judge at the start of the lunar month was dismissed during that month.

To begin, we let t index lunar years and merge judge changes and Nile floods by lunar year. These regressions are the monthly equivalent to those run by lunar year above. Consequently many lunar months suffer from the misassignment of the Nile flood level. Results from these regressions are reported in panel 1 of table 3.

Column (1) presents the results using the untransformed Nile deviation calculated using Hijazi’s data. Results in columns (2)-(4) present results using the square of Hijazi’s residual. Results in column (4) include solar year and solar month dummies. This specification allows for fine-level comparisons (recall that in panel 1 the variable $DevNile_t^2$ is assigned by lunar year, thus allowing variation within solar year). Results from a specification identical to that in column (4) but substituting the absolute value of Hijazi’s residual for the squared deviation are presented in column (5). Column (6) presents results from an identical specification using a dummy variable equal to one if the Hijazi’s residuals are in the top 2.5% or lowest 2.5%

of the residual distribution. Results in panel 1 are generally consistent with those presented in table 2, with the point estimates on the Nile’s deviation less than zero, but not significant at conventional levels.

Results in panel 2 of table 3, present the same regressions using the correctly assigned Nile flood. In other words, within a solar year the lunar months corresponding to January through June are assigned one flood (that of the flood that occurred in July of the previous solar year), while the months running from July through December are assigned another (that of the current solar year). Results using this reassigned metric are significant at conventional levels, and those in columns (2)-(4) suggest that a one meter increase in the Nile’s deviation was associated with a 0.6 percentage point decrease in the probability an incumbent judge was dismissed in a month. This translates into approximately a 7.2 percentage point decrease in the yearly hazard.⁴⁶

Recall, however, that Hijazi’s data are still subject to transcription error even after reassignment. Panel 3 attempts to address this issue by instrumenting for Hijazi’s data with Taghri Birdi’s (uncorrected) Nile flood levels. Since Hijazi’s flood data is now correctly assigned to lunar months, instrumenting should yield consistent estimates. Columns (2) and (3) show that results instrumenting in this manner are significant at the 10% level. Point estimates suggest that a one meter increase in the Nile’s deviation was associated with a roughly 3 percentage point decrease in the probability that the incumbent judge was dismissed. This estimate implies approximately a 36 percentage point decrease in the yearly hazard.

Finally, the results in column (4) of panel 3 show that once one includes year and month dummies the correlation between Hijazi’s and Taghri Birdi’s data disappears. This result is consistent with the misassignment of floods to lunar months in Taghri’s data.

⁴⁶To see this denote the hazard at $DevNile_t^2$ by $\theta(DevNile_t^2)$. Then the difference in the probability the judge survives a lunar year (assuming the monthly hazard is constant) is given by: $1 - (1 - \theta(1))^{12} - [1 - (1 - \theta(0))^{12}] \approx 12(\theta(1) - \theta(0)) = 12\beta_1$ by the binomial approximation.

Length of Effect The analysis has thus far examined the “instantaneous” effect (or impact multiplier) of Nile failure on the outcomes of interest. It may be the case, however, that Nile famines take time to have an effect (and inasmuch as Nile failures are correlated across time the estimated “impact” coefficients may also be picking up the effects of past floods). To investigate the long-term effect of Nile deviations on a given outcome we estimate a distributed lag specification for three years by running a regression of the form:

$$y_{mt} = \alpha_m + \sum_{k=0}^2 \sum_{i=1}^{12} \beta_{ik} DevNile_{t-k}^2 + \varepsilon_t \quad (3)$$

where we used Hijazi’s correctly assigned data. For each month we have 3 β_k where these β_k represent the coefficients on the respective distributed lags. The cumulative dynamic multiplier calculated by summing the β_{ik} is presented in figure 3. The lower graph shows that the effect of a Nile failure on judge deposition is statistically significant after the first year of the Nile’s failure, but is no longer so after the second year.

3.2.3 Sultans

Previous empirical studies suggest that civil wars should be more likely to occur during periods of economic downturn. The theoretical and historical discussion suggests that while in equilibrium the head judge should support the incumbent sultan, this support may not have been sufficient to deter rival mamluk factions from revolting and succeeding with a higher probability during periods of economic downturn. This section investigates this possibility empirically, examining the effect of Nile deviations on the fortunes of the incumbent sultan.

Year Table 5 presents results from a regression identical to (1) with a dummy indicating a change in the incumbent sultan replacing that which indicated a change in the head judge. The format of table 5 is identical that of table 2 and shows that a deviant Nile is robustly correlated with a higher probability of change in the

incumbent sultan in Hijazi's data, and to a lesser extent in Taghri Birdi's data (this result again suggests greater measurement error in Taghri Birdi's data).

Results presented in panel 2 of table 4 show this general relationship also holds when using IV. Point estimates instrumenting for Taghri Birdi's data suggest that a two standard deviation (one meter) increase in the Nile's deviation was associated with between a 13 and an 23 percentage point increase in the probability the incumbent sultan was deposed in that lunar year.

Lunar Month Table 6 presents results from a regression identical to 2 with a dummy indicating a change in the incumbent sultan replacing that indicating a change in the head judge. The format of table 6 is identical to that of table 3 and shows that while a deviant Nile is associated with a higher probability of change in the incumbent sultan (point estimates in column (2) suggest a meter increase in the Nile's deviation was associated with approximately a 10 percentage point increase in dismissal over the following lunar year), these results cease to be statistically significant after the introduction of controls.

This lack of statistical significance, in turn, may be partly driven by the fact that much of the effect of Nile failures on changes in the sultanate appear to have come only after a significant time delay (and in the lunar year regressions Nile misclassification worked to assign floods to future years). Alternatively, these results may indicate that the previous results are spurious, although this possibility is difficult to reconcile with the regression results at the lunar year level.

Length of Effect We calculate the cumulative dynamic multiplier as in equation (3) using a dummy for a change in the sultan and plot the results in the upper graph of figure 3. This graph shows that much of the effect of Nile failure on sultan dismissal appears to occur at the end of the first year and during the second year after a Nile failure. The cumulative effect is still statistically significant 3 years after the deviant Nile flood, suggesting that if a Nile failure raised incomes (à la Malthus) for those who survived this did not lead to abnormally greater political stability once the Nile failure had ended.

4 Assumptions and Alternative Frameworks

The results suggest that Nile failures led to a lower probability of judge dismissal and to a higher probability of sultan dismissal. When viewed through the lens of the theoretical framework, the judges who were dismissed in “good times” should be viewed as abnormally “principled” individuals. During normal periods, the sultan did not find it worthwhile to purchase their support. When the Nile failed, however, the sultan offered these judges enough concessions to cause them to remain in power.

It should be noted that the theoretical framework suggests that our use of judge dismissal as a metric for judge influence is likely to underestimate the increase in total judicial influence. This is due to the fact that while Nile failures did not affect the tenures of those less “principled” head judges, it did affect the amount of concessions (relative to total economic output) they were able to extract during periods of Nile failures.

Although the empirical results are consistent with the theory, they do not prove its relevance since there are alternative theoretical frameworks that are consistent with the observed data pattern. This section briefly investigates in greater detail a few of the crucial assumptions made in the theoretical and empirical sections and then discusses the plausibility of a number of alternative frameworks.

4.1 Assumptions

4.1.1 Judicial Independence

The theoretical framework has critically assumed that the head judge was chosen because of his popular influence and not (solely) because of nepotism or bribery.

This assumption is empirically testable. If most judges were the incumbent sultan’s “yes men”, one would expect the correlation between judge dismissal and sultan dismissal to be strong.

Results presented in table seven are consistent with our assumption of head judge independence. Table seven reports the output from a regression of $Judge_t$ on $Sultan_t$ (a dummy equal to one if the incumbent sultan at t lost power on the interval $(t,t+1)$)

at the yearly and monthly level.

The first two columns use the lunar year and the last three columns use the lunar month as the unit of observation. The results suggest that a change in the sultan in a given month was associated with only a 3-7 percentage point higher probability of a change in the judgeship. This result rejects a high level of dependence between the incumbent sultan and head judge.

4.1.2 No Judicial Infighting

We have assumed that the sultan always appointed the most influential judge (who remained uniquely so until his death or dismissal). This simplifying assumption has allowed us to abstract from the process leading to judicial appointment. One might worry, however, that periods of Nile-induced famines led religious elites to increasingly compete over the head judgeship as the amount of resources declined. This increased competition could have led to greater concessions by the incumbent head judge and thus to a lower probability of dismissal. This possibility, however, is difficult to justify from a theoretical standpoint and is not consistent with the available historical evidence.

