

Long-Term Opinion Dynamics and Social Change

RACHAEL T. KHA and VICKY C. YANG, Massachusetts Institute of Technology, USA

Public opinion evolves through a complex interplay of individual belief change, generational turnover, and institutional influence—but not all issues progress equally. While attitudes on gender roles and gay marriage have shifted steadily, others like abortion rights and healthcare fluctuate or remain stagnant. This paper introduces a dynamic model of long-term opinion dynamics that integrates two often-overlooked forces: the replacement of older generations with younger ones, and the feedback between public opinion and institutional rules. The model captures how young people form beliefs based on inherited views, social context, and perceived behavioral norms, while also accounting for societal pushback against perceived extremes in policy. Through simulations, we show that this framework can reproduce three types of trajectories in public opinion: steady progress, long-term stagnation, and oscillation. These dynamics are driven by issue-specific thresholds for belief change and the strength of societal resistance. Our results help explain why some social changes persist while others stall or reverse, and highlight the importance of institutional context and intergenerational dynamics in shaping public discourse. This work offers a foundation for understanding the conditions under which lasting societal change can occur.

ACM Reference Format:

Rachael T. Kha and Vicky C. Yang. 2025. Long-Term Opinion Dynamics and Social Change. 1, 1 (July 2025), 8 pages. <https://doi.org/10.1145/nnnnnnn.nnnnnnn>

Introduction

Public opinion in the United States has experienced numerous shifts, with notable advances on issues such as gender roles in the workforce and same-sex marriage. Yet, progress has been uneven. For instance, abortion rights remain highly contested, as underscored by the recent reversal of *Roe v. Wade*. Similar disparities in the trajectory of public opinion can be observed across a range of issues and are clearly illustrated in survey data. Figure 1 shows public opinion trajectories on two issues, using data from the General Social Survey and the American National Election Studies. Panel (A) tracks changing views on whether homosexual relations are wrong, with each color representing a different 10-year birth cohort. Panel (B) depicts opinions on whether the government should pay for medical care. In Panel (A), public attitudes show a clear pattern of change over time, with younger cohorts consistently holding more accepting views than older ones. In contrast, Panel (B) reflects relative stagnation, with opinion fluctuating slightly around a stable baseline and showing no clear direction of change. These divergent patterns raise a fundamental question: why do some issues see steady shifts in public opinion, while others do not?

Extensive research in opinion dynamics modeling has aimed to explain various equilibrium outcomes in the distribution of beliefs or opinions. These studies typically focus on collective opinion dynamics arising from pair-wise interactions between individuals [1]. However, this existing paradigm misses two important aspects of opinion change. First, long-term societal opinion change operates through two primary pathways: individual change and generational

Authors' Contact Information: Rachael T. Kha, rachaelk@mit.edu; Vicky C. Yang, vcyang@mit.edu, Massachusetts Institute of Technology, Cambridge, MA, USA.

Permission to make digital or hard copies of all or part of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for components of this work owned by others than the author(s) must be honored. Abstracting with credit is permitted. To copy otherwise, or republish, to post on servers or to redistribute to lists, requires prior specific permission and/or a fee. Request permissions from permissions@acm.org.

© 2025 Copyright held by the owner/author(s). Publication rights licensed to ACM.

cohort replacement. The former involves individuals changing their own opinions—a mechanism that has been the primary focus of existing opinion dynamics models. The latter arises from demographic shifts, as younger generations replace older ones, thereby changing the overall composition of societal beliefs. The second component has been largely missing from opinion dynamics models. Empirical studies in sociology have demonstrated that both pathways play an important role in societal opinion shifts, such as in gender roles and gay marriage, disentangling the relative contributions of each mechanism [2–5]. Despite this rich body of empirical work, few empirical studies have explored how variation between issues occurs, and there remains a lack of quantitative, first-principles models for societal-level outcomes.

