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Abstract

This paper revisits the political economy of transitions to democracy. We build on a canonical rational choice model of democratization by introducing demography, arguing that the demographic structure of a society shapes the material incentives for a democratic movement. A population's youth cohort can benefit from democratic improvements over a longer time horizon and may have a lower opportunity cost of participating in democratic movements than older cohorts. Hence, a rise in the population's proportion of youth during the demographic transition opens a democratic "window of opportunity" as the heightened incentives for a democratic movement might prompt an autocratic elite to concede more democracy. We test this prediction on two long country-year panel data sets containing detailed demographic data. Fixed-effects panel regressions demonstrate that an increase in the youth ratio is robustly associated with democratic improvements. The effect is particularly pronounced for "youth bulges" measured as the proportion of the population between the ages of 15 and 19. Two distinct instrumental variable strategies, using (i) lagged fertility rates in neighboring countries and (ii) past climatic conditions, allow for a causal interpretation of this correlation. Furthermore, the positive impact of the youth ratio on democratic improvements is more pronounced during recessions suggesting that demographic and macro-economic cycles are complementary channels. Finally, we show that low intensity conflict, such as riots, might act as a transmission channel, facilitating the positive impact of a high youth ratio on the probability of a democratic improvement.

Keywords: Political transition, Democracy, Demography, Youth bulge

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"The reason the younger generation [in Iran] is taking this kind of risk is because they feel they have nothing to lose, they have no hope for the future [without regime change]."

– Ali Vaez, International Crisis Group, in *The NY Times* on September 26, 2022

1 Introduction

The political science literature often considers that youthful populations can be sources of political instability and conflict. Youth cohorts, not yet well integrated into socioeconomic institutions, have been considered to be the segment of the population with the lowest opportunity costs of participating in organized violence and rebel movements such that the presence of a "youth bulge" may be destabilizing in liberal democracies (Weber, 2013, 2019). However, the aforementioned opportunity cost effect might also induce them to engage in pro-democracy movements in more autocratic settings. Moreover, young adults are also those who have the longest life horizons and, because of this, the highest incentives to invest in long-term institutional and political changes which they will enjoy for more time periods. We argue that, beyond its supposed destabilizing effect in liberal democracies, a high youth ratio increases the probability of observing a democratic improvement in societies that have not fully democratized. Figure 1 illustrates this relationship. It shows that, across all continents[1], a democratic improvement is more likely to be observed when the proportion of youth is high (dark circles) rather than low (light circles). This pattern is particularly salient for Africa and Latin America where many episodes of transition have been observed in the post-war era.

In this paper, we empirically demonstrate that this positive effect of a high youth ratio on democratic improvements constitutes a robust result. This finding enriches the Acemoglu and Robinson (2001, 2006) theory of political transition [henceforth referred to as AR], in which political elites might be induced to make concessions, in the form of institutional changes, under a threat of revolution. According to the AR theory, economic slowdowns open a "window of opportunity" for a democratization since, during recessions, opportunity costs of participating in democratic movements are low and the threat of revolution is high. We shed light on a complementary channel by showing that demographic variables—the youth ratio in particular—can also be a factor that opens a window of opportunity for democratization. Moreover, we demonstrate that economic and demographic forces reinforce each other: the impact of a recession on the probability of a transition is magnified when the youth ratio is large. With this result, we also revisit the modernization theory (Lipset, 1959) according to which democracy is a by product of economic prosperity. While we do not conclude that economic development *per se* is the main engine of democracy, we argue that demographic transformations, associated with the development process, pave the way for democratic improvements. Nevertheless, since the youth ratio rises and then falls in the course of the demographic transition, the window of opportunity for a democratic transition, stemming from the modification of the age structure of a society, only corresponds to a specific and temporary period of the development process of that society.

Our conceptual framework builds on the canonical rational choice model of democratization (Acemoglu and Robinson, 2001, 2006). The population is divided into two groups, the elite—holding the coercive power

[1] We have putted together Europe, North America and Oceania in order to have a sufficiently high number of episodes of democratic improvements in each region.

