Oxford Research Encyclopedia of Politics

The Age-Structural Theory of State Behavior

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Subject: World Politics Online Publication Date: Aug 2017
DOI: 10.1093/acrefore/9780190228637.013.327

Summary and Keywords

Over the past three decades, economic and political demographers, using various measures, have discerned that increased age-structural maturity makes significant statistical contributions to levels of per capita income, to educational attainment, to declines in the frequency of onsets of intrastate conflict, and to the likelihood of achieving and maintaining liberal democracy. Some of the stronger statistical relationships have been used in forecasts. For example, using the United Nations Population Division (UNPD) demographic projections, political demographers have relied on the strong statistical association between age structure and stable liberal democracy to forecast the rise of democracy in North Africa more than two years in advance (in 2008)—at a time when regional experts believed that forecast to be absurd.

Whereas critics remain skeptical of the murky causal connections of age-structural theory, its proponents counter that causality in the development of state capacity is complex and is less important than the theory's positive qualities (namely, that it is forward-looking, its statistical findings are easily repeated, its forecasts have outcompeted regional experts, and its predictive products can be readily adapted to the needs of intelligence foresight, defense planning, and foreign policy analysis). Perhaps most important, the age-structural theory of state behavior has yielded a surprising number of "novel facts"—new knowledge concerning the observed pace and timing of state political, social, and economic behaviors.

Keywords: political demography, forecasting, youth bulge, population aging, demographic dividend, empirical international relations theory, age-structural theory of state behavior

Introduction

Rather than focusing on explanatory narratives and causality, the age-structural theory of state behavior is concerned with generating “timed expectations.” At the core of this theory lies the *age-structural transition*—the continuous path of cohort reconfiguration that leads from a youthful population to one numerically dominated by middle-age adults and seniors. Age-structural theory’s most tested models and functional forms are built upon this fundamental demographic process.

The body of age-structural theory is growing. At the leading edge of age-structural research are an expanding set of newly generated models, each reflecting a hypothesized relationship between the known position of states in this transition, and their corresponding likelihood of being observed in a specific political, social, or economic condition. In time, some of these hypothetical models undoubtedly will become more deeply woven into age-structural theory—but only if successful forecasts and other out-of-sample tests show them worthy of greater certainty, and if they are found analytically useful or create new insights into the relationships that they portray.

Forecasting is integral to age-structural theory. To investigate the future, age-structural models are simply repositioned one or two decades into the future—into a demographic future already described in detail by the United Nations Population Division (UNPD) series of demographic projections (UNPD, 2015). Since age-structural models were first generated in 2008, this method has yielded a string of successful forecasts, discerning a window of time for future events and oncoming conditions that regional and country experts missed or thought were improbable. Moreover, several of the early conclusions of age-structural models—that states with youthful populations are vulnerable to political violence and experience difficult political and social environments for achieving and maintaining democracy—are increasingly accepted as fact by many foreign affairs policymakers.

The principal objectives of this article are to outline the age-structural theory of state behavior in its current form and to provide insights into its methodology. The discussion begins by demonstrating age-structural theory’s predictive potential by recounting its most dramatic forecasts. It then fields a discussion of the origins and mechanics of age-structural models and reviews their graphic functional forms. Finally, the text introduces four predictive products that have been used to present statistical portraits of the future to foreign affairs, defense, and intelligence analysts: group statistical forecasts, age-structural maps, country-specific tables, and regional summaries.

The 2008 Forecasts

While not the age-structural theory's only prescient prediction, this initial set of forecasts more than two years prior to the Arab Spring remains the most dramatic display of the theory's ability to outdo the experts, and the most illustrative of the theory's yet-unexplored potential.

Based on an age-structural model, a 2008 article in *Foreign Policy* (Cincotta, 2008, p. 82; a similar quote appears in Cincotta, 2008–2009, p. 15) stated:

> The first (and perhaps most surprising) region that promises a shift to liberal democracy is a cluster along Africa's Mediterranean coast: Morocco, Algeria, Tunisia, Libya, and Egypt, none of which has experienced liberal democracy in the recent past. The other area is in South America: Ecuador, Colombia, Venezuela, each of which attained liberal democracy demographically "early" but was unable to sustain it. Interpreting these forecasts conservatively, we can expect there will be one, maybe two, in each group that will become stable liberal democracies by 2020.

This forecast was first presented at a U.S. State Department–sponsored expert meeting on the Middle East and North Africa (MENA) region in February 2008, where this forecast was repeated. In this presentation, the author (in response to a question) suggested that Tunisia, because of its sustained near-replacement fertility and the rapid maturing of that country's population age structure, was a likely launch point for democratization before 2020. Most of the nearly two dozen attending academics specializing in the MENA region (including several natives of the region), plus government analysts in attendance, burst into raucous laughter—so much so that the meeting's chairman was forced to terminate the session.[1]

In October 2010, two months before demonstrations erupted across Tunisia, Cincotta submitted the following unclassified (Cincotta, 2010, unpublished) forecast to a U.S. intelligence agency requesting the submission of hypothetical low-probability, high-impact events that might occur over the next two years, affecting U.S. interests:

> In this scenario, a North African state, probably Tunisia, undergoes a color revolution—a swift and non-violent transition to liberal democracy. This may bring Islamists into power—or maybe not. However, the possibilities for spreading democracy through the region and for new political dynamics to play out in an age-structurally maturing Arab state could produce both risks and opportunities for the US.[2]

After Tunisia's and Egypt's revolutions successfully upended what Middle East analysts had assumed to be rock-solid autocratic regimes, Nasim Taleb and Mark Blyth (2011) identified the North African uprisings as the culmination of an extended buildup of suppressed social forces, culminating in a politically explosive event, the nature and timing of which were impossible to predict—a “black swan.”

Yet regime change in North Africa was clearly not impossible to predict. More than two years prior to the North African revolutions, age-structural theory had been used to confront influential academic Middle East experts and U.S. government analysts with a reasonable image of this future—an image generated by associating the attainment of liberal democracy with a phase of the age-structural transition. They simply chose to believe that this image, and the method that conveyed it, were absurd.