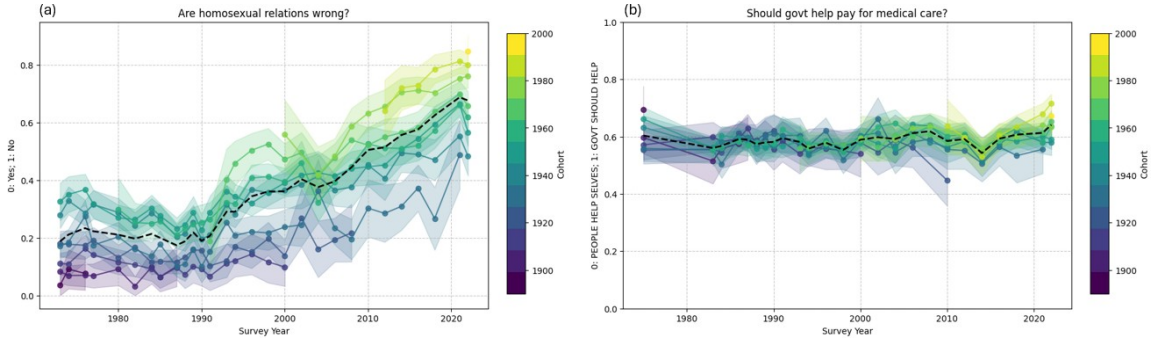


Fig. 1. Data from the General Social Survey [6] plotted by birth cohort over time for (a) views towards homosexual relations and (b) government responsibility for medical care. Each color represents the mean of responses obtained from individuals born within the same decade, ranging from 1900s (dark purple) to 2000s (yellow). The mean across all cohorts *each survey year* is shown with a dashed black line, and 95% confidence intervals are shown for each cohort’s average opinions. Views towards homosexual relations show substantial progress with opinions changing drastically between 1980 to 2020, whereas views towards whether the government should help pay for medical care has remained relatively stagnant throughout the same time frame.

Second, it has long been recognized that long-term societal change is shaped not only by interpersonal influence but also by institutional rules [7]. Although institutional rules are themselves influenced by evolving public discourse—and thus by existing public opinion—they also shape future attitudes. This two-way feedback loop is a critical yet underexplored component of societal opinion change, and it remains largely absent from current opinion dynamics models.

To address these two key gaps in modeling long-term societal opinion change, we introduced a coarse-grained, cohort-level framework that integrates both cohort replacement and institutional effects into models of opinion dynamics. This approach helps explain why society achieves steady, lasting progress on certain issues while remaining stagnant on others. Central to this framework is the need to unpack four distinct mechanisms of opinion change: (1) how individuals update their beliefs over time; (2) how new generations form their opinions as they enter society; and (3) where do institutional rules come from; and (4) how do rules shape individuals’ opinions. We now discuss the mechanisms in the existing literature on each of these elements.

(1) How do individuals update their beliefs? Most models of opinion dynamics assume some form of social averaging, where individuals adjust their beliefs toward those of others in their network. This idea is foundational in classic models such as the DeGroot model [8] and the voter model [9]. These models typically represent belief change as a gradual, iterative process driven by social interaction and local convergence.

(2) Where do young people’s opinions come from? Empirical research has identified two primary factors shaping the opinions of young people. First, family plays a formative role: young individuals’ political and social views highly correlate with those of their parents, which often serve as a baseline for their adult beliefs. Second, the broader cultural and social environment during their formative years also significantly shapes their beliefs [10]. Notably, empirical evidence suggests that new cohorts often enter society with more progressive views than any previous generation, for example, on issues such as gender roles and gay marriage [cite]—challenging the notion of simple belief convergence posited by many traditional models. This pattern may be explained by threshold-based models of opinion change. Granovetter’s (1978) model [11], for example, proposes that individuals adopt new behaviors once a critical mass of peers has done so. Recent studies of online communities suggest that as little as 25% of a committed minority can catalyze a broader shift in group norms [12], indicating how new generations may spearhead change.