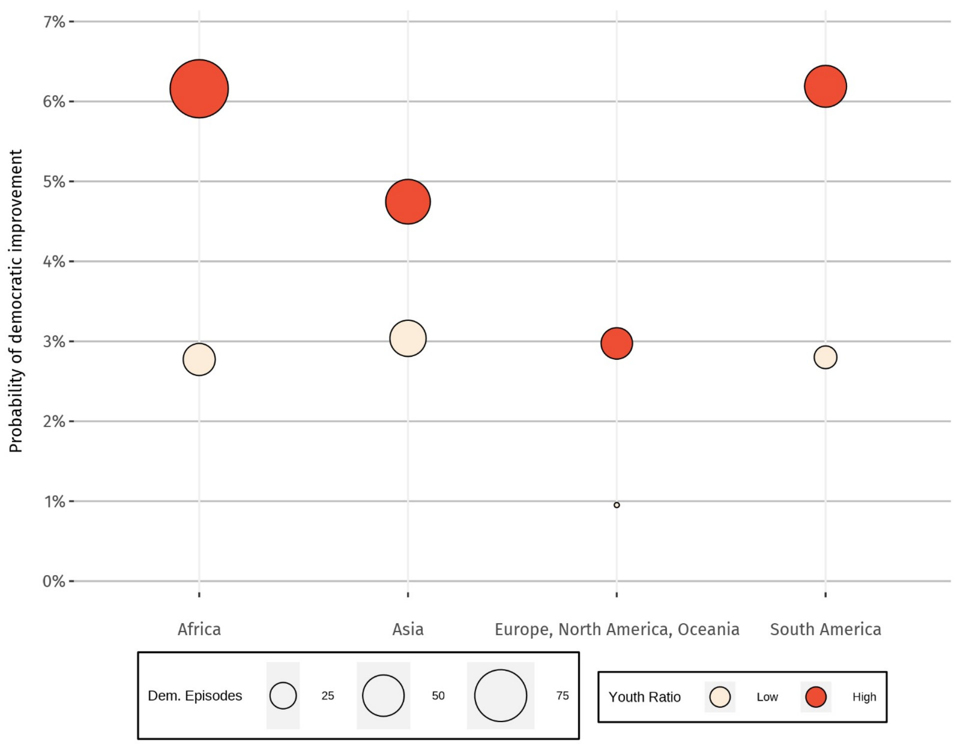


Figure 1: Democratic improvements and the proportion of youth.

Notes: We use yearly country data covering the period 1950-2017. For each continent, we split our sample into observations for which the proportion of youth is low (below the median of the continent) and high (above the median of the continent). On the figure, we report the proportion of observations for which a democratic transition occurs in each sub-sample (the sizes of the circles correspond to the absolute number of democratic improvements in each sub-sample and for each region). A democratic improvement corresponds to a rise in the Polity 2 index of at least 2. The proportion of youth corresponds to the share of the population aged between 15 and 19 in the total adult population (15 years and above). More details about the construction of those variables are provided in Section 4.

of the state and using this power to capture a share of the total output produced in the economy—and the non-elite. Non-elite members choose to engage or not in a democratic movement by comparing the short-run costs of their participation to the long-run benefits of democracy. We introduce a role for demography in this stylized version of the AR model. We assume that individuals live for three periods (they are successively *young*, *mature* and *old*) and that costs and benefits of a democratic movement evolve with age. In particular, young adults are disproportionately more likely to participate in a democratic movement due to the combination of two forces: *i*) smaller opportunity costs due to lower economic opportunities and fewer social responsibilities (such as domestic partnerships and offspring to care for) and *ii*) a longer time horizon over which to enjoy the benefits of living in a democratic society. Hence, the presence of a "youth bulge" constitutes a threat of revolution that might induce the elite to concede democracy. Note that a recession—modeled as a temporary fall of wages—by reducing the opportunity costs of participation also increases the threat of revolution as predicted by AR, but this is all the more true when the share of youth in the population is large.

We test these theoretical predictions using two country-year panel data sets covering the periods 1950–2017 and 1800–2017, respectively. Using fixed effects regressions including relevant controls, we identify a robust empirical regularity: the youth ratio is positively correlated with the likelihood of a democratic improvement, measured by a sizable variation of the Polity 2 index.[2] Our first data set, the UN demographic projections data (1950–2017), contains detailed information on the age structure of the population. It allows us to clarify which age group drives this result. Interestingly, we observe that the effect is predominantly driven by the youngest cohorts. The proportion of the population aged 15-19 in the adult population (aged over 15 years) exerts the most significant impact, while the youth bulge effect remains evident when considering the population aged between 15-24. Consistent with our theoretical insights, this phenomenon could be explained by the existence of a sharp discontinuity in the opportunity costs of participating in a democratic movement, occurring somewhere between the ages of 20 and 25. This is the age range at which individuals typically become integrated into social institutions such as marriage and the labor market. We confirm the positive impact of the youth ratio on democratic improvements on a longer panel (1800-2017) for which we do not have such detailed information about age structure. To do so, we use the fact that, along the demographic transition, the net fertility rises and then falls such that we can identify a period—about 15 years after the peak of the demographic transition—around which the youth ratio is likely to be at the highest. Delventhal, Fernández-Villaverde and Guner (2021) provide, for every country, a date of that peak. Then, using fixed effect estimators, we show that a democratic improvement is significantly more likely to occur around 15 years after this peak net fertility date.