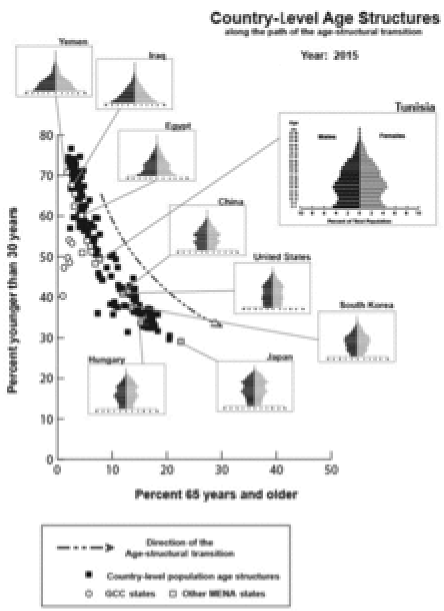

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Figure 1. The path of the age-structural transition, depicted for the world’s independent states (< 500,000 population) in 2015. Age-structural profiles are depicted for nine states: Yemen (median age, 19 years), Iraq (19 years), Egypt (25 years), Tunisia (31 years), China (37 years), United States (38 years), South Korea (41 years), Hungary (41 years), and Japan (47 years).

The forecast of one or more North African liberal democracies before 2020 (Cincotta, 2008–2009, p. 15)—states assigned FREE status, rather than PARTLY FREE or NOT FREE,[3] in Freedom House’s annual global assessment of political rights and civil liberties—was realized in 2014 with Freedom House’s assessment of Tunisia as FREE (FH, 2015). Since then, Colombia’s peace process has lurched haltingly forward, making a second published forecast look increasingly promising. That forecast predicts the rise of a liberal democracy before 2020 among the three-state cluster of Colombia, Venezuela, and Ecuador (Cincotta, 2008–2009). In its most recent assessment, Freedom House (2017) placed Colombia on the very borderline between PARTLY FREE and FREE—a Freedom Score of 3.0, trending upward toward FREE.

The Age-Structural Transition

Initiated by fertility decline, the age-structural transition entails gradual shifts in the relative size of age cohorts through a lengthy, relatively predictable series of configurations (Figure 1). The age-structural theory of state behavior owes much of its predictive potential to (a) the power of these configurations to influence, amplify, control, and reflect a broad range of interacting demographic, social, and economic conditions; and (b) the ability of demographers to predict future configurations using cohort component methodologies. To describe the age-structural transition with some narrative clarity, this article employs the classification system published in the U.S. National Intelligence Council's *Global Trends* series of publications (NIC, 2012, 2017). Although the age-structural transition is continuous, this system intuitively divides the transition into four discrete phases, based on country-level median age (the age of the middle person, at which 50% of the population is younger): the youthful, intermediate, mature, and postmature phases.

The path of the age-structural transition can be described as a nonlinear influence on state capacity—in colloquial terms, a bad-news, good-news, bad-news story (Cincotta, 2012). Countries in the earliest, high-fertility portion of the transition experience youthful age structures that feature high childhood dependency and present obstacles to attaining high levels of institutional capacity and state legitimacy (Dyson, 2010). In the intermediate and mature phases, working-age adults proportionately dominate the population, yielding low levels of childhood and old-age dependency. Then, in the postmature phase of the transition, more than half of the age structure is occupied by the most mature portions of the working-age population (over age 45) and retirees—a condition that is bound to yield high levels of dependency and present challenges for pension systems.

With more than half of their population composed of newborns, infants, school-age children, adolescents, and women in their peak childbearing years, demand for health and educational services in youthful states (so-called youth-bulge countries, with median age less than 25.50 years) typically outstrips the state's institutional capacity. Because annual growth rates among youth cohorts run high, children typically face school placement insufficiency and crowding, as well as low levels of societal investment per pupil (Lee & Mason, 2011). Meanwhile, young adults in these countries typically face intense competition for jobs and underemployment (Easterlin, 1968). Politically difficult to manage, youthful populations tend to feature locally powerful extended family and patronage networks (Wusu & Isiugo-Abanihe, 2006), and an elevated risk of intrastate conflict and other forms of political violence (Goldstone, 2012; Urdal, 2006; Goldstone, 2002; Mesquida & Wiener, 1999; Möller, 1968).

Countries that advance into the intermediate phase of the age-structural transition (median age of 25.50–35.49 years) experience lower proportions of their population among cohorts of dependent children and higher proportions in the productive, and taxable, working ages (a worker bulge). This transformation, typically the result of fertility decline below 2.5 children per woman, has been associated with improvements in health status, increased per-child investment in schooling (Lee & Mason, 2011), growth in savings (Higgins & Williamson, 1997), increased participation of women in the economy (Bauer, 2001), and often a faster pace of economic development and wealth accumulation (see chapters in Birdsall, Kelley, & Sinding, 2001)—a process that demographers generally term the “demographic dividend” (Bloom, Canning, & Sevilla, 2002, p. 25).

Economic growth rates tend to slow as states enter the third phase of the age-structural transition, the mature phase (median age of 35.50–45.49 years). Despite an aging workforce and a growing group of retirees in mature states, favorable economic and political conditions often prevail—a so-called second demographic dividend (Lee & Mason, 2006), a situation typically associated with states that amassed human capital during the intermediate phase.

In the final phase of the age-structural transition, states incur another challenging set of distributions: a series of postmature age structures (median age of 45.50 or greater) characterized by a large proportion of seniors and dependent elderly and declining numbers in the younger working ages. Whereas by 2016 only three states—Japan, Germany, and Italy—have entered this category, some researchers hypothesize that, as a group, future postmature states will face declining per capita productivity, fiscal imbalances (Jackson & Howe, 2008), substantial foreign debt (Eberstadt & Groth, 2010), and constrained participation in the international system (Haas, 2007).

Age-Structural Models

The age-structural domain is the unifying feature of age-structural theory. Rather than considering relationships over chronological time, age-structural models reposition state behaviors on the age-structural domain—an *x*-axis that follows the continuous path of the age-structural transition, situating it as the principal independent variable. The age-structural domain, measured by median age, is the only continuous independent variable in logistic regression analysis. All controls and treatment variables are dichotomous (0,1). Likewise, the functional forms that are fitted to data by logistic regression (discussed later in this article) are displayed across a domain beginning at a median age of 15 years and ending at 55 years.

Each age-structural model begins as a hypothesis—whether generated notionally (from theory) or observationally—that a measurable state behavior is typically associated with the movement of states through the age-structural transition. It is important to stress—and periodically reiterate—that these models begin as a hypothesis that is epistemologically situated at the very edge of age-structural theory. Some age-structural models have been strengthened and brought into the more certain body of theory by repeated in-sample testing, out-of-sample testing, and some form of successful prediction. A few others—particularly hypotheses associated with the age-structural model of liberal democracy (ASM-LD)—have demonstrated their utility by outcompeting other methods of analysis and by exposing original insights into the processes under study.