4.1.3 Constant Effects

In the empirical section, we have considered results spanning the entire period covered by the data. In reality, however, the religious composition of the Egyptian population changed over this period (as the populace converted to Islam) and thus one might expect the head judge to become more influential as time progressed. Although there is some evidence that this is the case, one cannot reject the equality of coefficients before and after the emergence of a firmly Sunni Egypt in 1169 CE.⁴⁷

⁴⁷Consistent with this finding, the secondary literature suggests that the institutional framework described in section one is in many ways similar to that of earlier periods. See Lapidus (1975), Ayalon (1977), Beshir (1978) and Pipes (1981).

4.1.4 Linear Residuals and Long Memory

Linear Residuals Calculating Nile residuals using a linear trend was done for transparency and to facilitate the theoretical discussion regarding IV. In addition, it seems a reasonable measure for the “goldilocks” flood level (or the flood level that maximized agricultural productivity the following year). This is confirmed by figure 1 which shows that around the Muslim conquest of Egypt, the linear trend is almost exactly at 16 cubits, or the level considered to be the most adequate for agricultural production.

In any case, results using residuals from an autoregression or those generated using moving averages or higher-order polynomial in time are similar to those presented.

Long Memory Throughout this paper we have conditioned on the Nile flood level. This has allowed us to abstract from the fact that the Nile flood data have been shown to exhibit “long memory” or slowly decaying autocovariances (Beran 1994).

This long-memory property of Nile floods raises a somewhat subtle point involving the causal effects we are able to identify. In other words, even if the Nile flood level is exogenous, we may be attributing some of the effect of past Nile floods to today’s flood. Although this is not a threat to the causality of the results, on the one hand it does suggest caution when attributing the results to any specific Nile flood. On the other hand, the empirical results seem to be largely driven by larger deviations that appear to have happened relatively independently of lower-frequency cycles.

4.2 Alternative Frameworks

4.2.1 “Hunkering Down” During Famines

One alternative explanation for the observed results is that judges were irrelevant bureaucrats and the sultans were simply less likely to dismiss anyone in the government during famines.

This alternative explanation contradicts the historical record on two counts.

First, as discussed in sections one and two there is significant evidence that judges were relevant, especially during periods of political crisis. Second, the historical record suggests that some less influential officials were targeted as “scapegoats” for the rise in bread prices following Nile failures (Shoshan 1980, p. 471).

Had the head judge –who was the highest ranking religious official in Egypt– been completely powerless it seems plausible the sultan would have blamed the Nile’s failure on the his lack of divine influence and dismissed him. The data, however, show the opposite occurred.

4.2.2 “Starving” Judges

In the theoretical framework, a *ceteris paribus* decrease in the judge’s outside option makes him more likely to accept the sultan’s offer of payments. This fact might lead one to fear that the judge had no control over rebellions but that during Nile failures the judge’s outside option fell faster than the sultan’s wage offer. This possibility, however, is difficult to explain in a neoclassical framework (since a maximizing sultan should set the bureaucrat’s wage to make him indifferent to leaving his post).

4.2.3 Increased Superstition

Another alternative hypothesis that is consistent with the results involves an increase in “superstition” on the part of the ruler or populace or a belief that Nile failure was a divine punishment for some misdeed. Under this explanation, the sultans were less likely to dismiss judges during periods of Nile failure because they were afraid of an increase (or prolongation) of God’s wrath. Alternatively, the populace was more likely to follow the judge’s mandates for the same reason.

This explanation is observationally equivalent to our theory and consistent with the historical record. Although the causal channel is different than the neoclassical argument stressed throughout the paper, the ultimate outcome – increased clerical influence– is the same in both situations.⁴⁸

⁴⁸If results are interpreted in this light they complement those in Oster (2004) and Miguel (2005).

5 Conclusion

Recent work has shown that economic crises i. foster political instability and ii. can lead to institutional change. The empirical and historical evidence presented in this paper complements the first set of studies by showing that economic shocks led to political instability in pre-modern Islamic Egypt.

The historical evidence is also consistent with many of the mechanisms detailed in the second set of studies. Deviant Nile floods helped solve the collective action problem in medieval Egypt by making rioting individually optimal for a larger section of the populace. Despite this fact, the institutional framework Napoleon found in Egypt in 1798 was quite similar to the framework that existed in the Middle Ages.

The empirical, theoretical and historical evidence presented in this paper sheds light on why Nile shocks did not lead to fundamental institutional changes. The evidence suggests that the lower probability of head judge dismissal during deviant Niles was a product of the increased bargaining power of a subset of these judges. It also highlights that the head judge's political influence derived from his control over popular coordination networks. One would not expect substantial institutional innovations during economic downturns if the religious elites who controlled these networks did not view such changes in their best interest.

Consistent with this interpretation, one prominent historian of medieval Egypt has argued that the control of the religious authorities over popular coordination networks played an important role in “inhibit[ing] more revolutionary developments” (Lapidus 1984, p. 153). In his framework, Egyptian institutions did not fundamentally change following economic downturns because the religious scholars empowered by such shocks did not see change in their interest. These religious scholars found it optimal to temporarily increase their payoffs (and to pass some of the gains on to the populace), but not to overthrow the existing system.

This discussion suggests that future research investigating the political economy of religious organizations may provide important insights into the process of institutional change and the formation of cultural beliefs. If religious authorities extracted rents from their control over popular assembly, then it seems reasonable to expect

them to develop teachings emphasizing obedience and to resist the emergence of alternative coordination networks. These observations are consistent with studies emphasizing that many religions have encouraged political “quietism” and discouraged the development of social capital, civil society and democracy.⁴⁹

Although conjectural at this point, the approach of viewing religious elites as rational actors suggests that religious beliefs and teachings are in part endogeneously formed. Thus, a deeper understanding the political environment in which religious organizations operate may help explain cross-sectional differences in religious teachings as well as changes and persistence in religious and other cultural beliefs (for studies emphasizing the persistence of such beliefs see Bisin and Verdier (2001), Guiso et al. (2003, 2006) and Tabellini (2008b)).

Finally, it is interesting to note that the emergence of non-religious coordination networks representing the interests of artisans and peasants had occurred in Latin Europe by the 13th century (Cohn 2006). Such coordination networks do not appear to have existed in Western Europe in the 8th century, when religious organizations controlled these networks (Ullmann 1969, pp. 43-70). This observation suggests that political developments in Latin Europe between the 8th and 13th centuries may hold important insights into the institutional evolution of the West and its political and economic divergence from the Islamic world.

References

- ‘Abd al-Laṭīf al-Baghdādī, M. 1231 [1869]. *Al-Ifāda wa al-‘Itibār fī al-Umūr al-Mushāda wa al-Hawādith al-Mu’āyina bi-Arḍ Miṣr*. Cairo: Maṭba’at Wādī al-Nīl.
- Acemoglu, D. and J. A. Robinson.** 2000. “Political Losers as a Barrier to Economic Development.” *American Economic Review*, 90(2) 126-130.
- Acemoglu, D. and J. A. Robinson.** 2001. “A Theory of Political Transitions.” *American Economic Review*, 91(4) 938-963.
- Acemoglu, D. and J. A. Robinson.** 2006. *Economic Origins of Dictatorship*

⁴⁹See, among a large literature, Lipset (1959), Putnam (1993) and Stepan (2000).