Since the proportion of youth may be endogenous, the aforementioned relationship between the youth ratio and the likelihood of democratic improvements cannot be interpreted causally. In order to overcome this issue, we mobilize two distinct instrumental variable strategies. First, we use the 15-years-lagged fertility rates to instrument for the proportion of youth. We argue that the lagged fertility rate should not be affected by contemporaneous democratization episodes and affects contemporaneous democratization episodes only through its impact on the youth ratio 15 years later. However, one might think that fertility behaviors and political changes 15 years later are jointly affected by some unobservable variables.[3] To deal with this possibility, we also instrument the proportion of youth in one country by the lagged fertility rate in neighboring countries. This approach builds on existing evidence of a geographic diffusion of fertility norms (Daudin, Franck and Rapoport, 2019; Spolaore and Wacziarg, 2022). Our second strategy relies on an instrument which is arguably less directly related to the youth ratio but more exogenous than behavioral variables like the lagged fertility rate. Specifically, we use the Standardized Precipitation-Evapotranspiration Index (SPEI) data set to construct an indicator of climatic conditions that we interact with a measure of the weight of agriculture in the economy. We use it as an instrument for the youth ratio 15 years later. The rationale is that, in countries where more households depend on the agricultural sector of the economy, climatic variations translate into income variations which, in turn, might affect fertility behaviors. We show that, in those countries, favorable climatic conditions have a negative impact on fertility rates. This is consistent with the idea that a positive income shock increases the opportunity costs of raising children (Becker and Tomes, 1976; Becker and Lewis, 1973; Becker et al., 1960; Rosenzweig, 1977). Both instrumental strategies corroborate the results obtained using OLS regressions, suggesting a causal relationship. The "youth bulge" effect is even magnified in the IV regressions.

We establish several further results. First, as predicted by the AR theory of democratization, we find that

[2]The Polity 2 index is a widely used measure of the degree of democracy. More details about this index are provided in Section 4.

[3]Note that this risk remains limited since we add country specific and time varying fixed effects to our regressions and because we use the one year lagged value of the Polity score as control variable.

a democratic transition is more likely to occur during recessions. Furthermore, we show that the youth bulge effect is amplified during recessions, suggesting the existence of a complementarity between economic and demographic forces. Next, we examine the "revolutionary threat" mechanism, exploring the impact of the youth ratio on low-intensity conflicts and its potential to catalyze a transition towards democracy. Specifically, our findings demonstrate that a rise in the youth ratio correlates with an increase in incidents of riots, and crucially, these riots, fueled by a higher youth ratio, are a key factor in driving democratic transformations. Overall, these findings align with the AR theory, suggesting that in numerous instances, elites acquiesce to democratic reforms when faced with the prospect of revolution, as a strategic measure to prevent widespread civil unrest. We also conduct a series of robustness checks and placebo tests that confirm our main results.

Our paper is related to several strands of the economics and political science literature. We first contribute to the vast empirical literature on the determinants of democratization. Most of this literature has focused on the post-war period (Teorell, 2010) and on social and economic factors, such as income inequality (Knutsen and Wegmann, 2016; Haggard and Kaufman, 2012; Dorsch and Maarek, 2020; Kotschy and Sunde, 2021), macroeconomic business cycles (Acemoglu and Robinson, 2001; Burke and Leigh, 2010; Brückner and Ciccone, 2011), economic development and the modernization hypothesis (Barro, 1999; Lipset, 1959; Murtin and Wacziarg, 2014; Przeworski and Limongi, 1997), or economic opportunities and aspirations in the context of the Arab spring (Campante and Chor, 2012).[4] To the best of our knowledge, Dyson (2013) and Wilson and Dyson (2017) are the only ones to have considered the role played by demographic factors. They conclude that the median age of the population has a positive impact on the probability of democratization. The scope of their study is more limited than our own, however. Wilson and Dyson (2017) only consider 77 countries over the period 1970-2015 while, in our baseline regressions, we consider 165 countries over the period 1950-2017.[5,6] More importantly, our IV strategy allows us to interpret our main result as a causal relationship while Wilson and Dyson (2017) only emphasize a positive correlation between median age and democratization. In terms of the interpretation of the results, while the youth ratio—what we use as our main explanatory variable—and median age are linked, they are far from being equivalent. Importantly, while the youth ratio rises and then falls over the course of the demographic transition, the median age is likely to steadily increase over time. Hence, while the positive impact of the youth ratio on democratic improvements is compatible with AR's window of opportunity theory of democratization, the positive effect of the median age cannot be interpreted in this way. The window of opportunity theory of political transition has found empirical support in a number of studies (e.g, Aidt and Franck 2015; Burke and Leigh 2010; Brückner and Ciccone 2011). Nevertheless, these studies exclusively focus on the role played by economic shocks while the theory is more general. Our article demonstrates the relevance of extending the window of opportunity argument to demographic factors.

Our paper is also related to the body of political science literature exploring the socio-political repercussions of sizable young cohorts. This literature primarily delves into the consequences of youth bulges on civil conflicts (Flückiger and Ludwig, 2018; Apolte and Gerling, 2018), social unrest, violent protests, and political instability

[4] See also Rød, Knutsen and Hegre (2020) or Papaioannou and Siourounis (2008) for a more systematic examination of the multiple determinants of democratization.

[5] We also use a longer panel covering the period 1800-2017 for some countries.

[6] Dyson (2013) provides descriptive evidence of a positive correlation between median age and democratic improvements using data on Western Europe and the United States over the period 1850-2005.

(Goldstone, 2002, 2016; Urdal, 2006; Weber, 2013; Farzanegan and Witthuhn, 2017; Weber, 2021). Consistent with these studies, we observe a positive impact of the "youth bulge" on low-intensity conflicts such as riots. However, our findings do not suggest a propensity for these riots to escalate into larger scale conflicts or induce democratic reversals. On the contrary, our research reveals that riots fueled by a high youth ratio increase the likelihood of democratic improvements. It suggests that elites strategically concede democratic advancements in response to riots, which highlight the credible threat of revolution posed by a substantial proportion of young people in the population.