(3) Where do institutional rules come from? Institutional rules, such as laws and policies, are strongly shaped by public opinion [13]. However, individuals who make the rules and policy are typically older, and may hold a different set of beliefs from young people. For example, in 2025, the median age in the US Senate is 64.7 years [14], and across states, the average age of legislators tends to be over 50 years [15].

(4) How do rules shape individuals’ opinion? Rules can affect public opinion in two primary ways. First, they can alter people’s perceptions of social norms, what is perceived as socially acceptable, mainstream, or legitimate. For example, the U.S. Supreme Court’s decision to legalize same-sex marriage contributed to a broader shift in social behavior [16]. [Additional examples could be added here, such as policy changes related to smoking bans, environmental regulations, or gender equality in the workplace.] Second, when institutional rules shift too far in one direction or seem overly coercive, they can trigger societal pushback. This is evident in public opinion research, which shows that people are concerned about radical changes and that such concern can serve as a real constraint on politicians’ behavior [17]. For instance, COVID-19 vaccine mandates have, in some cases, led to a backlash in individuals’ attitudes towards vaccines [18].

Model Formulation

We now mathematically formalize the four mechanisms described above within a dynamic model. We consider a population consisting of individuals between the ages of 18 and 80. At each time step, all individuals age up 1 year. Individuals over the age of 80 leave the system, and the same number of individuals aged 18 are added to the system.

This model considers three key state variables: beliefs (or opinions) held by each individual, social norms (or behavior), which is a collective-level property, and formal rules, which is also a collective-level property.

In this context, “opinion” and “belief” (denoted as B) are used interchangeably to represent individuals’ private views about whether a particular action—such as women’s participation in the workforce, abortion, or same-sex marriage—should be permitted or prohibited. While some literature distinguishes between these terms, such differentiation is unnecessary at the level of abstraction used in this model.

“Norm” (H) refers to the prevalence of a given action, as indicated by the visibility of that action in public or by expressions of support or opposition. This captures the behavioral aspect of social influence. In this model, we consider norm is determined by as a weighted sum between average beliefs and current rules, and $\beta \in [0, 1]$ is the weighting parameter.

$$H_t = \beta(\bar{B}_t) + (1 - \beta)R_t \quad (1)$$

“Rules” (R) denote formal regulations—such as laws—that define the acceptable range of behaviors for a given action. For modeling purposes, we assume that these rules reflect the beliefs of older generations, who typically dominate the institutions responsible for rule-making.

Opinion formation is modeled for emerging cohorts—those transitioning from childhood to adulthood—and consists of two components: inherited beliefs and an adjustment term. Inherited beliefs reflect the adoption of views from influential figures in the individual’s environment, such as parents, teachers, and community members. The adjustment term incorporates both a threshold term, capturing how personal experience may lead individuals to revise these inherited beliefs if certain conditions are met, and a pushback term, which is a response to the extremity of existing rules. The formulation for young people’s belief as they enter the system is,

$$B_{t,age=18}^i = \begin{cases} \bar{B}_t + (k_B(H_t - H_0) - P_t^{\text{extreme}})\bar{B}_t & h_t < 0 \\ \bar{B}_t + (k_B(H_t - H_0) - P_t^{\text{extreme}})(1 - \bar{B}_t) & h_t \geq 0 \end{cases} \quad (2)$$

Here, the threshold (H_0) is an issue-specific parameter representing the benchmark against which younger cohorts evaluate their experiences. At a high level, the mechanism assumes that young people initially adopt the prevailing beliefs in their environment ($\bar{B}_t$), but may adjust these beliefs based on their own experiences. The threshold functions as a minimum level of evidentiary support required for them to diverge from the views of previous generations.

Young cohorts’ opinion formation is also impacted by pushback, which is a response to the extremity of existing rules (R_t). From a prior study on the impact of mandates [18], which demonstrates how setting an explicit rule or regulation can lead to opposition, even when people’s prior opinions or behaviors would have otherwise complied with the goals of the rule. Here, the pushback term takes on a parabolic form, centered around 0.5.

$$P_t^{\text{extreme}} = k_1 \cdot (R_t - 0.5)^2 \cdot \text{sign}(R_t - 0.5) \quad (3)$$

Once cohorts have formed a belief, they update their beliefs as the world changes, specifically response to changes in others’ opinions and behaviors. This model assumes a basis of reinforcing dynamics for belief updating, in which cohorts update their beliefs to match the world around them – if the world is more progressive, their beliefs become more progressive (similarly if the world becomes less progressive).