In the most recent analyses by Cincotta (2015A, 2015B, 2015C), age-structural models employ the country-level median age as the only continuous independent variable. In these analyses, logistic regression has been used to determine *whether or not* the presence of a specific, discrete condition (the dependent variable) varies as states advance across the age-structural transition. If, indeed, it varies across this transition, then age-structural methods proceed to determine *how* that specific condition varies (i.e., its functional form); and the *level of certainty* that is associated with that variation (i.e., its confidence interval, or CI).

In age-structural models, the dependent variable (composed of data coded 1 or 0) must be discrete or discretized by creating a gradient of discrete categories. Examples of discrete conditions include the presence or absence (in a year) of a type of political regime or the presence or absence of an intrastate conflict. Examples of discretized variables include the attainment of specific levels of per capita income (e.g., the World Bank's Upper-Middle Income Category), or levels of educational attainment (secondary school participation).

For logistic regression to produce a reasonable fit to these data, the frequency of the dependent variable, as it is sampled across the age-structural domain, must be adequately described by a logistic function—a monotonic sigmoid curve generated by the Verhulst equation (an *S*-shaped function, beginning low and approaching an upper asymptote), or to some segment of a logistic curve (Menard, 2001).[4] Therefore, a segment of a logistic function can neither be fit adequately to frequency data that (a) rises substantially and then falls, or (b) falls substantially and then rises again across the domain.

Age-structural theory is a reductionist project. Operating on a single, continuous *x*-axis simplifies statistical analyses and permits the visual display of relationships on a two-dimensional graph—and, like all simplified statistical theories, it has limitations. First, it suffers from the "small number problem"—that is, predictions are most successful when considering clusters of states rather than a single state. Second, by itself, taking only median age into account, age-structural models are blind to the influence of nondemographic and subnational demographic factors. Unless these are noted through observation, studied through separate analyses, or added experimentally as discrete (0,1) variables to the statistical analysis, its reliance on the country-level scalar measure of median age as the lone continuous domain of its analysis can obscure important factors. For example, observations of the functional form of the age-structural model of liberal democracy have shown that the presence of a small population size (under 5 million) and regime types have substantial impact on outcomes (Cincotta, 2015A, 2015B; Weber, 2012).

Median Age

While median age is not the only age-structural indicator in use as an independent variable, it was the initial preference of Timothy Dyson, and later the preference of Richard Cincotta, as the measure of the age-structural domain (see Dyson, 2013 for an earlier example, and also Cincotta, 2015B). Other age-structural indicators include various “youth bulge” measures (see Staveteig, 2005, for a review of indicators), and childhood and old-age dependency ratios. Except for median age, age-structural indicators have been focused on a specific phase of the age structural transition. Therefore, each has its own mathematical peculiarities. Whereas all are moderately to strongly correlated, among scalar measures, median age appears (to me, so far) to be relatively unbiased across the current extent of the age-structural transition—which today ranges from a median age of 15 years in Niger to today’s maximum, 47 years, for Japan’s population.

Nonetheless, as a characterization of age structure, median age is a rather unsophisticated reduction of a complex multicohort distribution. Admittedly, it can mask potentially important differences among age structures. That said, median age provides a simple and intuitive means for analysts to estimate and visualize the three most important analytical qualities in age-structural theory: a state’s *position* in the age-structural transition, its *direction* of movement, and its *rate* of change (Figure 2).

In the six Arab-majority states (Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates) of the Gulf Cooperation Council (GCC), the relative sizes of male cohorts, from 25 to 40 years of age, are heavily influenced by the presence of temporary labor migrants. Rather than use the UNPD’s estimates and projections of median age for all residents in the GCC states, this article uses unpublished estimates and projections of citizen residents only (which excluded temporary labor migrants) from the U.S. Census Bureau’s International Program Center. These data are not currently available from the center’s International Data Base (USCB-IPC, 2015).[5]

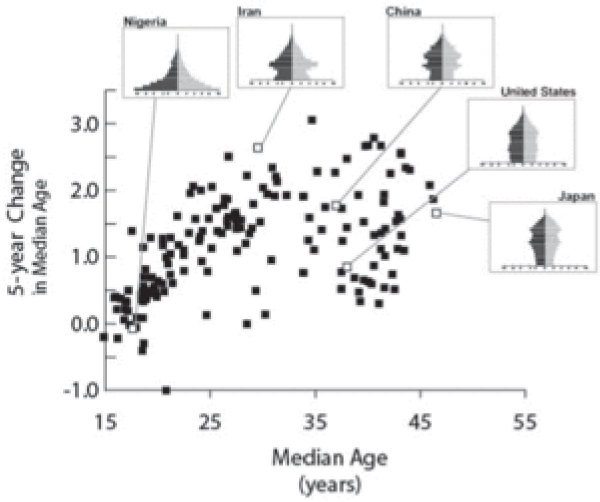

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Figure 2. The five-year rate change in median age versus country-level median age, at midyear 2015. Age-structural profiles are depicted for five states: Nigeria (median age, 18 years), Iran (30 years), China (37 years), the United States (38 years), and Japan (47 years). Data are drawn from UN demographic estimates (UNPD, 2015).

The UNPD also publishes demographic projections, which begin at the last estimated year and proceeds until 2100. For forecasting, this discussion uses future median ages that are projected by the United Nations (UN) medium fertility variant, which represents the statistical midpoint of simulated future trajectories.[6] However, the UNPD also generates other standard projections: the UN high, low, and constant fertility variants, which together provide a broad vision of future possibilities.

How accurately does the UN medium fertility variant projection portray future median ages? Over a 15- to 20-year period, UNPD demographers have been reasonably close. While there have been a few demographic surprises over the past 50 years—Iran's rapid fertility decline beginning in 1988, the emergence of HIV/AIDS, and an unexpected wave of migration to Israel following the breakup of the Soviet Union in the early 1990s—over a 20-year period, unexpected turnarounds have been rare.

The Sample

The models generated in research by Cincotta and coauthors are based on data from 1972 onward—the year that Freedom House first made its annual assessment of civil liberties and political rights. This selection of years corresponds to a period after the dissolution of the remaining European empires (British, French, and Portuguese).

As a matter of consistent practice, this article uses the list of recognized independent political entities supplied by the United Nations. From this list, two types of entities have been eliminated from the UN data: any nonindependent political entity (e.g., Palestine, Western Sahara) whose state behavior may be constrained or induced by an occupying entity; and small, independent states with populations under 500,000 (including Belize, Iceland, Brunei, and numerous small island states). These states will be returned to the data pool when, and if, they obtain independence and their population grows to be larger than 500,000. Based on those criteria and the formation of new states (e.g., Eritrea, former Soviet republics, former Yugoslav republics, Slovak Republic, South Sudan, etc.), the annual data set has grown from 131 states in 1972 to 166 in 2015.