- and Democracy*. New York: Cambridge University Press.
- Acemoglu, D. and J. A. Robinson.** 2008. "Persistence of Power, Elites, and Institutions." *American Economic Review*, 98(1) 267-293.
- Acemoglu, D., D. Ticchi and A. Vindigni.** 2010. "A Theory of Military Dictatorships." *American Economic Journal: Macroeconomics*, 2(1), 1-42.
- Ayalon, D.** 1977. "Aspects of the Mamlūk Phenomenon." *Der Islam*, 54 1-32.
- Barro, R. and R. McCleary.** 2003. "Religion and Economic Growth across Countries." *American Sociological Review*, 68(5): 760-781.
- Barro, R. and R. McCleary.** 2005. "Which Countries Have State Religions?." *Quarterly Journal of Economics*, 120(4): 1331-1370.
- Barro, R. and R. McCleary.** 2006. "Religion and Political Economy in an International Panel." *Journal for the Scientific Study of Religion*, 45(2): 149-175.
- Beran, Jan.** 1994. *Statistics for Long-Memory Processes*. New York: Chapman & Hall.
- Beshir, B.** 1978. "Fatimid Military Organization." *Der Islam*, 55: 37-56.
- Bianquis, T.** 1998. "Autonomous Egypt from Ibn Ṭūlūn to Kāfūr" in Carl Petry Ed. *The Cambridge History of Egypt 650-1517*: 86-119.
- Bisin, A. and T. Verdier.** 2001. "The Economics of Cultural Transmission and the Dynamics of Preferences." *Journal of Economic Theory*, 97: 298-319.
- Blattman, C. and E. Miguel.** 2010. "Civil War." *Journal of Economic Literature*, 48(1): 3-57.
- Borsch, S.** 2000. "Nile Floods and the Irrigation System in Fifteenth-Century Egypt." *Mamlūk Studies Review*, 4: 131-145.
- Borsch, S.** 2005. *The Black Death in Egypt and England: A Comparative Study*. Austin: University of Texas Press.
- Brückner, M. and A. Ciccone.** 2009. "Rain and the Democratic Window of Opportunity." Mimeo: Universitat Pompeu Fabra
- Brückner, M. and A. Ciccone.** 2010. "International Commodity Prices, Growth, and the Outbreak of Civil War in Sub-Saharan Africa." *Economic Journal*, 120 (May): 519-534.

- Chaney, E.** 2008. "Tolerance, Religious Competition and the Rise and Fall of Muslim Science." Mimeo
- Chaney, E.** 2010. "Islam and Human Capital Formation: Evidence from Pre-Modern Science." In R. McCleary (ed.) *The Oxford Handbook of the Economics of Religion*, forthcoming
- Chassang, S. and G. Padró i Miquel.** 2009. "Economic Shocks and Civil War." *Quarterly Journal of Political Science*, 4: 211-228.
- Cohn, S.** 2006. *Lust for Liberty: The Politics of Social Revolt in Medieval Europe*. Cambridge: Harvard University Press.
- Cooper, R.** 1976. "The Assessment and Collection of Kharāj Tax in Medieval Egypt." *Journal of the American Oriental Society*, 96(3): 365-382.
- Coşgel, C., T. Miceli and R. Ahmed** 2009. "Law, State Power, and Taxation in Islamic History." *Journal of Economic Behavior & Organization*, 71: 704-717.
- Crone, P.** 1980. *Slaves on Horses: The Evolution of the Islamic Polity*. New York: Cambridge University Press.
- Crone, P.** 2004. *God's Rule: Government and Islam*. New York: Columbia University Press.
- Escovitz, J.** 1984. *The Office of Qādī al-Qudāt in Cairo under the Bahrī Mamlūks*. Berlin: Klaus Scharz Verlag.
- Frantz-Murphy, G.** 1986. *The Agrarian Administration of Egypt from the Arabs to the Ottomans*. Cairo: Institut Français D'Archéologie Orientale.
- Freeman-Grenville, G.S.P.** 1995. *The Islamic and Christian Calendars AD 622-2222 (AH 1-1650)*. Reading: Garnet Publishing.
- Greif, A.** 2006. *Institutions and the Path to the Modern Economy*. New York: Cambridge University Press.
- Grossman, H and J. Mendoza.** 2003. "Scarcity and Appropriative Competition." *European Journal of Political Economy*, 19: 747-758.
- Guiso, L., P. Sapienza and L. Zingales.** 2003. "People's Opium? Religion and Economic Attitudes." *Journal of Monetary Economics*, 50: 225-282.
- Guiso, L., P. Sapienza and L. Zingales.** 2006. "Does Culture Affect Economic Outcomes?." *Journal of Economic Perspectives*, 20(2): 23-48.

- Hassan, F.** 2007. "Extreme Nile floods and famines in Medieval Egypt (AD 930-1500) and their climatic implications." *Quaternary International* 173-174: 101-112.
- (Al-)Ḥijāzī, S.** 1470. *Nail al-Rā'id min al-Nil al-Zā'id*. Biblioteque National de la France, Manuscripts Orientaux: manuscript 2261.
- Ibn Ḥajar, S.** 1449 (1998). *Raf'u al-Iṣr 'an Qudāt Miṣr*. Cairo: Maktaba al-Khānjī.
- Iyigun, M.** 2008. "Luther and Suleyman." *Quarterly Journal of Economics*, 123(4): 1465-1494.
- Irwin, R.** (1986). *The Middle East in the Middle Ages: the Early Mamluk Sultanate*. Carbondale: Southern Illinois University Press.
- Irwin, R.** (1986 b). "Factions in Medieval Egypt." *Journal of the Royal Asiatic Society of Great Britain and Ireland*, 2: 228-246.
- Jabartī, A.** 1822 [1994]. *'Ajā'ib al-Āthār fī al-Tarājim wa al-Akhhār*, tr. T. Phillip and M. Perlmann. Stuttgart: Franz Steiner Verlag.
- Lancaster, T.** 1990. *The Econometric Analysis of Transition Data*. New York: Cambridge University Press.
- Lapidus, I.** 1975. "The Separation of State and Religion in the Development of Early Islamic Society." *International Journal of Middle Eastern Studies*, 6: 363-385.
- Lapidus, I.** 1984. *Muslim Cities in the Later Middle Ages*. New York: Cambridge University Press.
- Lipset, S.** 1959. "Some Social Requisites of Democracy: Economic Development and Political Legitimacy." *The American Political Science Review*, 53(1): 69-105.
- Lev, Y.** 1991. *State and Society in Fatimid Egypt*. Leiden: E.J. Brill.
- Lewis, B.** 1953. "Some Observations on the Significance of Heresy in the History Of Islam." *Studia Islamica*, 1: 43-63.
- Maqrīzī, T.** 1405 [1994]. *Ighāthat al-Ummah bi-Kashf al-Ghummah* tr. Adel Al-louche. Salt Lake City: University of Utah Press.
- Maqrīzī, T.** 1441 [1997]. *Al-Sulūk li-Ma'arifat Duwal al-Mulūk*. Beirut: Dār al-Kutub al-'Ilmiyya.
- Miguel, E.** 2005. "Poverty and Witch Killing." *Review of Economic Studies*, 72: 1153-1172.
- Miguel, E., S. Satyanath and E. Sergenti.** 2004. "Economic Shocks and

- Civil Conflict: An Instrumental Variables Approach.” *Journal of Political Economy*, 112(4): 725-753.
- Murphy, K. and A. Shleifer.** 2004. “Persuasion in Politics.” *American Economic Review*, 94(2): 435-439.
- Nielsen, J.** 1985. *Secular Justice in an Islamic State: Mazālim under the Bahrī Mamlūks*. Istanbul: Nederlands Historisch-Archaeologisch Instituut.
- North, D., J. Wallis and B. Weingast.** 2009. *Violence and Social Orders*. New York: Cambridge University Press.
- Oster, E.** 2004. “Witchcraft, Weather and Economic Growth in Renaissance Europe.” *Journal of Economic Perspectives*, 18(1): 215-228.
- Perho, I.** 2001. “Al-Maqrīzī and Ibn Taghrī Birdī as Historians of Contemporary Events.” In *The Historiography of Islamic Egypt (950-1800)*, ed. Hugh Kennedy, 107-121. Leiden: Brill.
- Petry, C.** 1981. *The Civilian Elite of Cairo in the Later Middle Ages*. Princeton: Princeton University Press.
- Petry, C.** 1994. *Protectors or Praetorians?: the Last Mamluk Sultans and Egypt’s Waning as a Great Power*. Albany: SUNY Press.
- Pipes, D.** 1981. *Slave Soldiers and Islam: the Genesis of a Military System*. New Haven: Yale University Press.
- Popper, W.** 1951. *The Cairo Nilometer*. Berkeley: University of California Press.
- Raymond, A.** 1973. *Artisans et Commerçants au Caire au XVIII Siècle (I)*. Damascus: Institut Français de Damas.
- Raymond, A.** 1974. *Artisans et Commerçants au Caire au XVIII Siècle (II)*. Damascus: Institut Français de Damas.
- Raymond, A.** 2002. *Cairo: City of History*, tr. Williard Wood. New York: The American University in Cairo Press.
- Ruzmaikin, A., J. Feynman and Y. Yung.** 2006. “Does the Nile Reflect Solar Variability?.” *Proceedings IAU Symposium 233*: 1-8.
- Sabra, A.** 2000. *Poverty and Charity in Medieval Islam*. Cambridge: Cambridge University Press.
- Sāmī, A.** 1916. *Taqwīm al-Nīl*. Cairo: Maṭb’a al-‘Amiriya.