Here, Δg_t is a weighted overage of recent changes in the mean opinion of a population ($\bar{B}_t$) and mass behavior (H_t) compared to the prior year, and $\alpha \in [0, 1]$ is a weighting term that determines how much influence comes from changes in public opinion versus changes in mass behavior.

$$\Delta g_t = \alpha(\bar{B}_t - \bar{B}_{t-1}) + (1 - \alpha)(H_t - H_{t-1}) \quad (4)$$

This is then used to determine the ‘indicated’ opinion level of the cohort i , B_t^{*i} :

$$B_t^{*i} = \begin{cases} B_t^i + \Delta g_t B_t^i & \Delta g < 0 \\ B_t^i + \Delta g_t (1 - B_t^i) & \Delta g \geq 0 \end{cases} \quad (5)$$

However, the actual opinions of cohort i at the next time step is computed according to:

$$B_{t+1}^i = B_t^i + \frac{B_t^{*i} - B_t^i}{\tau_B} \quad (6)$$

where τ_B is the belief updating time (in years).

Changes in rules (R_t) comes from changes in the beliefs or opinions of the older generation (here, indicated as individuals between 50 - 80 years old), who are considered the “rule makers,” whether explicitly (by creating laws, etc.)

or implicitly (by leading by example, passing on traditions, etc.):

$$R_{t+1} = R_t + \frac{\bar{B}_t^R - R_t}{\tau_R} \quad (7)$$

where τ_r is a parameter that influences the speed at which rules update to the beliefs of rule-makers.

Results

The simulation was able to demonstrate multiple modes of behavior, as shown in Figure 2. These reflect the dynamics seen in public opinion. For example, the opinions about homosexual relations are similar to those shown in Figure 2a, where opinion starts closer to one end of the opinion spectrum (against homosexual relations) but then approaches the opposite end of the spectrum over time (approving of homosexual relations), as shown in Figure 1a. Similarly, the behavior shown in Figure 2b reflects the dynamics of opinion about government responsibility for medical care, which is mainly stagnant. Note that even though Figure 2b, where the opinion stagnates is at a different value than in Figure 1b, the dynamics of the behavior are the same in that it stays constant at a single value.