Finally, our findings are related to modernization theory (Lipset, 1959) as they shed light on the intricate dynamics between economic development and political change. Previous research in this domain has predominantly centered on education as a pivotal transmission factor (e.g. Huang 2012). Technological evolution and industrial progress, on one hand, have heightened the demand for human capital (Galor and Moav, 2006; Galor, Moav and Vollrath, 2009), compelling the elite to invest in mass education. On the other hand, investments in education, by augmenting the de facto power of the masses, have facilitated the transition to democracy (Murtin and Wacziarg, 2014; Parente, Sáenz and Seim, 2022). Our results contribute by suggesting that these interactions gain strength when demographic changes are considered as a complementary channel. Unified Growth Theory (Galor and Weil, 2000; Galor et al., 2005) underscores the inherent links between technical changes, increased demand for human capital, and demographic shifts. Our study specifically adds to the existing literature by highlighting the potential of demographic transformations to enhance the likelihood of democratic improvements. In turn, democratic transitions may instigate public policies with the potential to accelerate demographic changes. While this is clearly beyond the scope of this paper, our results suggest that the development of a unified theory that intricately connects economic development, demographic changes, and political transitions would constitute a promising avenue for future research.

The rest of paper is organized as follows. Section 2 introduces a stylized model of democratization that adds age structure to the baseline model of Acemoglu and Robinson (2001), Section 3 outlines our empirical strategy, Section 4 presents the data we use, our main results are presented in Section 5 and further results in Section 6, robustness tests are provided in Section 7, and Section 8 concludes.

2 A stylized model

In this section, we offer a simple analytical framework—inspired by a canonical rational choice model of democratization (Acemoglu and Robinson, 2001, 2006)—to investigate the role of demography in the democratization process.[7] We consider an economy with a population divided into two groups $g \in \{e, ne\}$, where *elite* members (indexed by e) are in proportion $\lambda < 1/2$ and *non-elite* members (ne) are in proportion $1 - \lambda$. The political regime can be *democratic* or *non-democratic*. In a non-democratic regime, the coercive power of the state is controlled by the elite, who can use this power to capture a share of the output produced by the non-elite. On the contrary, in a democracy, the coercive power of the state is equally shared between all citizens so that no partic-

[7]Since the main purpose of the model is illustrative, we consider a very stylized version of the AR framework. Our stylized model shares features of the model proposed by Shadmehr and Haschke (2016) to study the relationship between age structure, threat of revolution and state repression.

ular group is able to capture a disproportionate share of the whole output.[8] We are interested in the likelihood that a society switches from a non-democratic regime to a democratic regime.

2.1 The demographic structure

All individuals, whatever their group g, are economically and politically active during three periods indexed by $i \in \{y, m, o\}$. During a first period they are *young* (y), in a second period they are *mature* (m), and in a third period they are *old* (o). We denote by $N_{i,t}^{g}$ the number of individuals of age i belonging to the group g at date t and by $N_{i,t}$ the total number of individuals of age i, with $N_{i,t} = \lambda N_{i,t}^{e} + (1-\lambda) N_{i,t}^{ne}$. Finally, the whole population at date t will be denoted $N_t = N_{y,t} + N_{m,t} + N_{o,t}$. Young individuals become mature with probability one while the survival probability from the mature to the old period is denoted π such that $N_{m,t+1}^{g} = N_{y,t}^{g}$ and $N_{o,t+1}^{g} = \pi N_{m,t}^{g}$ for any $g \in \{e, ne\}$.[9]

2.2 Economic environment, political institutions and regime change

Each individual, whatever his group $g \in \{e, ne\}$, produces a good with a productivity ω_i that might depend on his age $i \in \{y, m, o\}$. It captures the fact that, at different ages, individuals do not have access to the same technology (the same market opportunities) and reflects that productivity might increase with experience.[10] If the regime is non-democratic, elite members are able to capture a share of the production of non-elite members. More precisely, a share θ (with $\theta > \lambda$) of the total output produced by one age group is equally distributed among elite members of the same age group while the remaining share is equally distributed among non-elite members.[11] In a democracy, no particular group can exert a coercive power over another group so that each individual earns his productivity.

Since we are interested in the democratization process we will focus on the case of a society which is initially non-democratic. Then, we assume that, if at a given date t a democracy is established, the society will remain democratic at all subsequent dates $t' \geq t$. If at date t the political regime is non-democratic, the elite might decide to establish a democracy. If it does not, some individuals might decide to participate in a democratic movement. Let us denote by ρ_t the number of individuals who find it profitable to join a movement for democracy. We assume that a democratic movement becomes a revolution if and only if:

$$\rho_t / N_t \geq \zeta \tag{1}$$

with ζ the realization of a random variable with cumulative distribution function denoted $\phi(.)$. This variable

[8] In the AR model, the two social groups (*rich* and *poor*) differ in terms of income and the two political regimes (*democracy* and *non-democracy*) differ in terms of which group decides over the redistributive policy. In a non-democracy, the elite (i.e. the rich people) chooses the policy while, in a democracy, the median voter (who is poor) decides. Our very simple set-up might be viewed as a reduced form version of the AR model. In AR, elite members prefer a non-democratic regime as it allows them to prevent the redistributive pressure of the majority, whereas in our model this is because it allows them to capture a share of the income produced by the non-elite.