- Sanders, P.** 1994. *Ritual, Politics, and the City in Fatimid Cairo*. Albany: State University of New York Press.
- Al-Sayyid Marsot, A.** 1972. “The Ulama of Cairo in the Eighteenth and Nineteenth Centuries” in *Scholars, Saints, and Sufis: Muslim Religious Institutions since 1500*, Edited by Nikki R. Keddie pp. 149-165.
- Al-Sayyid Marsot, A.** 1973. “The Political and Economic Functions of the ‘Ulamā’ in the 18th Century.” *Journal of the Economic and Social History of the Orient*, 16(2/3): 130-154.
- Shoshan, B.** 1980. “Grain Riots and the “Moral Economy”: Cairo, 1350-1517.” *Journal of Interdisciplinary History*, 10(3): 459-478.
- Shoshan, B.** 1993. *Popular Culture in Medieval Cairo*. New York: Cambridge University Press.
- Smith, A.** 1999 [1776]. *The Wealth of Nations: Books IV-V*. New York: Penguin Books.
- Stepan, A.** 2000. “Religion, Democracy, and the “Twin Tolerations”.” *Journal of Democracy*, 11(4): 37-57.
- Tabellini, G.** 2008a. “Institutions and Culture.” *Journal of the European Economic Association*, 6(2-3): 255-294.
- Tabellini, G.** 2008b. “The Scope of Cooperation: Values and Incentives.” *Quarterly Journal of Economics*, 123(3): 905-950.
- Tabellini, G.** 2010. “Culture and Institutions: Economic Development in the Regions of Europe.” *Journal of the European Economic Association*, 8(4): 677-716.
- Taghrī Birdī, A.** 1468 [1976]. *Al-Nujūm al-Zāhira fī Mulūk Miṣr wa al-Qāhira vol. 1-7*, tr. William Popper. New York: AMS Press.
- Taghrī Birdī, A.** 1468b [1990]. *Hawādith al-Duhūr fī Mada al-Ayyām wa al-Shuhūr*. Cairo: Wizāra al-Awqāf.
- Toussoun, O.** 1925. *Memoire sur l’histoire du Nil, vol. 9*. : Memoires a l’Institut d’Egypte.
- Tsugitaka, S.** 1997. *State and Rural Society in Medieval Islam*. Leiden: E.J. Brill.
- Tucker, W.** 1981. “Natural Disasters and the Peasantry in Mamluk Egypt.” *Journal of the Economic and Social History of the Orient*, 24(2): 215-224.

Tyan, E. 1960. *Histoire de l'Organisation Judiciaire en Pays d'Islam*. Leiden: E.J. Brill.

Ullman, W. 1969. *The Carolingian Renaissance and the Idea of Kingship*. London: Methuen & Co.

6 Appendix

6.1 Proof of Proposition 1

Proceed by backward induction. The judge will sanction a revolt if and only if $h(1)(\rho\tau\frac{Y_{\max}}{2}) > \max(P_J, \bar{w}_J)$ (recall that we assume that if indifferent the judge does not sanction the revolt). Since $h(1) \leq \gamma$ on $[\bar{Y}, Y^{Goldilocks}]$, the judge will set $J=0$ on this interval regardless of the sultan's actions.

If $Y < \bar{Y}$, then $h(1) > \gamma$ and the judge will sanction a revolt unless the sultan pays him at least $h(1)\rho\tau\frac{Y}{2}$.

The sultan, conditioning on the judge's behavior, sets $P_J = 0$ as long as $Y \geq \bar{Y}$. If $Y < \bar{Y}$ the sultan pays the judge $h(1)\rho\tau\frac{Y}{2}$ since we assume that assumption 3 holds. ■

6.2 Instrumental Variables

The true deviation of the Nile height from its long-term average in year t $z_t \equiv Nile_t - \widehat{Nile}_t$ is measured both by Taghri Birdi and Hijazi with error. Denote Hijazi's measurements by $w_t = z_t + \nu_t$ and Taghri Birdi's measurements by $x_t = z_t + \eta_t$. Denote the variable of interest by y_t . The regression of interest is $y_t = \beta_0 + \beta_1 z_t^2 + \varepsilon_t$. We assume that $z_t, \eta_t, \varepsilon_t$ and ν_t are mutually independent and have mean 0.⁵⁰ In addition we assume all necessary moments exist.

Without loss of generality, consider estimating β_1 in the regression $y_t = \beta_0 + \beta_1 w_t^2 + u_t$ by instrumenting for w_t^2 with x_t^2 . Standard arguments then imply that $\beta_1^{IV} \xrightarrow{p} \beta_1 + \frac{Cov(x_t^2, u_t)}{Cov(x_t^2, w_t^2)}$. Now observe that $E[x_t^2 u_t] = E[(z_t^2 + \eta_t^2 + 2z_t \eta_t)(-\beta_1 \nu_t^2 -$

⁵⁰These are stronger assumptions than necessary but are made for expositional simplicity.

$2\beta_1 z_t v_t + \varepsilon) = E[(z_t^2 + \eta_t^2 + 2z_t \eta_t)E[-\beta_1 \nu_t^2 - 2\beta_1 z_t v_t + \varepsilon | z_t, \eta_t]] = E[x_t^2]E[-\beta_1 \sigma_\nu^2] = E[x_t^2]E[u_t]$ and thus $CoV(x_t^2, u_t) = 0$. ■

7 Data Appendix

7.1 Flood Data, Hijri and Solar Years

Nile flood data are drawn from records provided by Hijazi (1470) and Taghri Birdi (provided by Sami (1916)). Hijazi (1470) provides the Nile maximum by lunar year uninterrupted (aside from “skip years”, see below) over the interval [1,873] AH. Taghri Birdi provides a parallel set of statistics covering the interval [20,855] AH (see Sami (1916, introduction, pp. 4-9)).

All Nile statistics are recorded by hijri (lunar) year in the sources. This year contains 354 days (355 days in a leap year), as compared to the slightly less than $365 \frac{1}{4}$ days in the solar year. Consequently, the lunar year “recedes” approximately 11 days each solar year.

The use of the lunar calendar in the original sources created two empirical problems: i. assigning each Nile flood to a given solar year and ii. assigning judge and sultan changes to a solar month and year.

7.1.1 Assigning Nile floods to Solar Years

When assigning a Nile flood (which followed the solar year) to a lunar year, the chroniclers appear to have used one of 3 different mappings:

i. assigning the lunar year on which the Nile maximum actually occurred, ii. assigning the Nile maximum to a year that contained a fixed solar date regardless of the actual maximum date of the Nile or iii. numbering the years by convention. To better understand the implications of these three mappings we will consider them one by one.

Assigning the lunar year on which the maximum occurred For the purpose of discussion, suppose that the Nile flood in the solar year 1177 CE occurred on the

4th of September. The 4th September, 1177 CE fell in the year 573 AH (which spanned the interval [30, June 1177; 18, June 1178]). Thus, we would assign this flood to the lunar year 573 AH.

When assigning solar events such as the Nile flood to lunar years, roughly every 33 years one lunar year should be skipped from enumeration. To see why this is the case, suppose for simplicity that the solar flood occurred every September 4th (which it did not since the flood’s maximum date was stochastic). If this were the case, then the year 566 AH [14 September, 1170; 3 September, 1171] did not contain a Nile maximum and should be left blank in the Nile statistics. Similarly, the year 600 AH [10 September, 1203; 28 August 1204] should also be blank and so on. These years are referred to in Popper (1951) as “skip years.”

Assigning the lunar year that contained a fixed solar date The chroniclers could also assign the Nile flood from a given solar year to the lunar year that contained a fixed date. For example, June 20th was the start of the Nile year, and a chronicler could assign the minimum and maximum of the Nile year starting on June 20th to the lunar year that contained June 20th.

Thus –returning to our previous example– the flood of the year 1177 which occurred on September 4th would be assigned to the year 572 AH since June 20th, 1177 fell at the end of 572 AH.

Numbering years by convention Finally, Hijazi’s data appears to have assigned solar year floods to lunar years by convention, at least on the interval [1,622] AH. He says that his data covering this interval was copied from an original source where approximately every 34th lunar year was a skip year. This omission defines a mapping on this interval between lunar and solar years, but the “skip years” do not have any calendar (i.e. solar month) regularity .

Such conventions appear to have often been used, and could at times mean that the flood assigned to a given lunar never actually “treated” any portion of the lunar year it was assigned to.⁵¹

⁵¹See Popper (1951, pp. 123-149) for a discussion.