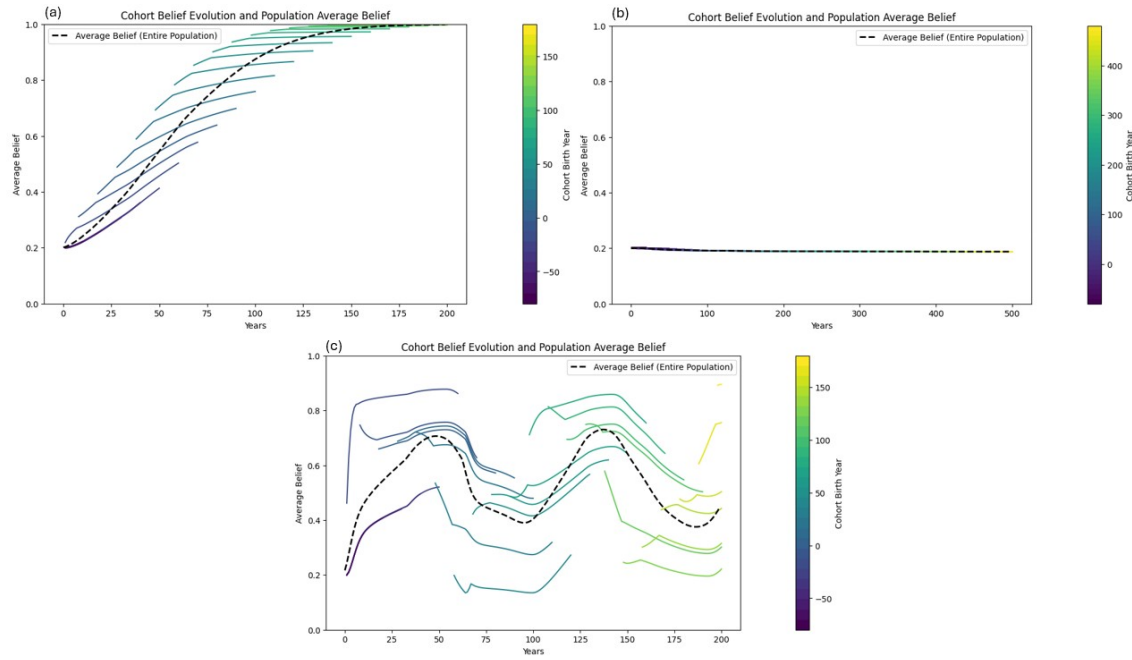


Fig. 2. Three primary modes of behavior are produced by the simulation: (a) progress is made from one end of the spectrum to the other; (b) overall opinion is stagnant over time; (c) oscillatory behavior occurs. The behavior in each simulation is set with $k_B = \tau_B = \tau_R = 1$; $\alpha = \beta = 0.5$. The variation in behavior is primarily due to changes in the behavior threshold (H_0) and pushback strength (k_1) parameters. All dynamics shown have the same starting distribution which is $N(0.2, 0.005)$.

The primary parameters responsible for these distinct results are the values of the behavior threshold (H_0) and pushback strength (k_1), which can also be tuned to achieve different rates of overall change or to equilibrate at different values (e.g. stagnation at a value other than 0.2). The values used to obtain the behavior shown in Figure 2 are listed in Table 1. A further exploration of these variables is shown in Figure 3. Here, the simulation outcomes are shown for

Behavior	H_0	k_1
Figure 2a	0.1	0
Figure 2b	0.5	3.2
Figure 2c	0.33	16

Table 1. Behavior threshold (H_0) and pushback strength values for simulation results shown in Figure 2

a range of behavior threshold and pushback strength values. Across both Figure 3a and b, we see that *without any pushback*, the average opinion or beliefs of the population converge to 1 or 0 depending on the relative value of the behavior threshold to the average starting opinion. When the threshold is lower than the average starting opinion, the simulation moves towards 1, whereas when the threshold is above the average starting opinion, the simulation moves towards 0.

However, when there is pushback, the behavior becomes more complex. For a given behavior threshold, the pushback strength can impact where overall opinion equilibrates, or whether it equilibrates at all. In the sections covered by black squares, Figure 3a and b demonstrate pairs of behavior threshold and pushback strength that result in oscillatory behavior, as shown in Figure 2c.