The use of states as the unit of analysis has several analytical limitations. The country-level median age may obfuscate the presence of significantly large minorities or noncitizens, who may display population dynamics differing substantially from the majority. Even when the country-level age structure has matured, minority-majority differences in demographic dynamics can be associated with ethnic tensions (Blomquist & Cincotta, 2016; Cincotta, 2011).

Control Variables

It is useful to begin with the simplest form of the age-structural model—the naïve model, which is devoid of any control variables (Model 1; see the example in Table 1). To refine this model, dichotomous (presence or absence) control variables, or combinations of these three variables, can be added to refine the naïve model. States with these qualities often, but not always, perform differently than the larger group of states. Before graphing the function, running experiments with other dichotomous variables, or identifying exceptional states, it has been useful to control for the following three factors, depending on the dependent variable:

1. *States with small populations*. This factor identifies states with a midyear population of fewer than 5 million. The source of this estimate was the UNPD's 2015 revision of *World Population Prospects* (UNPD, 2015).
2. *States engaged in high-intensity conflict*. A state is deemed to be in high-intensity conflict if, for that year, it experiences more than 1,000 battle-related deaths, according to the current version of the UCDP Conflict Dataset (UCDP/PRIO, 2016; Gleditsch, Wallensteen, Eriksson, Sollenberg, & Strand, 2002).
3. *Resource-reliant states*. A state was deemed as experiencing significant oil and mineral wealth if revenues from these resources comprised over 15% of GDP. Annual levels of oil revenue, mineral revenue, and GDP were obtained from the 2015 version of the World Bank's World Development Indicators (WB, 2016).

Thus, current analyses typically feature controlled models (Model 2; see examples in Table 1) that feature various combinations of this model (e.g., Models 2a, 2ab, 2ac, 2bc, and 2abc).

Table 1. Logistic Regression for the Age-Structural Model of Liberal Democracy

Models ⇨	**Model 1 (Naïve)**	**Model 2a**	**Model 2b**	**Model 2ab**	**Model 2c**	**Model 2ac (Basic 1)**	**Model 2abc (Basic 2)**
Dependent variable ⇨	**Probability of being assessed as FREE**						
Data source ⇨	**Freedom House, Freedom in the World data (1972–2015)**						
Scope of data ⇨	*All states*	*All states*	*All states*	*All states*	*All states*	*All states*	*All states*
Variable list ⇩	Statistical significance of coefficients: * $p < 0.05$, ** $p < 0.01$						
Age-structural domain variable (continuous)	*Model coefficients and standard errors*						
Median age	0.180** (0.005)	0.183** (0.005)	0.179** (0.005)	0.183** (0.005)	0.175** 0.005)	0.179** (0.005)	0.179** (0.005)

Dichotomous controls for							
(a) Small populations (< 5 million)	–	−0.464** (0.070)	–	−0.484** (0.071)	–	−0.468** (0.072)	–0.488** (0.073)
(b) High-intensity conflict (> 1,000 battle-related deaths/year)	—	—	–0.004 (0.127)	–0.180 (0.130)	—	—	–0.174 (0.131)
(c) Resource reliance (mineral and oil revenue >15% of GDP)	–	–	–	–	0.718** (0.124)	0.699** (0.124)	0.697** (0.124)
Constant	—5.226 (0.121)	–5.002 (0.124)	–5.197 (0.173)	–4.819 (0.181)	–5.739 (0.155)	–5.503 (0.157)	–5.323 (0.207)
N	6246	6246	6245	6246	6246	6246	6246

Pseudo-r^2 (%)	27.2	27.4	26.9	27.5	27.6	27.9	27.9
FREE$_{50}$ (median age, years)	29.0	29.8	29.0	29.9	28.6	29.4	29.7

As a general observation, the effect of a small population generally has the strongest statistical impact on a naïve model. The control for high-intensity conflict has occasionally been statistically significant, particularly in health- and income-related models, but is omitted when the dependent variable is conflict-related. Oil-mineral reliance has been statistically significant in most age-structural models.

Age-Structural Functions

The most basic and often the most effective way to both conceptualize and communicate the results of age-structural modeling has been to display the resultant age-structural relationship in its two-dimensional standard form, where (a) the dependent variable is expressed as a probability (0.0–1.0) of a status on the vertical axis, and (b) the range of country-level median ages (15–55 years) is expressed on the horizontal axis—the age-structural domain. The function can be generated by substituting the regression coefficients from the logistic regression analysis into the standard logistic model, and then computing the probability (*p*) of condition *Y* for median age (*MA*) across the contemporary range (currently from 15 to 47 years):

$$pY = \frac{e^{(b+a(MA))}}{1+e^{(b+a(MA))}}$$

Although age-structural models typically include dichotomous controls and occasionally additional experimental dichotomous variables, they are driven by a single continuous independent variable (median age). Thus, most commercial software that computes logistic regression will generate as output dependent variable probabilities (*pY*), their upper and lower 0.95 CIs, and a graphic depiction of the function.

Classes of Age-Structural Functions

Not all age-structural functions are qualitatively similar. Age-structural functions can be placed in one of three classes (I, II, III), depending on their conditions, form, and fit.

Class I age-structural functions belong to a family of cumulative distribution functions (CDFs). These CDFs are generally associated with irreversible, or virtually irreversible, processes and are generated by the numerical integration of the normal or near-normal frequency distribution that discrete levels of these processes characteristically produce (e.g., the World Bank Income Categories and under-5 mortality levels). When these data are submitted to logistic regression analysis, Class I age-structural functions generally produce an ideal fit that takes the form of a complete logistic function (an *S*-shaped curve) that typically produces higher pseudo-r^2 values and narrower CIs than functions in Classes II and III. Class I functions that rise quickly on the age-structural domain are the most appropriate for forecasting. The median age at the function’s inflection point and nearby median ages are indicative of a region where analysts should expect a higher-than-average achievement of the condition being studied.

Class II age-structural functions appear as complete, or nearly complete, logistic functions. They describe a state process that largely moves in one direction across the age-structural domain but is not irreversible, and there is no a priori assumption that every state will complete the transition (e.g., the presence of liberal democracy). Class II functions can rise sufficiently rapidly to become the basis of statistical forecasts. However, since they are fit to a reversible process, there is no guarantee that at all regions of the age-structural domain, the direction of movement is equally strong.