For an example, consider Hijazi’s statistics assigned to 573 AH [30, June, 1177; 18, June, 1178]. These statistics, correspond (following Toussoun (1925)) to the flood from the solar year 1178. Since the Nile did not start appreciably rising until the start of July, this means that the flood that is assigned to the lunar year 573 AH did not treat the true lunar year 573 AH at all.

Moreover, the problem gets worse as the solar year flood of 1179 was assigned to the hijri year 574 AH [19, June, 1178; 7, June, 1179]; that of 1180 to 575 AH [8, June, 1179; 27, May, 1180], that of 1181 to 576 AH [28, May, 1180; 16, May, 1181] and that of 1182 to 577 AH [17, May, 1181; 6, May, 1182].

Finally, the year 578 AH [7, May, 1182; 25, April, 1183] was skipped and the flood of 1183 was assigned to 579 AH [26, April, 1183; 13, April, 1184], bringing the flood back within the assigned lunar year.

7.1.2 Misassignment Measurement Error

The previous discussion suggests that using the lunar year as the unit of observation resulted in the misassignment of some floods and to their assignment to different lunar years in different sources. For example, Hijazi appears to have assigned the flood from 1178 CE to the year 573 AH. Whereas a different observer (using the data on which the maximum occurred) would have recorded the flood of 1177 CE in the year 573 AH.

In general –as should be clear from the previous discussion– one lunar year was almost always “treated” by two Nile floods. Thus, even if the assigned flood occurred in the lunar year it was assigned to, the entire lunar year was generally not treated only by this flood. If the two Nile sources used roughly the same mapping between floods and lunar years (which seems likely), IV will not address this problem.

Fortunately, for Hijazi’s data we have an idea of the mapping used between lunar and solar years which can help address this error. Results reassigning Nile floods using Toussoun’s (1925) mapping in section 3.2 suggests that this source of measurement error acts to attenuate the coefficients in the lunar year regressions.

For the purposes of the empirical analysis at the lunar year level, we treat missing

data in both Hijazi's and Taghri Birdi's data as denoting a skip year and assign missing floods the flood from the previous lunar year.

7.2 Assigning Lunar Months to Solar Months

Converting hijri months to solar months was more straightforward. To do this I developed a simple algorithm using the mapping provided in Freeman-Grenville (1995). Their conversion tables assume that the 12 lunar months of the hijri year alternate between 30 and 29 days. In addition, they give lunar leap years on pages 18-72.

To create the mapping between hijri and Julian years I created a metric measuring the days elapsed from 16th July, 622 CE which corresponded to 1st Muharram, 1 AH.⁵² This metric is equal to 1 on this date for both the Muslim and the Julian Calendars. Then using the leap years provided by Freeman-Grenville, I wrote a loop appending normal years and leap years when appropriate. A similar loop appended normal and skip years for the Julian Calendar. I then merged the two data sets on the days elapsed metric to obtain the mapping between a hijri day, month and year and its Julian counterpart.

This mapping is quite accurate, and in a random sample of 20 days was never more than two days off the mappings provided by alternative algorithms (which themselves have non-zero probabilities of error. For one alternative see <http://www.islamicfinder.org/dateConversion.php>).

Once equipped with this mapping at the daily level, I created the monthly mapping as follows. I first calculated the percentage of each hijri month occupied by a given Julian month. I then assigned a hijri month to a Julian month if the Julian month occupied 50% or more of the hijri month. Since the solar year is longer than the lunar year, sometimes 2 different hijri months are assigned to 1 Julian month (that is one Julian month occupied 50% or more of two hijri months).

For clarity in the monthly regressions, I retained the lunar month as the unit

⁵²We 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.

of observation. This decision meant that some Julian years actually have 13 lunar months assigned to them (since one of Julian month occupies 50% or more of two hijri months).

7.3 Cubits and Fingers

The original data give the minimum and maximum levels of the Nile flood in cubits and fingers. I used the mapping provided by Popper (1951, pp. 104-105, table 1) to convert cubits and fingers into meters above sea-level.

7.4 Nile Silting

As time progressed it appears that the Nile bed (and the surrounding land) silted up “inflating” the measured Nile height (Popper 1951, pp. 242-243). For this reason, we approximate the “real” Nile flood deviation by calculating the deviation of the Nile from the time trend:

$$NileHigh_t = \alpha + \beta t + \varepsilon_t \quad (4)$$

the coefficient β is estimated using Taghri Birdi’s data to be (time is measured in hijri centuries) 0.105 with a standard error of (0.008) and using Hijazi’s data is 0.107 (0.008) (i.e. the Nile bed rose by approximately 10cm every hijri century due to silting). These nearly identical coefficients are what we would expect if Nile measurement errors are “classical” and suggest that we are able to measure the long-term “goldilocks” flood level with a reasonable degree of accuracy.

7.5 Head Judges

Head judge appointment and release dates were taken from Ibn Hajar (1449). Of the 254 judge changes reported by Ibn Hajar on the interval [20, 10th month of 842 AH] the year of dismissal was available (or could be imputed) for 253 (99.6%) and the year and month of dismissal was available for 220 (86.6%) of the judges.

Missing dismissal dates were imputed as follows. Ibn Hajar (1449, pp. 4-21) provides a poem that lists judges in chronological order. When a judge’s dismissal date was missing, he was assigned the appointment data of the judge that chronologically followed him in the poem. When the month/year of the following judge was missing, the dismissal month/year was left blank.

When there was more than one head judge (briefly under the Fatimids and under Mamluks after 1265), I included the dismissal data of the Shafi’i judge (since the Shafi’i school was the most influential in Egypt during the Mamluk era).

Since we do not completely view the year 842 AH, we discard it from our sample. We are left with 253 judge dismissals spanning the years [20,841 AH].

7.6 Sultans

The lunar years and months of changes in the political leadership of Egypt were taken from Sami (pp. 2-251).

7.7 Total Number of Observations

7.7.1 Year

After assigning missing lunar years the previous year’s value, in the empirical section we use the continuous time series spanning the interval [20,841] AH (this is the intersection of all the data sets). Using Hijazi’s (Toussoun’s (1925)) mapping between lunar and solar years, these 822 lunar years correspond to 798 solar years ([641,1438] CE). The number of solar years in the data set is equal to the number of lunar year (822) minus the number of skip years (24 years, see below).

7.7.2 Month

The hijri years that are “skipped” using Toussoun’s (1925) mapping are 34, 68, 102, 136, 170, 204, 238, 272, 306, 340, 374, 408, 442, 475, 510, 544, 578, 612, 646, 681, 714, 748, 781, 817. If this convention is assumed it allows us to map lunar years into

solar years.⁵³

Equipped with this mapping, we use the mapping explained in section 7.2 to assign each hijri month its solar counterpart (while retaining the lunar month as the unit of observation). We then merged this data set (using solar month and year) with the Nile flood data set. We treated missing months/years of judge changes as if they had not occurred.

We then reassigned the solar Nile flood to lunar months by Nile years. To better understand these Nile years, consider the solar year 1000 CE. This solar year was “treated” by two different Nile floods. The Nile flood that occurred in 999 CE, and the one that occurred in 1000 CE. We thus assign the flood value from 1000 CE to the months [7,12] of 1000 CE and the months [1,6] of 1001 CE. The first six months of 1000 CE are assigned the flood from 999 CE.

We then define the “Nile year” 1000 to be equal to the union of [7,12] of 1000 CE and [1,6] of 1001 CE; that is, the Nile year 1000 runs from July 1000 CE through June 1001 CE. Toussoun’s (1925) mapping implies that the last recorded flood level in 1438 CE (which was recorded in the year 841 AH) never treated the year 841 AH (which ended on June 23, 1438 CE). Thus our sample contains the Nile years [641,1437], that is the data run from July, 641-July, 1437. If we do not make these corrections (that is, we leave the Nile floods assigned by lunar year and assign each month in that lunar year that year’s assigned flood level) our data covers the interval [20,841] AH.

Consequently, if we run monthly regression using the uncorrected lunar month data we are left with $822*12=9864$ observations. If we use the corrected data we have 9857 observations. This number can be understood as follows. If we ran the regressions at the solar month level we would have we would have $797*12=9564$ observations. In practice, however, we maintain the lunar month as the unit of observations. Recall that some solar years encompass 13 lunar months (see section 7.2). There are 293 of these years, and thus the total number of monthly observations is $9564+293=9857$.

⁵³This mapping, however, is not perfect after 622 AH. See Popper (1951, pp. 129-130) for details.