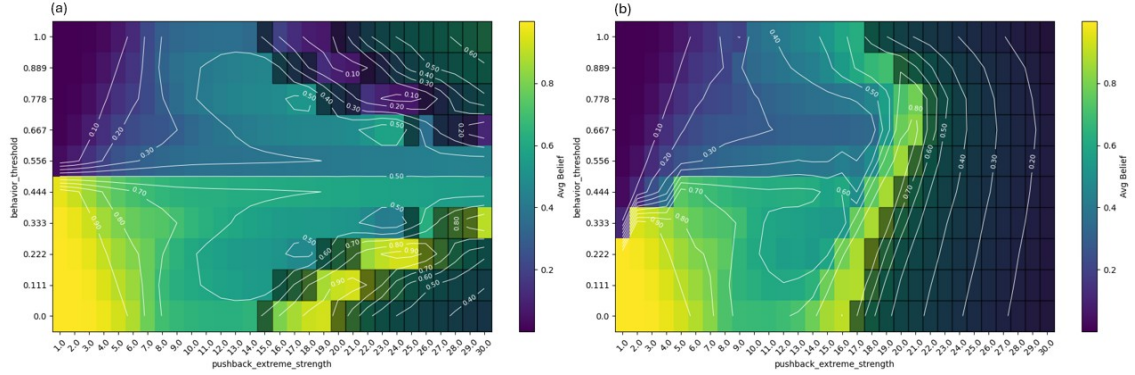


Fig. 3. Simulation results for various values of pushback strength (k_1) and the behavior threshold (H_0) after 200 years with a starting point of around (a) 0.5 and (b) 0.2. Areas shaded in black are regions where the simulation does not converge. The colors of the plot refer to the average belief value that the simulation reaches – yellow is 1, while purple is 0. Results from (a) demonstrate symmetric results across the a behavior threshold (H_0) value of 0.5. Results from (b) show more complex outcomes, when the starting point is biased towards 0. In both cases, the other simulation parameters were set as: $\alpha = \beta = 0.5$, $\tau_B = \tau_R = 1$ year, $k_B = 1$. The two sets of simulation results demonstrate the competing mechanisms of the behavioral threshold and the pushback strength, in which the strength of pushback can overcome the impact of a high behavioral threshold. However, high pushback can also prevent much progress from being made.

Discussion

We present a model of long-term opinion dynamics and social change, demonstrating the primary modes of behavior seen in social issues: progress, stagnation, and oscillation. The first shows how some issues have been able to make stable progress over time. The latter two, however, highlight that not all issues progress, such as in the cases of the government's role in paying for healthcare, over which public opinion has made limited, if any, progress. While this model demonstrates how multiple modes can be possible, it does not explain *why* this is the case for these particular issues.

There are also no exogenous features in this model, which could further influence these dynamics. For example, economic shocks, wars, or new technology (i.e. the internet boom) could impact the rate of change for various issues. There could also be spillover effects from progress made in related domains, as the progress of any social is not isolated from other progress.

Beyond the particular mechanisms featured in this model, another area for future work includes investigating the particular properties of issues themselves – how they are understood or framed in terms of moral or normative arguments – that can be responsible for these different modes of behavior. This could feed back into the simulation by influencing the pushback term or the speed of belief updating. For example, some issues may be more contentious than others, leading to stronger reaction to the extremes. Issues might also be more or less 'easy to digest' in which new information or perspectives are more readily able to change people's minds. The characteristics of issues and how people understand them could also be encapsulated in the state of the world weighting variable α , which weighs the influence of observed behaviors and rules in how individuals understand context of a particular issue. For example, some issues such as abortion may be perceived more as a matter of principle or moral value, making beliefs or public opinion more robust to changes in rules or behaviors, whereas gender roles can be understood as more normative and therefore more influenced by simply seeing different behaviors in the world.

In line with its coarse-grained perspective, this model uses broad definitions of 'beliefs,' 'behaviors,' and 'norms,' which can be somewhat ambiguous and limit the model's ability to capture much of the nuance in many of these issues. This model only considers one form of 'belief,' averaged over cohorts or the population to indicate overall the opinion across a group of individuals, whereas other models or studies have often further broken down these terms (especially, 'beliefs') into more fine-grained concepts. This could be important for considering *actual* versus *expressed* beliefs, different levels among a hierarchy of belief-types (i.e. core values versus fleeting attitudes), as well as *perceived* beliefs (also frequently called second order beliefs) [19–22]. While these are not necessary for the goals of this model, these distinctions are important to have in mind when interpreting this model's results.

Further research into how the behavior threshold and the pushback strength parameters are reflected across various opinion topics would also help contextualize the simulation outcomes and provide better guidance on how to utilize the results of this model. For example, understanding how the strength of pushback is related to a particular domain (e.g. how is pushback against the right to abortion different from pushback to gay marriage) or how pushback is influenced by current and past events (e.g. protests, media, legislation).