Class III age-structural functions appear as a portion of a logistic curve and carry no a priori assumptions that all states will undergo the hypothesized transition. Because Class III functions are typically a poor fit to the data, the underlying data deserve close inspection to determine whether a monotonic portion of a logistic curve accurately characterizes the dependent variable's variation in the age-structural domain. Other statistical models may be more appropriate.

A Class I Function: The World Bank's Income Categories

The World Bank Income Category Model (ASM-GNI) is composed of four Class I age-structural functions that generate expectations of the age-structural timing of each of the World Bank's standard income categories (Figure 3). These categories are based on gross national income per capita (GNI per capita), calculated in current-year (or other standard-year) U.S. dollars using the World Bank's Atlas Method (WB, 2016). States rarely slip from a higher to a lower category.

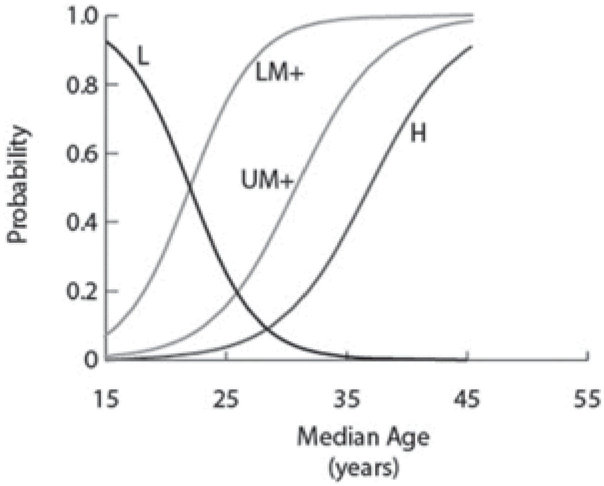

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Figure 3. A set of four Class I age-structural functions describing the probability of being assessed in one of the World Bank's four per capita income categories (WB, 2016), based on GNI per capita (U.S. dollars, Atlas Method), at a median age within the age-structural domain. The four curves represent Low Income (L), Lower-Middle Income and higher categories (LM+), Upper-Middle Income and higher categories (UM+), and High Income (H). The 0.95 CIs surrounding these functions are, at their maximum, ±0.9 years of median age.

GNI per capita (Atlas Method) data were transformed into four dependent variable data sets, each composed of presence (denoted by 1) or absence data (denoted by 0). To generate the age-structural function for the World Bank's Low Income Category, each annual quantitative datum was transformed to indicate whether the country in question was, during that year, within the Low Income Category (1), or not (0). For the three higher categories (Lower-Middle Income, Upper-Middle Income, and High Income), GNI per capita data were transformed to identify whether the state was in the chosen category (1), a higher category (also denoted as 1), or a lower category (0).

The functions displayed in this graph are the product of *Model 2ac*, which uses two statistically significant controls ($p < 0.05$): small population size (< 5.0 million) and reliance on oil or mineral resources (> 15% of GDP). Thus, controlled, relatively narrow 0.95 CIs, reaching a maximum of ±0.9 years on the median-age axis at low median ages, surround each of the logistic functions.

While still untested by forecasting and experimentation or examined in terms of the behavior of its exceptional states, the model reveals fresh aspects of the relationship between age structure and income. While it appears that states routinely achieve the World Bank's Lower-Middle Income category in the youthful phase of the age-structural transition (median age of 25 years or older), the results of modeling suggest that states must be well into the intermediate phase of the age-structural transition (thus attaining fertility levels below 2.5 children per woman) to achieve Upper-Middle Income status—a milestone on the pathway to economic development at which development donors "graduate" countries from basic sectors of development.

Notably, the *demographic window of opportunity*—introduced by UNPD (2004) to estimate the period of greatest potential for economic development—coincides closely with the period when most states attain Upper-Middle Income status. In its original formulation, the demographic window was calculated to open when the proportion of children 0–14 years of age dipped below 30% of the total population and seniors (65 years and older) remained below 15% of the population. In the age-structural domain, that ranges from a median age of about 26 years to about 41 years.

A Class II Function: The Presence of Liberal Democracy

The ASM-LD generates timed expectations of the likelihood of being assessed at a high level of democracy across the age-structural axis. The ASM-LD is the most well studied of all age-structural functions, having been investigated by three independent research efforts, each of which used different measures of age structure (several variations of “youth bulge” measures, median age), and various indicators of democracy. Indications of democracy include Freedom House’s FREE status (Cincotta, 2008, 2008–2009), high levels (8–10) of Polity IV regime scores (Cincotta & Doces, 2012; Weber, 2012), and high levels of voting as a proportion of eligible voters (Dyson, 2013). The conclusions were similar. Moreover, the ASM-LD is the subject of several successful forecasts and statistical experiments, which in turn have inspired additional hypotheses and modeling (Cincotta, 2008–2009; Cincotta & Doces, 2012; Cincotta, 2015A, 2015B).

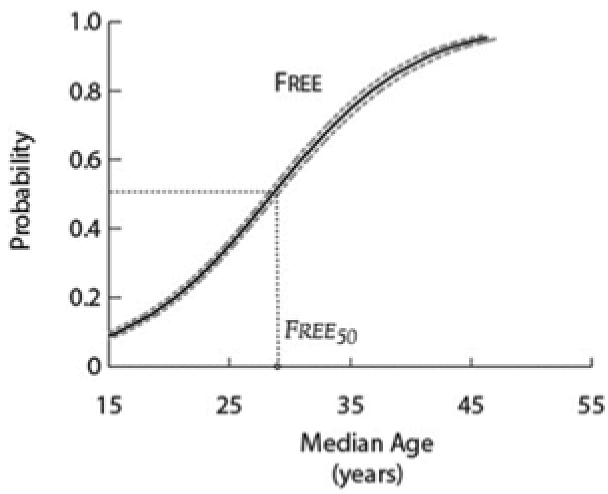

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Figure 4. A Class II age-structural function, describing the probability of being assessed as FREE in Freedom House’s annual survey of civil liberties and political rights (FH, 2017). The function’s 0.95 CIs are shown as dotted lines surrounding the logistic curve. FREE_{50} is this function’s inflection point (at median age of about 29 years), and the point where the probability of being assessed as FREE is 0.50.