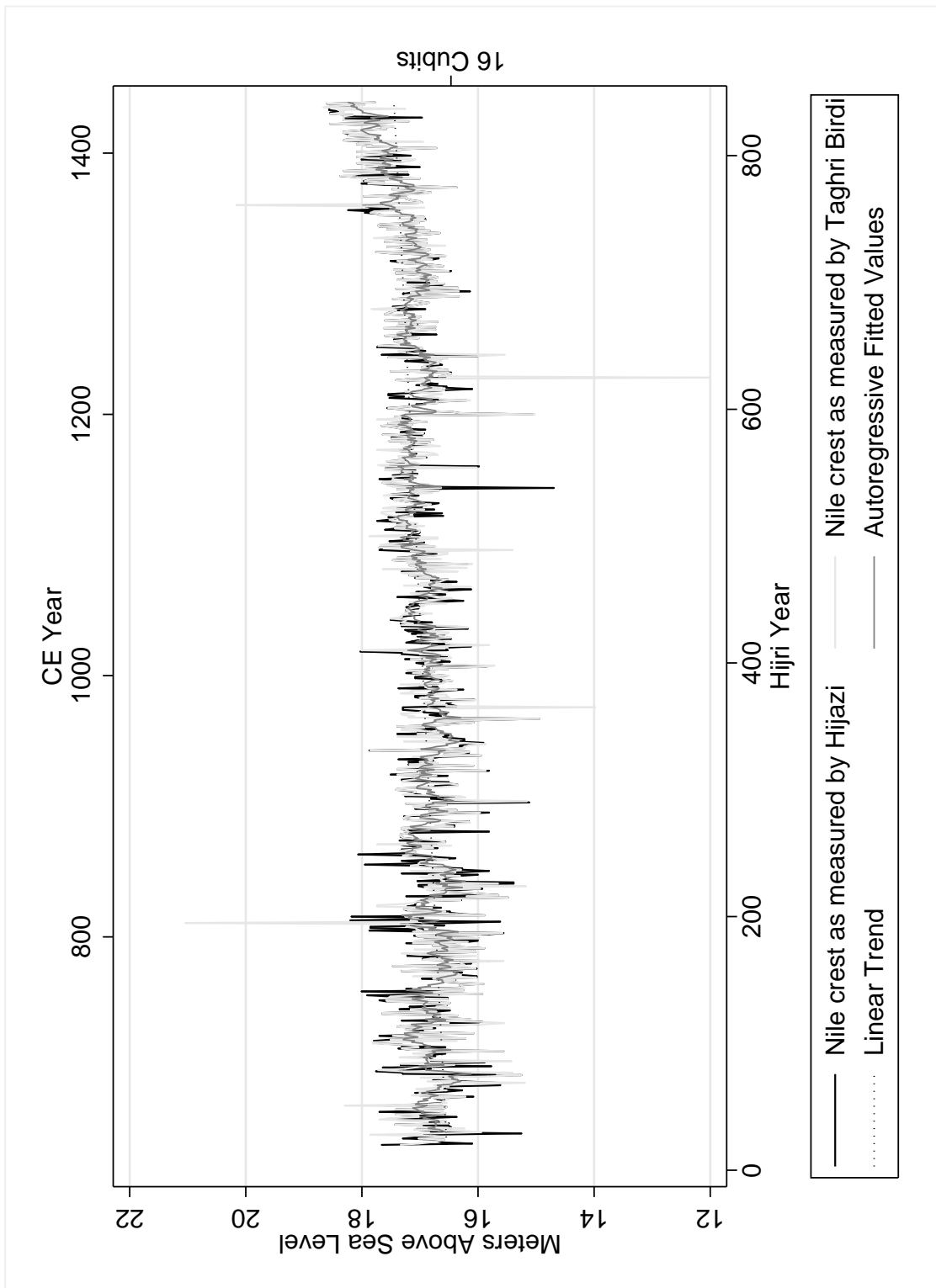


Figure 1: **Highest Measured Crest of Nile in Meters above Sea Level**
 Sixteen Cubits (16.47 meters) marks “Plenitude”

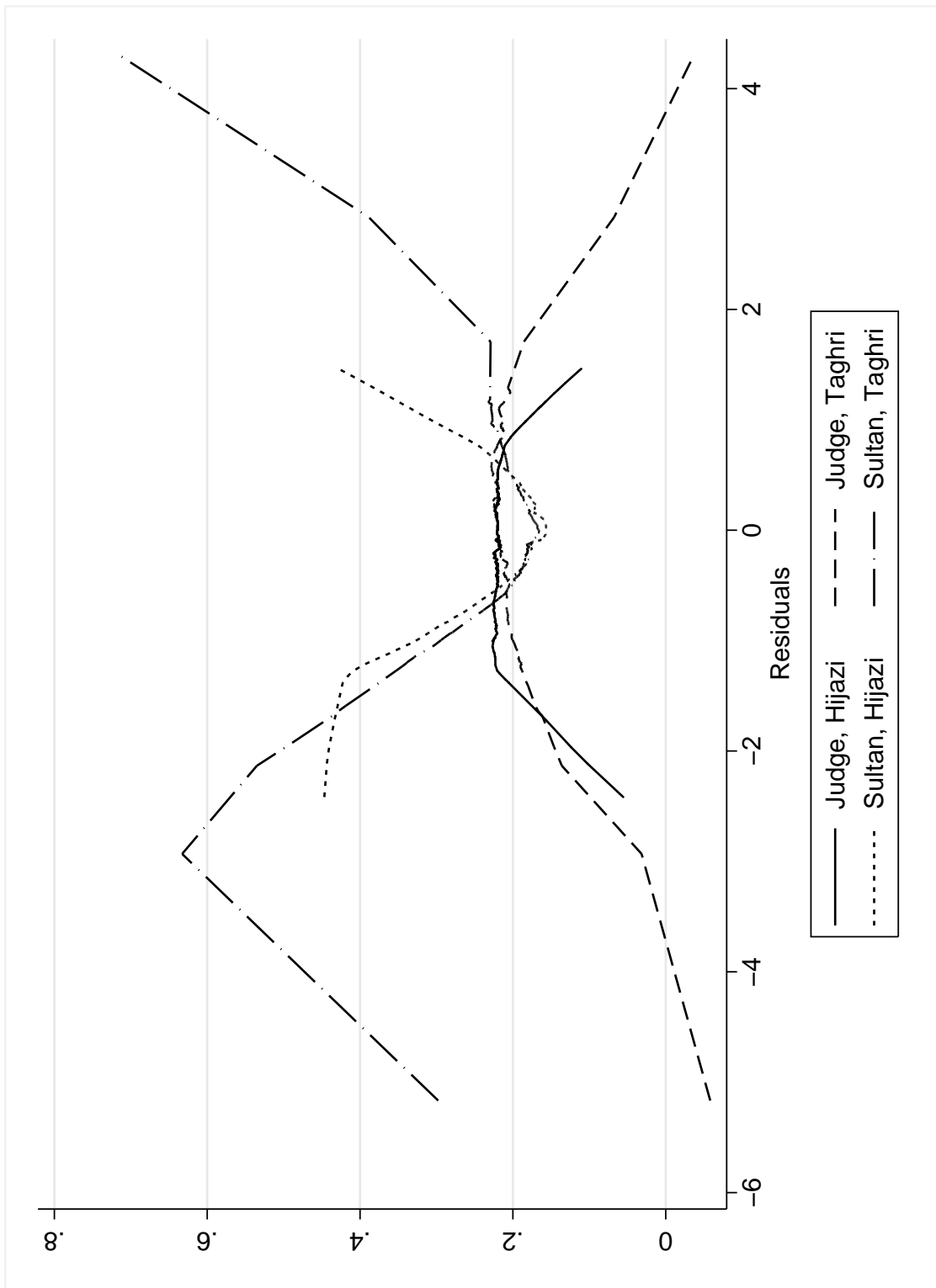


Figure 2: Nile Variation and Probability of Change
 Graphs detail (raw) non-parametric relationship between changes in the Judgeship, the Sultanate and Nile deviation.