[9] In order to simplify the exposition we assume that the survival probability π is identical for the two groups. As it will become clear, our analysis would not be modified if we had allowed for group-specific survival probabilities.

[10] As it will be clarified below, we might have a broader interpretation of the parameter ω_i. It might encompass, not just individual earnings, but also some subjective rewards associated with marital life and parenthood for instance. Hence, this parameter might be lower for young individuals which are more likely to be unmarried and childless.

[11] Again, the assumption according to which elite members capture the output of people of their age group simplifies the exposition without qualitatively affecting the analysis.

accounts for the chance of a revolution, which could depend on unexpected circumstances. According to equation (1) the proportion of democratic activists within the whole population, rather than the absolute number of activists, matters for the success of a revolution. It captures the fact that, for a given number of activists, the number of individuals who do not have an incentive to take part in the democratic movement reduces the chance of a successful revolution. A similar assumption is made by Persson and Tabellini (2009), Shadmehr (2019) or Bueno de Mesquita and Shadmehr (2022).

If a revolution is successful (i.e. if the above condition is satisfied), it always results in democracy being established at the beginning of the next period. During a revolution, a fraction μ of the resources produced by each individual is destroyed (for ease of simplicity we assume that this fraction is the same for all g and i). We also assume that, during this period, the elite is not able to capture any resources.

To sum-up, at a given date t, the society can be in one of the three following political regimes: non-democracy (ND), democracy (D) or revolution (R). Denoting $w_t^g(P)$ the flow of income of an individual belonging to the group $g \in \{e, ne\}$, having age $i \in \{y, m, o\}$ and under the political regime $P \in \{ND, D, R\}$, we have $w_i^{ne}(ND) = \frac{1-\theta}{1-\lambda}\omega_i < \omega_i$, $w_i^e(ND) = \frac{\theta}{\lambda}\omega_i > \omega_i$, $w_i^{ne}(D) = w_i^e(D) = \omega_i$ and $w_i^{ne}(R) = w_i^e(R) = (1-\mu)\omega_i$. In the following, we assume that the share of income destroyed during the revolution is larger than the amount captured by the elite in a non-democratic regime:

Assumption 1. $\mu > \frac{\theta-\lambda}{1-\lambda}$.

Under this assumption, a revolution incurs immediate costs for the people so that a non-elite member will participate in a democratic movement if and only if these costs are overcome by future benefits.

2.3 Individuals' decisions

Assuming that, at the beginning of a period t, the political regime is non-democratic ($P = ND$), the events of the period t unfold as follows:

1. nature chooses ζ;
2. the elite decides to establish a democracy or not;
3. if the elite decided not to establish a democracy in stage 2, each individual decides to take part in a democratic movement or not.

Individuals make their decisions in order to maximize their expected flow of income over their entire life. For simplicity, we assume that individuals' expectation with respect to the political regime that will prevail in the future are myopic. If at date t the elite does not democratize, individuals anticipate that the political regime that will prevail in $t' > t$ will be non-democratic if a revolution does not occur during the period t. The problem is solved by backward induction. We first look at the decision to participate or not in a democratic movement when the elite has decided not to democratize (Stage 3), then we analyze the decision of the elite to democratize or not (Stage 2).

Participation in a democratic movement (Stage 3). We do not consider the coordination issue.[12] Instead, we assume that an individual will decide to take part in a democratic movement if and only if his life cycle utility with an initiated revolution is higher than in the absence of revolution. This condition is called the *revolution constraint* and is obviously violated for the members of the elite (of all ages). Indeed, since elite members receive a higher share of the total output in a non-democratic regime, for them a revolution incurs immediate costs and does not generate any future net benefits. For non-elite members, the cost and benefits associated with a revolution depends on age. The revolution constraint for an individual of age i (RC_i) is written as:

$$\frac{1-\theta}{1-\lambda}\left(\omega_i + \tilde{W}_i\right) \leq (1-\mu)\omega_i + \tilde{W}_i \qquad (\text{RC}_i)$$

where $\tilde{W}_i$ is the expected future flow of income of a ne individual of age i, such that $\tilde{W}_o = 0$, $\tilde{W}_m = \pi\tilde{\omega}_o$ and $\tilde{W}_y = \tilde{\omega}_m + \pi\tilde{\omega}_o$ ($\tilde{\omega}_i$ is the expected value of ω_i). This inequality has a simple interpretation. The decision to participate or not in a democratic movement is based on the comparison between the expected income associated with remaining in a non-democratic regime[13] and the expected income associated with participating in a successful revolution. The (RC_i) can be rewritten as:

$$\left(\frac{\theta-\lambda}{1-\lambda}\right)\tilde{W}_i \geq \left(\mu - \frac{\theta-\lambda}{1-\lambda}\right)\omega_i. \qquad (\text{RC}'_i)$$

The LHS corresponds to the future benefits associated with the switch from a non-democracy to a democracy, $\tilde{W}_i - \frac{1-\theta}{1-\lambda}\tilde{W}_i = \left(\frac{\theta-\lambda}{1-\lambda}\right)\tilde{W}_i$; while the RHS corresponds to the net costs of participating in a revolution, $\frac{1-\theta}{1-\lambda}\omega_i - (1-\mu)\omega_i = \left(\mu - \frac{\theta-\lambda}{1-\lambda}\right)\omega_i$ (which is positive under Assumption 1).