The functional form of the ASM-LD, shown here (Figure 4), plots the timed expectation of attaining FREE in Freedom House’s annual survey (Model 2ac; see Table 1), as a probability calculated across the age-structural domain (Cincotta, 2015B). The most rapid pace of shifts to FREE from lower categories should be expected to occur around the theoretical infliction point, where the probability of being assessed as FREE is 0.5. This point, called FREE_{50}, is at about 29.5 (±0.5) years of median age.

Class III Function: The Presence of Intrastate Peace

The Age-Structural Model of Intra-State Peace (ASM-ISP) predicts the probability of the absence of intrastate conflict across the age-structural domain. The model draws its data on the presence or absence of intrastate conflict (more than 25 battle-related deaths per year) from the UCDP-PRIO Conflict Database, maintained and published cooperatively by the Uppsala Conflict Database Project (UCDP) and Peace Research Institute of Oslo (PRIO) (UCDP/PRIO, 2016; Gleditsch et al., 2002; Themnér & Wallensteen, 2013). Its function (Figure 5) is a Class III age-structural function based upon the ASM-ISP, with controls for small population (< 5.0 million), and natural resource reliance (resource rents < 15.0% of GDP).

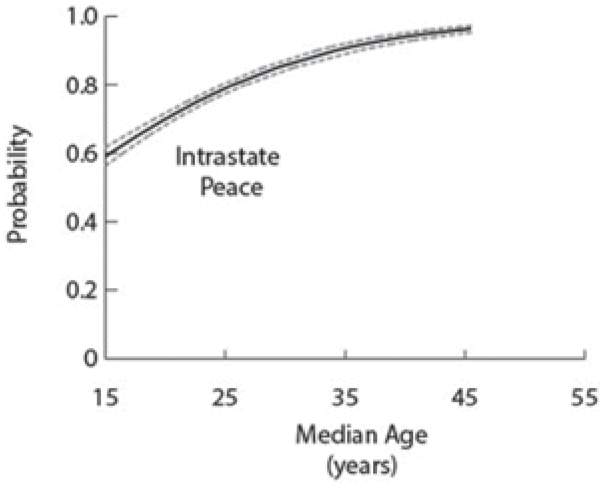

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Figure 5. The Class III age-structural function associated with the absence of low- or high-intensity intrastate conflict. Dotted lines surrounding the function represent its 0.95 CI. Data are drawn from the UCDP/PRIO Conflict Dataset (UCDP/PRIO, 2016).

The ASM-ISP is neither a tightly fit nor strongly predictive model—its gradual slope is not conducive to forecasting. It is nonetheless useful in mapping states, now and over the next two decades, that are generally vulnerable to the outbreak of intrastate conflict and other forms of political violence. It is worth noting that, according to the ASM-IP, at a median age of 15.0 years, roughly 60% of all states are unlikely to be experiencing an intrastate conflict. Further investigations of the function indicate that while civil conflicts appear almost exclusively in the youthful portion of the age-structural domain (median age of 25 years or less), ethnoreligious conflicts extend throughout the domain (Yair & Miodownik, 2016).

Exceptional States

Whereas age-structural analyses have demonstrated the association between age-structural configurations and the behavior of states, they also have shown that other factors—including some regime types (Urdal, 2006; Cincotta, 2008, 2008–2009, 2015A, 2015B, Cincotta & Doces, 2012), regional neighbors (Cincotta, 2015A, 2015B), and minority domestic demographics (Leuprecht, 2010; Blomquist & Cincotta, 2016)—can mediate, and even overpower, country-level age structure's apparent influences. These factors have been made apparent by the observation of two types of states: (a) those that fall short of the model's expectations; and (b) those that far exceed expectations. In both cases, analysts engaged in this method should be asking themselves the following questions:

- What are the qualities of that exceptionalism?
- Where, along the age-structural transition, do these exceptions cluster?
- What properties do these states possess in common at the time of their exceptionalism that might permit or encourage them to behave in an exceptional manner?

Observations of exceptional state behavior have spawned new hypotheses and experimental models and helped identify control variables. For example, Cincotta (2008–2009, 2015B) indicated that while generating the age-structural model of liberal democracy, he became curious about the political dynamics of two groups of exceptional states: (a) those that were assessed as liberal democracies when youthful (median age 25 years or less); and (b) those that remained nondemocracies when their age structure became mature (median age 36–45 years). He observed youthful democracies, as a group, to be ephemeral. Most maintained FREE status well under a decade before dropping to a lower status category. Of the 62 declines from FREE status recorded in Freedom House's data, 58 occurred among states with a median age of less than 26 years (Cincotta, 2015C).

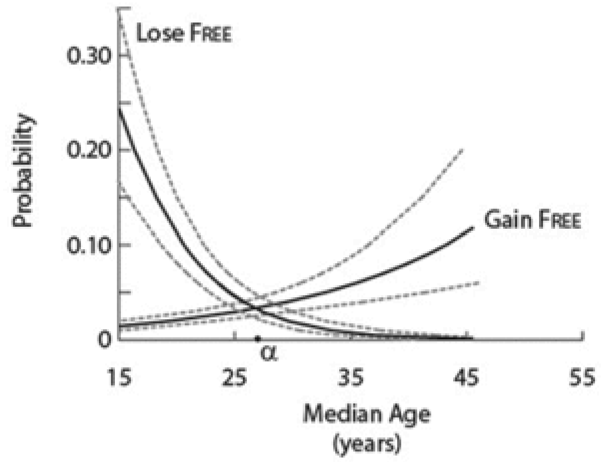

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Figure 6. Two Class III functions describing two distinct changes in regime status along the age-structural domain: the probability of a state that is currently not assessed as FREE becoming FREE during the next year (Gain FREE); and the probability of a state currently assessed as FREE losing that assessment in the next year (Lose FREE). Together, the functions suggest that a rise to FREE before α, between median age 26 and 27 years, is unlikely to be stable. Data are drawn from Freedom House data (FH, 2017).

Both Cincotta (2008–2009, 2015A) and Weber (2012) further investigated the hypothesis that youthful democracies are ephemeral regimes by fitting regression models to the probability of a state gaining liberal democracy and to the probability of a state losing it, once gained (Figure 6). They were unable to disprove these hypotheses. Cincotta (2015B) concluded that states assessed as FREE were unlikely to achieve stable liberal democracy before a median age between 26 and 27 years. Among states with a population greater than 500,000, only three contemporary exceptions can be found so far—Costa Rica, Jamaica, and Botswana—all under 5 million in population.