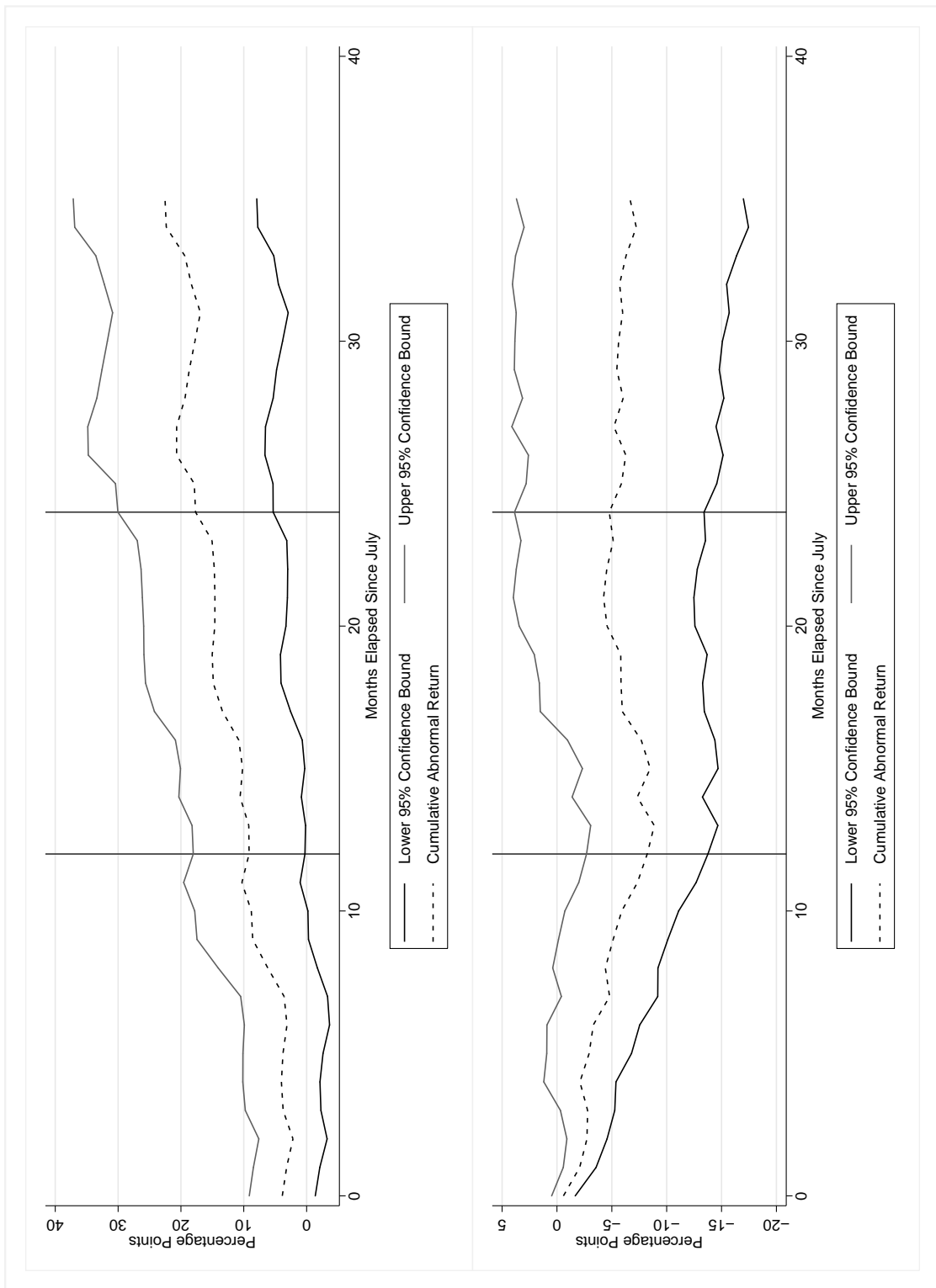


Figure 3: Length of the Effect: Solar Months Since Flood
 Upper graph details the cumulative dynamic multiplier for sultans, lower graph for judges. Vertical line marks the end of the first and second “Nile” year.

Table 1: Summary Statistics (by lunar year)

<i>Variable</i>	<i>Description</i>	<i>Mean</i> (1)	<i>Min/Max</i> (2)	<i>St.Dev</i> (3)	<i>N</i> (4)	<i>Prov</i> (5)	<i>Tul</i> (6)	<i>Fat</i> (7)	<i>Agy</i> (8)	<i>Mam</i> (9)
Nile										
<i>Hijazi_t</i>	Nile Crest (m)	16.99	14.70/18.60	0.58	822	16.74	16.75	17.00	17.00	17.42
<i>TaghriBir_{di}t</i>	Nile Crest (m)	16.98	12.02/21.04	0.62	822	16.76	16.78	16.96	16.89	17.42
<i>DevHijazi_t²</i>	(Deviation from trend) ²	0.27	0/5.84	0.45	822	0.37	0.29	0.16	0.23	0.26
<i>DevTaghri_t²</i>	(Deviation from trend) ²	0.33	0/26.69	1.26	822	0.40	0.28	0.21	0.57	0.29
Political Changes										
<i>Sultan_t</i>	Sultan Change	0.19	0/1	0.39	822	0.37	0.16	0.06	0.10	0.18
<i>Judge_t</i>	Judge Change	0.22	0/1	0.41	822	0.20	0.22	0.22	0.19	0.25
Dynasty										
Province	(640-868 CE)	0.28	0/1	0.45	822	1				
Tulimid/Ikhshidid	(868-969)	0.13	0/1	0.33	822		1			
Fatimid	(969-1169)	0.25	0/1	0.43	822			1		
Ayyubid	(1169-1250)	0.10	0/1	0.30	822				1	
Mamluk	(1250-end)	0.24	0/1	0.42	822					1

Notes: unit of observation is one lunar year.

Data span the time interval [20,841] AH (822 lunar years) or [641,1438] CE (798 solar years).

Entries to the right of the vertical line provide mean values of the respective variable across dynasties.

See text and data appendix for details.

Table 2: **Economic catastrophes and judicial instability (Lunar Year)**

100*Indicator variable equalling one if the incumbent judge at t lost power on the interval $(t, t+1)$

	<i>Judge_t</i>	<i>Judge_t</i>	<i>Judge_t</i>	<i>Judge_t</i>	<i>Judge_t</i>
	(1)	(2)	(3)	(4)	(5)
Panel 1 (Hijazi)					
<i>DevHijazi_t</i>	-0.53 (2.68)				
<i>DevHijazi_t²</i>		-3.16 (2.36)	-4.08 (2.35)		
$ DevHijazi_t $				-4.15 (4.27)	
<i>CatHijazi_t</i>					-6.37 (5.93)
<i>t</i>			0.07 (0.02)	0.07 (0.02)	0.07 (0.02)
Panel 2 (Taghri)					
<i>DevTaghri_t</i>	1.26 (2.27)				
<i>DevTaghri_t²</i>		-1.16 (0.39)	-1.19 (0.43)		
$ DevTaghri_t $				-2.74 (2.82)	
<i>CatTaghri_t</i>					0.29 (6.68)
<i>t</i>			0.06 (0.02)	0.07 (0.02)	0.06 (0.02)
<i>N</i>	822	822	822	822	822
<i>Dynasty Dummies?</i>	No	No	Yes	Yes	Yes

Notes: robust standard errors in parentheses.

$Dev()_t$ denotes the residuals from a linear time trend computed with Hijazi's or Taghri Birdi's data.

$Dev()_t^2$ denotes the square of these residuals.

$|Dev()_t|$ denotes the absolute value of these residuals.

$Cat()_t$ is a dummy variable equal to one if the residuals are in the top or bottom 2.5% of the distribution.

See text for details.

Table 3: **Judicial Instability and Hijazi's Uncorrected and Corrected Data (Lunar Month)**

100*Indicator variable equalling one if the incumbent judge at t lost power on the interval (t,t+1)

	<i>Judge_{mt}</i>	<i>Judge_{mt}</i>	<i>Judge_{mt}</i>	<i>Judge_{mt}</i>	<i>Judge_{mt}</i>	<i>Judge_{mt}</i>
	(1)	(2)	(3)	(4)	(5)	(6)
Panel 1 (Uncorrected)						
<i>DevHijazi_t</i>	-0.16 (0.29)					
<i>DevHijazi_t²</i>		-0.38 (0.25)	-0.29 (0.24)	-0.49 (0.50)		
<i> DevHijazi_t </i>					-0.53 (0.80)	
<i>CatHijazi_t</i>						0.06 (1.36)
<i>N</i>	9864	9864	9864	9864	9864	9864
Panel 2 (Corrected)						
<i>DevHijazi_t</i>	-0.07 (0.28)					
<i>DevHijazi_t²</i>		-0.60 (0.23)	-0.52 (0.22)	-0.61 (0.26)		
<i> DevHijazi_t </i>					-0.85 (0.44)	
<i>CatHijazi_t</i>						-1.39 (0.59)
Panel 3 (Corrected IV)						
<i>DevHijazi_t</i>	-0.26 (0.63)					
<i>DevHijazi_t²</i>		-3.30 (1.70)	-2.95 (1.64)	-422.91 (2237.07)		
First Stage F-Stat	87.24	3.61	3.61	0.04		
<i>N</i>	9857	9857	9857	9857	9857	9857
<i>Dynasty Dummies?</i>	No	No	Yes	No	No	No
<i>Solar Year Dummies?</i>	No	No	No	Yes	Yes	Yes
<i>Solar Month Dummies?</i>	No	No	No	Yes	Yes	Yes

Notes: standard errors are clustered by lunar year in panel 1 and by Nile year in panels 2 and 3.