Condition (RC'_i) is central for our analysis as it clarifies how the decision to participate depends on an individual's age and, accordingly, how the probability of a successful revolution depends on the age structure in the society. According to (RC'_i), the age impacts both the benefits and the costs of participation. The future benefits are impacted through a simple horizon effect, as younger people have a longer life expectancy, they will mechanically benefit from democracy for a longer period: $\tilde{W}_y = \tilde{\omega}_m + \pi\tilde{\omega}_o > \tilde{W}_m = \pi\tilde{\omega}_o > \tilde{W}_o = 0$. However, the opportunity costs of a revolution also depends on age. Indeed, since market opportunities (ω_i) depend on age, so to does the opportunity cost of taking part in revolutionary activities. While we do not make any specific assumptions about the relative values of age specific productivities (ω_i), it is reasonable to think that they are increasing with age through a return to experience effect: $\omega_o \geq \omega_m \geq \omega_y$. However, the positive effect of age on the opportunity cost of a revolution is probably highly non-linear. In particular, in many countries, there exist barriers to entry into the labor force for young people who consequently have low market opportunities compared to other age groups who defend their well-established economic positions (Lindbeck and Snower,

[12] As revolutionary activities generate collective benefits at the expense of private costs, they typically raise a collective action problem. Following Acemoglu and Robinson (2000, 2001, 2006) we ignore this issue. Acemoglu and Robinson (2006) provide an extensive discussion on the different ways to deal with this collective-action problem, including the use of ideology and pecuniary benefits by revolutionary groups. They also provide evidence about how the collective-action problem is solved in practice. From a theoretical point of view, Persson and Tabellini (2009), Shadmehr (2019) or Bueno de Mesquita and Shadmehr (2022) show the crucial role played by imperfect information about the likelihood of success of a revolution (the distribution of ζ in our model) in solving the coordination problem. The introduction of those elements is beyond the scope of our illustrative model.

[13] Remember that, under our myopic expectations assumption, individuals assume that, in the absence of a revolution today, the regime will remain non-democratic forever.

2001; Saint-Paul, 2002).[14]

Let us now come back to the decision to participate or not in a revolution for each age. Under Assumption 1, it is clear that (RC_o') is never satisfied since the LHS equals 0 while the RHS is positive. Hence, it is never in the interest of old individuals to participate in a democratic movement as the horizon effect cannot compensate the costs. For mature and young individuals, (RC_i') is satisfied if μ is lower than a threshold denoted $\overline{\mu}_i$ with:

$$\overline{\mu}_y = \frac{\theta-\lambda}{1-\lambda}\left(1+\frac{\tilde{\omega}_m+\pi\tilde{\omega}_o}{\omega_y}\right) \quad \text{and} \quad \overline{\mu}_m = \frac{\theta-\lambda}{1-\lambda}\left(1+\frac{\pi\tilde{\omega}_o}{\omega_m}\right).$$

As previously discussed, it is reasonable to assume that w_y is (at least weakly) lower than w_m:

Assumption 2. $\omega_m \geq \omega_y$.

Under this assumptions it is clear that $\frac{\theta-\lambda}{1-\lambda} \leq \overline{\mu}_y \leq \overline{\mu}_m$ so that

$$\rho_t = \begin{cases} (1-\lambda)(N_{y,t}+N_{m,t}) & \text{if} \quad \mu \leq \overline{\mu}_m \\ (1-\lambda)N_{y,t} & \text{if} \quad \mu \in \left(\overline{\mu}_m, \overline{\mu}_y\right] \\ 0 & \text{if} \quad \mu > \overline{\mu}_y \end{cases}$$

Hence, the probability of a successful revolution at date t might be expressed as the following function of the demographic structure:

$$\mathcal{P}(\Psi_{y,t}, \Psi_{ym,t}) = \begin{cases} \phi\left((1-\lambda)\Psi_{ym,t}\right) & \text{if} \quad \mu \leq \overline{\mu}_m \\ \phi\left((1-\lambda)\Psi_{y,t}\right) & \text{if} \quad \mu \in \left(\overline{\mu}_m, \overline{\mu}_y\right] \\ 0 & \text{if} \quad \mu > \overline{\mu}_y \end{cases} \tag{2}$$

with

$$\Psi_{y,t} := \frac{N_{y,t}}{N_t} \qquad \text{and} \qquad \Psi_{ym,t} := \frac{N_{y,t}+N_{m,t}}{N_t},$$

denoting respectively the share of young people in the whole population and the share of young and mature people in the whole population.[15]

Decision of the elite (Stage 2). Since members of the elite know the realisation of ζ when they have to choose to democratize or not they can perfectly anticipate if a successful revolution will occur or not. If it is not the case, they do not have any incentive to democratize while, if it is the case, they always have incentives to do so. Indeed, if a revolution occurs, their flow payoff will be $(1-\mu)\omega_i$ and the democracy will be established at the next date. If, instead, they democratize before the occurrence of the revolution, they will benefit from a flow

[14] The participation in revolutionary activities, which are inherently dangerous, might also generate additional disutilities and psychological costs. It is reasonable to think that those costs are disproportionally lower for young people who are more likely to be unmarried and not raising a family. Introducing such additional costs would strengthen our conclusions.