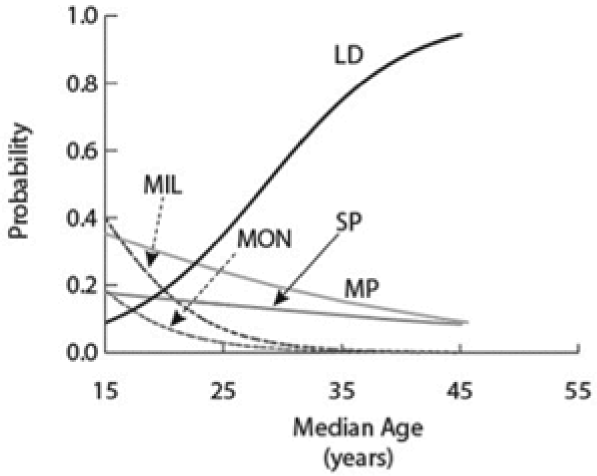

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Figure 7. Four Class III age-structural functions plotting the probability of specific authoritarian regime types, as identified by the Authoritarian Regime Data Base, version 5 (Wahman et al., 2013) across the age-structural domain: military regimes (MIL), monarchical regimes (MON), single-party regimes (SP), and multiparty regimes (MP). A fifth function (LD) plots the probability of a liberal democracy, which is FREE in Freedom House's annual assessment.

Similarly, it was observed that military rulers were notably absent among the authoritarian regimes that survived into the mature portion of the age-structural transition (median age of 36–45 years). Also, it was hypothesized that, although military regimes have a reputation for longevity, they are displaced quickly in age-structural time—deposed or voluntarily ended by the end of the intermediate phase (Cincotta, 2008, 2008–2009, 2015A, 2015B). Since the publication of that research, Cincotta has performed several preliminary tests of this observational hypothesis (Figure 7) using data from the Authoritarian Regime Data Base (Wahman, Teorell, & Hadenius, 2013; Hadenius & Teorell, 2007).

Forecasts and Other Predictive Products

Besides the functional form, other age-structural products have been used to make statistical forecasts, explore the future (horizon scanning), build early-warning problems, and demonstrate relationships that are illuminated by age-structural theory. In this section, four of these that have helped analysts better understand the future are presented: group statistical forecasts, age-structural maps, country-specific statistical forecasts, and regional statistical summaries.

Group Statistical Forecasts

Recounting a successful forecast provides the most useful description of how to organize a statistical forecast using the age-structural theory. The 2008 group forecasts advised of the high likelihood of one state in North Africa (out of five states) and one in the northwestern corner of South America (out of three states) becoming FREE by 2020. The reason for choosing these two contiguous groups was simple. At the time of the forecasts, none of the states were assessed as FREE. However, by 2020, several in each region were projected to pass FREE_{50}, a median age of 28–29 years—the theoretical peak-change in the probability of being assessed as FREE.

Generating statistical probabilities from a large data set and applying them, for the purposes of forecasting, to small groups is a risky venture. Statisticians call it the *small number problem*—the smaller the group, the greater chance it has of being entirely clustered near an edge of the population's distribution, far from its behavioral central tendency.

Therefore, to make a reasonable forecast with a small group, the probability of a behavior being observed should be very high. For the North African group, it was. In 2008, the age-structural model generated for this problem calculated the probability of observing at least one assessment of FREE, by 2020, among the five-state North African cluster at 0.97.[7] For the three-state South American cluster, it was not as high—that same calculation yielded a probability of 0.89.

In Freedom House's assessment for the end of 2016 (FH, 2017), only two states are scored FREE that were not similarly scored in 2008: Tunisia and Senegal. Since Freedom House's assessment was first published in 1972, Tunisia had never been scored FREE. Senegal was last scored FREE from 2002–2007, dropped to PARTLY FREE for three years, was again assessed as FREE in 2012, and retains that assessment today.

The probability of successfully picking one of the two, by randomly choosing a group of five states from the field of 99 PARTLY FREE and NOT FREE states in 2008, was 0.10 (9-to-1 odds against a correct pick). Choosing from eight states increases the probability to 0.15 (5.6-to-1 against a correct pick). Had both Tunisia and Colombia been assessed FREE, their probability of being chosen at random in 2008 would have been 0.02.

Age-Structural Maps

The intuitive products are maps that follow the four, discrete age-structural phases, assigned to each country, in chronological time (Cincotta, 2015B). When exploring Class III age-structural functions, which are insufficiently steep to support definitively timed forecasts, maps of the age-structural phases—in the past, the present, and two or three decades into the future—may be the most effective and informative means to communicate age-structural changes and the possibilities that are associated with them. Moreover, maps are the least statistically presumptuous. They allow their audience to come to their own conclusions by viewing the geographic distribution of the four age-structural phases.

Country-Specific Statistical Forecasts

When change in a political, social, or economic variable is statistically associated with movement through the age-structural transition, age-structural models can be used to generate statistical predictions of a state being in a discrete category of that variable. One example of a country-specific table, on Iran (Table 2), uses the four Class I categories (see Figure 4) to describe the relationship between a state's position in the age-structural transition (measured by median age) and the probabilities of being in each of the four categories of the World Bank's Income classes.

Table 2. Statistical Expectations of Being in Each of the Four World Bank Income Classes, Iran

IRAN: GNI per capita (2011 $US, Atlas Method)				
World Bank Income Classes	**Class Ranges (2011 $US)**	**2015 Expectation *(probability)***	**2025 Expectation *(probability)***	**2035 Expectation *(probability)***
Low Income	≤ 1,025	0.05	0.01	< 0.01
Lower-Middle Income	1,026–4,035	0.56	0.19	< 0.01
Upper-Middle Income	4,036–12,475	0.26	0.39	0.25
High Income	> 12,475	0.13	0.41	0.75
Median Age (years)		29.5 *(UNPD estimate)*	35.5 *(UNPD medium fertility variant)*	40.9 *(UNPD medium fertility variant)*

Note: (*) The World Bank Income Class to which Iran is assigned, 2015 (GNI per capita of $6,550, 2011 $US). (WB, 2016).

In this example, probabilities are generated for 2015 using the UNPD estimate for Iran, and for 2025 and 2035 using UNPD medium fertility variant projections (UNPD, 2015).

Regional Summaries

Age-structural models can be used to generate regional summary tables (Cincotta, 2015A, 2015B) that provide consumers with the model's most relevant output (Table 3). In this example, the table lists the state's name (column 1); its median age (in years) (column 2); its current age-structural category (column 3); its most recent Freedom Score and Freedom Status (column 4); the probability of that state being assessed as FREE in the current year (column 5); and the year that the median age has passed, or is projected to pass, FREE_{50}—a median age of 29.0 years, according to the UNPD's estimates or medium fertility variant projections (column 6). FREE_{50} is the year that the state first attains a 0.50 chance of being assessed as FREE, according to the age-structural model.