Nile floods vary by lunar year in panel 1 and by Nile year [July-July] of the solar year in panels 2 and 3.

DevHijazi_t denotes the residuals from a linear time trend computed with Hijazi's or Taghri Birdi's data.

DevHijazi_t² denotes the square of these residuals.

|DevHijazi_t| denotes the absolute value of these residuals.

CatHijazi_t is a dummy variable equal to one if the residuals are in the top or bottom 2.5% of the distribution.

See text for details.

Table 4: **Instrumental Variables (Lunar Year)**

100*Indicator variable equalling one if the incumbent judge or sultan at t lost power on the interval $(t,t+1)$

Panel 1 (Judge)						
	<i>Judge_t</i>	<i>Judge_t</i>	<i>Judge_t</i>	<i>Judge_t</i>	<i>Judge_t</i>	<i>Judge_t</i>
	(1)	(2)	(3)	(4)	(5)	(6)
<i>DevHijazi_t</i>	2.31 (4.16)					
<i>DevTaghri_t</i>		-0.79 (4.20)				
<i>DevHijazi_t²</i>			-18.02 (10.59)		-19.70 (11.71)	
<i>DevTaghri_t²</i>				-6.33 (5.44)		-8.37 (5.53)
<i>t</i>					0.08 (0.03)	0.07 (0.03)
<i>N</i>	822	822	822	822	822	822
<i>Dynasty Dummies?</i>	No	No	No	No	Yes	Yes
First Stage F-Stat	59.91	296.87	2.56	15.21	2.43	13.25
Panel 2 (Sultan)						
	<i>Sultan_t</i>	<i>Sultan_t</i>	<i>Sultan_t</i>	<i>Sultan_t</i>	<i>Sultan_t</i>	<i>Sultan_t</i>
	(1)	(2)	(3)	(4)	(5)	
<i>DevHijazi_t</i>	-0.74 (5.20)					
<i>DevTaghri_t</i>		-1.33 (4.60)				
<i>DevHijazi_t²</i>			31.96 (23.40)		27.03 (21.31)	
<i>DevTaghri_t²</i>				22.76 (7.35)		13.06 (6.77)
<i>t</i>					0.03 (0.04)	0.05 (0.03)
<i>N</i>	822	822	822	822	822	822
<i>Dynasty Dummies?</i>	No	No	No	No	Yes	Yes
First Stage F-Stat	59.91	296.87	2.56	15.21	2.43	13.25

Notes: robust standard errors in parentheses.

Each Nile-related entry reports the results of instrumenting for the listed variable with the one that is not listed.

$Dev()_t$ denotes the residuals from a linear time trend computed with Hijazi's or Taghri Birdi's data.

$Dev()_t^2$ denotes the square of these residuals.

See text for details.

Table 5: **Economic catastrophes and political instability (Lunar Year)**

100*Indicator variable equalling one if the incumbent sultan at t lost power on the interval (t,t+1)

	<i>Sultan_t</i>	<i>Sultan_t</i>	<i>Sultan_t</i>	<i>Sultan_t</i>	<i>Sultan_t</i>
	(1)	(2)	(3)	(4)	(5)
Panel 1 (Hijazi)					
<i>DevHijazi_t</i>	-0.89 (3.09)				
<i>DevHijazi_t²</i>		11.36 (4.24)	6.36 (3.75)		
<i> DevHijazi_t </i>				9.55 (4.93)	
<i>CatHijazi_t</i>					16.92 (7.94)
<i>t</i>			0.05 (0.03)	0.05 (0.03)	0.05 (0.02)
Panel 2 (Taghri)					
<i>DevTaghri_t</i>	-0.40 (2.85)				
<i>DevTaghri_t²</i>		2.06 (1.73)	1.64 (1.38)		
<i> DevTaghri_t </i>				6.36 (3.96)	
<i>CatTaghri_t</i>					9.16 (7.38)
<i>t</i>			0.06 (0.03)	0.05 (0.03)	0.06 (0.03)
<i>N</i>	822	822	822	822	822
<i>Dynasty Dummies?</i>	No	No	Yes	Yes	Yes

Notes: robust standard errors in parentheses.

*Dev()*_t denotes the residuals from a linear time trend computed with Hijazi's or Taghri Birdi's data.

*Dev()*_t² denotes the square of these residuals.

*|Dev()*_t denotes the absolute value of these residuals.

*Cat()*_t is a dummy variable equal to one if the residuals are in the top or bottom 2.5% of the distribution.

See text for details.

Table 6: **Political Instability and Hijazi's Uncorrected and Corrected Data (Lunar Month)**

100*Indicator variable equalling one if the incumbent sultan at t lost power on the interval (t,t+1)

	<i>Sultan_{mt}</i>	<i>Sultan_{mt}</i>	<i>Sultan_{mt}</i>	<i>Sultan_{mt}</i>	<i>Sultan_{mt}</i>	<i>Sultan_{mt}</i>
	(1)	(2)	(3)	(4)	(5)	(6)
Panel 1 (Uncorrected)						
<i>DevHijazi_t</i>	-0.20 (0.30)					
<i>DevHijazi_t²</i>		0.84 (0.36)	0.41 (0.34)	0.09 (0.55)		
$ DevHijazi_t $					0.34 (0.95)	
<i>CatHijazi_t</i>						-0.96 (1.68)
<i>N</i>	9864	9864	9864	9864	9864	9864
Panel 2 (Corrected)						
<i>DevHijazi_t</i>	0.28 (0.33)					
<i>DevHijazi_t²</i>		0.91 (0.41)	0.48 (0.38)	0.15 (0.39)		
$ DevHijazi_t $					0.28 (0.55)	
<i>CatHijazi_t</i>						-1.10 (0.90)
Panel 3 (Corrected IV)						
<i>DevHijazi_t</i>	-0.62 (0.70)					
<i>DevHijazi_t²</i>		4.03 (3.29)	3.40 (3.22)	240.13 (1294.84)		
First Stage F-Stat	87.24	3.61	3.61	0.04		
<i>N</i>	9857	9857	9857	9857	9857	9857
<i>Dynasty Dummies?</i>	No	No	Yes	No	No	No
<i>Solar Year Dummies?</i>	No	No	No	Yes	Yes	Yes
<i>Solar Month Dummies?</i>	No	No	No	Yes	Yes	Yes

Notes: standard errors are clustered by lunar year in panel 1 and by Nile year in panels 2 and 3.

Nile floods vary by lunar year in panel 1 and by Nile year [July-July] of the solar year in panels 2 and 3.

DevHijazi_t denotes the residuals from a linear time trend computed with Hijazi's data.

DevHijazi_t² denotes the square of these residuals.

$|DevHijazi_t|$ denotes the absolute value of these residuals.

CatHijazi_t is a dummy variable equal to one if the residuals are in the top or bottom 2.5% of the distribution.

See text for details.

Table 7: **Judge Independence**

100*Indicator variable equalling one if the judgeship changed hands at least once in a given time period

	<i>Judge_t</i>	<i>Judge_t</i>	<i>Judge_{mt}</i>	<i>Judge_{mt}</i>	<i>Judge_{mt}</i>
	(1)	(2)	(3)	(4)	
<i>Sultan</i>	6.15	7.47	3.31	3.50	2.72
	(3.87)	(4.06)	(1.62)	(1.62)	(1.68)
<i>Constant</i>	20.60		2.04		
	(1.57)		(0.17)		
<i>Dynasty Dummies?</i>	No	Yes	No	Yes	No
<i>Solar Year Dummies?</i>	No	No	No	No	Yes
<i>Solar Month Dummies?</i>	No	No	No	No	Yes
<i>N</i>	822	822	9857	9857	9857

Notes: robust standard errors in parentheses.

Sultan_t is a dummy variable equal to one if the sultanate changed hands at least once in a given time period.