[15] To be precise, $\Psi_{y,t}$ corresponds to the count of young members within the non-elite across the entire population, encompassing both elite and non-elite members. Assuming a relatively small size of the elite, a reasonable assumption, $\Psi_{y,t}$ serves as a reliable approximation of what we will term the *youth ratio*, representing the proportion of young people in the entire population. The same caveat applies for $\Psi_{ym,t}$.

payoff of ω_i. Hence, the probability of a (voluntary) transition from non-democracy to democracy is exactly given by $\mathcal{P}(\Psi_{y,t}, \Psi_{ym,t})$ and a revolution never occurs in equilibrium.[16]

2.4 Discussion and testable predictions

Equation (2) illustrates the impact of demography on the probability of a democratic transition. According to this equation, the threat of revolution is higher when the population is not too old. This captures the horizon effect. Through this effect, a temporary increase in the youth ratio – associated with the demographic transition – might open a window of opportunity for democratization. This is the first prediction of the model.

Prediction 1. *A rise in the youth ratio increases the probability of a democratic improvement.*

However, the definition of the youth ratio needs to be refined. In the model, when $\mu \leq \overline{\mu}_m$ this is the relative number of young and mature individuals ($\Psi_{ym,t}$) which matters, while for $\mu \in \left(\overline{\mu}_m, \overline{\mu}_y\right]$, democratic improvements are driven by the relative size of the youngest generation ($\Psi_{y,t}$). The second configuration is more likely to occur when the relative opportunity cost of participating in a revolution for young people compared to mature ones (ω_m/ω_y) is high (indeed, $\overline{\mu}_i$ decreases with ω_i). As previously noted, this opportunity cost is likely to be disproportionately low for very young adults who are not yet integrated into socio-economic institutions like stable employment or marriage (Weber, 2013, 2021). These socio-economic forces might be reinforced by psychological factors. For instance, Fitzenberger et al. (2022) show that young people are less risk averse and more open to new experiences. Those personality traits make them more likely to participate in revolutionary actions (Nordås and Davenport, 2013; Weber, 2013, 2021). For these reasons, the relative size of the youngest cohort is likely to matter the most.

Demographic factors are complemented by economic factors which are at the heart of the Acemoglu and Robinson theory of democratization. In particular, it is clear from (RC$_i$) that a temporary fall in economic opportunities (that can be captured by a decrease in ω_i while keeping $\tilde{W}_i$ constant) will incentivize more people to participate in a democratic movement by decreasing the opportunity costs of participation. This effect might have a large impact on the probability of democratization. This is the case if, for instance, such a decrease pushes $\bar{\mu}_y$ above μ such that the probability of a revolution switches from 0 to $\phi\left((1-\lambda)\Psi_{y,t}\right)$.

Prediction 2. *A temporary fall in economic opportunities positively impacts the probability of a democratic improvement.*

Moreover, the impact of this temporary decrease of opportunity costs is magnified when the youth ratio is large (since $\phi\left((1-\lambda)\Psi_{y,t}\right)$ is increasing in $\Psi_{y,t}$). This is our third main prediction.

Prediction 3. *The positive impact of depressed economic opportunities on the probability of a democratic improvement is amplified when the youth ratio is large.*

Our simple theoretical framework also leaves some open questions. In particular, the result according to which the elite peacefully concedes before the onset of any civil disorder, is largely contingent on specific assumptions. Notably, in the absence of uncertainties, the threat of revolution becomes perfectly foreseeable to

[16] This is also the case in Acemoglu and Robinson (2001).

the elite, who can accurately discern, following the realization of the shock, whether a revolution will transpire or not. It is crucial to note that in situations involving uncertainties, civil disorders, protests, or riots may potentially influence the democratization process by lending credibility to the threat of revolution in the perception of the elite (Andrews and Jackman, 2005; Aidt and Leon, 2016). For this reason, our results might be somehow reconciled with the political science literature highlighting the role played by young people in riots or civil violence.[17] Those factors lead us to formulate an additional prediction.

Prediction 4. *Low intensity conflict, such as riots, might act as a transmission channel, facilitating the positive impact of a high youth ratio on the probability of a democratic improvement.*

Our empirical strategy, described in the next section, aims at testing those predictions.