Table 3. Summary of the Middle East and North Africa *(MENA) R*egion, 2016

State	Median Age 2016 (years)	Age-Structural Category	Freedom Score 2016	Probability of Free	FREE$_{50}$ (year)
Cyprus	36	Mature	1.0 (F)	0.79	1984
Israel	30	Intermediate	1.5 (F)	0.57	2006 *
Tunisia	31	Intermediate	2.0 (F)	0.62	2010
Turkey	30	Intermediate	↓ 4.5 (PF)	0.56	2012
Iran	30	Intermediate	6.0 (NF)	0.56	2014
Lebanon	29	Intermediate	4.5 (PF)	0.51	2016
Morocco	28	Intermediate	4.5 (PF)	0.47	2018
Algeria	28	Intermediate	5.5 (NF)	0.45	2020
Libya	28	Intermediate	6.5 (NF)	0.45	2020
Bahrain	27	Intermediate	6.5 (NF)	0.42	2022

Saudi Arabia	24	Youthful	7.0 (NF)	0.31	2026
Syria	21	Youthful	7.0 (NF)	0.20	2035-40
Jordan	23	Youthful	5.0 (PF)	0.25	2035-40
Egypt	25	Youthful	5.5 (NF)	0.33	>2040
Oman	22	Youthful	5.5 (NF)	0.23	>2040
Qatar	21	Youthful	5.5 (NF)	0.19	>2040
Kuwait	21	Youthful	5.0 (PF)	0.19	>2040
Yemen	20	Youthful	6.5 (NF)	0.16	>2040
Iraq	19	Youthful	6.5 (NF)	0.15	>2040
UAE	19	Youthful	6.0 (NF)	0.14	>2040

Notes: (*) Median age of citizen-residents only; labor migrants discounted.

(**) Age-structural transition confounded by episodic immigration.

(↓) Downward trending Freedom Score.

(F) FREE; (PF) PARTY FREE; (NF) NOT FREE (based on FH, 2017).

The order of states is established by chronologically sorting $FREE_{50}$ (low to high, in column 6). In this arrangement, states assessed as FREE (F) typically cluster near the top of the table, and states experiencing intrastate conflict tend to cluster near the bottom. Ideological political monopolies (e.g., Iran) characteristically behave without deference to the order of the list. In states near or past $FREE_{50}$, the rise of ideological leadership (e.g., Turkey) or persistent intrastate conflict (Turkey, Libya) tends to stall democratization. Military regimes and monarchies typically do not remain in power past a median age of 35 years.

Discussion

The age-structural theory of state behavior is a work in progress, as all theories should be. Its focus has been on generating timed expectations—on providing analysts and policymakers with a statistical means to anticipate intelligence-worthy events and conditions using a set of models and forward-looking products. There are good reasons to continue this effort. Studied in chronological time, the timing of dramatic political changes has often befuddled country and regional specialists and caught diplomats by surprise. When viewed over the age-structural time domain (measured in years of median age), however, some of these shifts appear quite predictable—not at all like the unique events that current academic literature portrays them as being.

Age-structural theory is not the answer to discerning the dynamics of all state behaviors. Of course, its predictive and heuristic potentials are limited to those aspects that are associated with progress along the age-structural transition. Within that limited scope, however, the availability of freely accessible data and reproducible models, the potential for iterative testing and prediction, and the possibility of model rejection and reformulation give pursuit of many of the progressive epistemological qualities of scientific research programs. Also, while age-structural theory is limited in scope, it may be among the few theories that could help produce a much firmer theoretical foundation for defense, foreign affairs, and intelligence analysts than they currently enjoy.

Analysts need not be mathematically savvy to benefit from this theory. Nor do they need to abandon other analytical tools or perspectives personally. To gain age-structural theory's insights, they need only temporarily suspend a few of the causal explanations they hold dear and step into *age-structural time*—into a world viewed from the perspective of the age-structural transition. Those who take that step enter an analytical environment that is far more orderly and predictable than the chronological world in which we live, and far less prejudiced by our experiences, by the politics of the analytical environment, or by the ideological biases of political theories.

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Notes:

(1.) One well-known Middle East scholar laughed until he was in tears. Because the laughter did not subside, the session's chair ended the question-and-answer session. Later, when the group was polled by the convener, only two of the roughly two dozen scholars at the session believed that there were any lessons to be learned from this politico-demographic analysis. After Tunisia's demonstrators had ousted President Ben Ali, I called or emailed several of the individuals who attended the meeting, inviting them to learn more about the method or to collaborate to help analysts overcome the problem of "timing." I received no positive response from those I contacted.

(2.) This quote is extracted from an unclassified submission, attached to an email on October 20, 2010, addressed to the director of the Strategic Futures unit of the (U.S.) National Intelligence Council. The objective of the low-probability, high-impact event exercise for which this submission was generated was to create a set of early warning problems, with appropriate indicators, for the coming two years. Because, at the time, analysts did not associate demography with democratization, they rejected it.

(3.) Freedom House's three Freedom Status categories are placed in small caps to set them apart from the text.

(4.) In its classic form (which was used to describe constrained population growth), the function begins at its lowest point, accelerates to an inflection point, decelerates, and then levels off as it approaches an upper asymptote. However, this function also can be parameterized to operate in reverse: to begin at its high point and descend to a lower asymptote. Upward or downward sections of the function can be fit to data as well.

(5.) The median age projections for the GCC states' citizen-resident populations were obtained from the author via email or downloaded from his website.

(6.) In the UNPD's current methods, UN demographers identify this scenario, the medium-fertility variant, as the most likely, given the range of trajectories followed by other countries during similar fertility transitions. The low- and high-fertility variants are generated by varying the end point of the fertility trajectory (by 0.5 child) downward for the low-fertility variant and upward for the high-fertility variant, as was the method in prior revisions. The constant-fertility variant is produced by maintaining fertility, during the projection period, at the last estimated level.

(7.) Since 2008, demographers have determined that prior fertility estimates for Egypt were lower than later surveys revealed. Since then, Egypt's median age has been lowered in both estimates and projections. Therefore, Egypt's calculated probability of being assessed as FREE is considerably lower today than it was when calculated from 2008 data, and the projected year that Egypt will reach FREE_{50} (a 0.50 probability of being assessed as FREE) is now after 2040 (see Table 3).

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