References

- [1] C. Castellano, S. Fortunato, and V. Loreto, “Statistical physics of social dynamics,” *Reviews of modern physics*, vol. 81, no. 2, pp. 591–646, 2009.
- [2] C. Brooks and C. Bolzendahl, “The transformation of us gender role attitudes: Cohort replacement, social-structural change, and ideological learning,” *Social Science Research*, vol. 33, no. 1, pp. 106–133, 2004.
- [3] G. D. Adams, “Abortion: Evidence of an issue evolution,” *American Journal of Political Science*, pp. 718–737, 1997.
- [4] D. M. Baunach, “Decomposing trends in attitudes toward gay marriage, 1988–2006,” *Social science quarterly*, vol. 92, no. 2, pp. 346–363, 2011.
- [5] Y. Yang, “Social inequalities in happiness in the united states, 1972 to 2004: An age-period-cohort analysis,” *American sociological review*, vol. 73, no. 2, pp. 204–226, 2008.
- [6] National Opinion Research Center (NORC), “General social survey (gss) data,” 2024, accessed: February 21, 2025. [Online]. Available: <https://gss.norc.umd.edu/>
- [7] W. R. Scott *et al.*, “Institutional theory,” *Encyclopedia of social theory*, vol. 11, no. 10, pp. 408–414, 2004.
- [8] M. H. DeGroot, “Reaching a consensus,” *Journal of the American Statistical association*, vol. 69, no. 345, pp. 118–121, 1974.
- [9] V. Sood and S. Redner, “Voter model on heterogeneous graphs,” *Physical review letters*, vol. 94, no. 17, p. 178701, 2005.
- [10] K. Janda, J. M. Berry, J. Goldman, and K. W. Hula, *The challenge of democracy*. Wadsworth Publishing, 2009.
- [11] M. Granovetter, “Threshold models of collective behavior,” *American journal of sociology*, vol. 83, no. 6, pp. 1420–1443, 1978.
- [12] D. Centola, J. Becker, D. Brackbill, and A. Baronchelli, “Experimental evidence for tipping points in social convention,” *Science*, vol. 360, no. 6393, pp. 1116–1119, 2018.
- [13] B. I. Page and R. Y. Shapiro, “Effects of public opinion on policy,” *American political science review*, vol. 77, no. 1, pp. 175–190, 1983.
- [14] “Age and generation in the 119th congress: Somewhat younger, with fewer boomers and more gen xers,” 2025. [Online]. Available: https://www.pewresearch.org/short-reads/2025/01/16/age-and-generation-in-the-119th-congress-somewhat-younger-with-fewer-boomers-and-more-gen-xers/?utm_source=chatgpt.com
- [15] E. Ronco, “Who, exactly, is the ‘average’ state legislator?” 2025. [Online]. Available: https://www.ncsl.org/state-legislatures-news/details/category/state-legislatures-news/who-exactly-is-the-average-state-legislator?utm_source=chatgpt.com
- [16] M. E. Tankard and E. L. Paluck, “The effect of a supreme court decision regarding gay marriage on social norms and personal attitudes,” *Psychological science*, vol. 28, no. 9, pp. 1334–1344, 2017.
- [17] J. A. Stimson, *Tides of consent*. Cambridge University Press, 2015.
- [18] K. Schmeltz and S. Bowles, “Overcoming covid-19 vaccination resistance when alternative policies affect the dynamics of conformism, social norms, and crowding out,” *Proceedings of the National Academy of Sciences*, vol. 118, no. 25, p. e2104912118, 2021.
- [19] P. E. Converse, “The nature of belief systems in mass publics (1964),” *Critical review*, vol. 18, no. 1-3, pp. 1–74, 2006.
- [20] J. Zaller, *The nature and origins of mass opinion*. Cambridge university press, 1992.
- [21] L. Bursztyrn, A. W. Cappelen, B. Tungodden, A. Voena, and D. H. Yanagizawa-Drott, “How are gender norms perceived?” National Bureau of Economic Research, Tech. Rep., 2023.
- [22] L. E. Thomas, “Generational discontinuity in beliefs: An exploration of the generation gap 1,” *Journal of Social Issues*, vol. 30, no. 3, pp. 1–22, 1974.