3 Empirical strategy

In this section we describe our empirical methodology. We begin by estimating a simple bivariate panel regression with a Linear Probability Model (LPM).

$$transition_{i,t} = \alpha + \beta \times youth\_ratio_{i,t-1} + \delta_i + \epsilon_t + u_{i,t}, \quad (3)$$

Our binary dependent variable, $transition_{i,t}$, takes value 1 when a country i experiences an increase in the Polity score of at least 2 points, which corresponds to a sizable variation, between year $t-1$ and year t. This is a standard measure of democratic improvements (Burke and Leigh, 2010; Brückner and Ciccone, 2011; Dorsch and Maarek, 2020).[18] Our main independent variable is the youth ratio. According to Prediction 1, the probability of a transition should be larger when this ratio is high. As aforementioned, which youth ratio matters the most requires clarification.[19] To that end, we test different constructions of the youth ratio measure. The country fixed effects (δ_i) control for any time-invariant characteristics of countries that may affect their propensity to democratize.[20] The time fixed effects (ϵ_t) control for global trends towards democratic governance, such as the dissolution of the Soviet Union or the "third wave" of democratization. Finally, $u_{i,t}$ represents the error term from the regression.

There are, however, country-specific, time-varying factors that are also important to control for. We proceed to add a vector of controls ($X_{i,t-1}$) to estimate a multiple panel regression model with the LPM.

$$transition_{i,t} = \alpha + \beta \times youth\_ratio_{i,t-1} + X'_{i,t-1}\Gamma + \delta_i + \epsilon_t + u_{i,t}. \quad (4)$$

Among those controls, macroeconomic fluctuations play a key role as, according to Prediction 2, a negative macroeconomic shock might facilitate democratic improvements (this is in line with, e.g, Acemoglu and Robinson 2001; Brückner and Ciccone 2011; Burke and Leigh 2010; Dorsch and Maarek 2020; Kotschy and Sunde 2021). In order to test Prediction 3, according to which the impact of a negative macroeconomic shock is higher

[17] Goldstone (2016, 2002) argues that young people are over represented in anti-state political movements and revolutionary activities.

[18] As robustness checks, we consider alternative constructions of the dependent variable (see Section 7.2). We also test the impact of the youth bulge on other outcomes like riots, revolutions or democratic reversal (see Sections 6.2 and 7.3).

[19] As illustrated by our model, it depends on how benefits and opportunity costs of revolting vary with age.

[20] As robustness checks, we introduce time-varying country fixed effects (see Section 7.5).

in the presence of a youth bulge, we also consider specifications where we interact the youth ratio with measures of macroeconomic fluctuations (Section 6.1).

Our baseline set of controls also includes other factors that the literature has identified as being possible drivers of democratization. In particular, we control for per capita income levels (see, e.g, Lipset 1959; Londregan and Poole 1996; Przeworski and Limongi 1997; Barro 1999; Acemoglu et al. 2008; Papaioannou and Siourounis 2008). Additionally, we control for the lag of the Polity score. Indeed, on the one hand, democratic improvement might be mechanically more difficult when the Polity score is already high (Burke and Leigh, 2010) while, on the other hand, state repression against revolutionary movements might be higher in autocratic countries (Davenport, 1995; De Mesquita et al., 2005; Davenport, 2007). Finally, in some regressions we also control for the log of population in order to distinguish the youth ratio effect from the impact of an increase in the population (Acemoglu, Fergusson and Johnson 2020 show that such an increase might generate political instability and conflicts), the Gini coefficient as inequality is often considered as an important driver of democratization (Acemoglu and Robinson, 2001; Haggard and Kaufman, 2012), school enrollment as education as been shown to favor the development and sustainability of democratic institutions (Murtin and Wacziarg, 2014; Parente, Sáenz and Seim, 2022), and the urbanization rate (Lipset, 1959; Glaeser and Steinberg, 2017).

Youth ratios can be affected by improvements in public policies and public health that are themselves a result of political development (Mulligan, Gil and Sala-i Martin, 2004; Besley and Kudamatsu, 2006). More broadly, some omitted variables may affect both the youth ratio and the probability of democratic improvements. As such, the panel regression results may not be estimating a causal effect. We therefore perform two-stage least squares (2SLS) procedures using two distinct instrumentation strategies. We first use lagged fertility rates as an instrument for the youth ratio. In one specification, we consider the country's own fertility rate, lagged by 15 years. Even with such a long lag built into it, the instrument may fail to satisfy the exclusion restriction, as the social and economic conditions that may lead to improvements in pre-natal health and decreasing infant mortality rates may also affect the likelihood of future democratization. Therefore, in another specification, we consider an average of the country's neighbors' fertility rates, lagged by 20 years. In that specification, we construct the following instrument for the youth ratio in country i of region r in period t, which we denote by $Z^r_{i,t}$:

$$Z^r_{i,t} = \frac{1}{N^r_{i,t} - 1} \sum_{j \in r, j \neq i} fertility\_rate_{j,t-20} \tag{5}$$

where $N^r_{i,t}$ corresponds to the number of countries in the region r of country i.[21] The regional instrument, similar in spirit to that used by Acemoglu et al. (2019) and Dorsch and Maarek (2019), captures the idea of a progressive geographical diffusion of fertility behaviors (Daudin, Franck and Rapoport, 2019; Spolaore and Wacziarg, 2022). A second distinct strategy uses past climatic variations as an instrument. Those variations, through their impact on household incomes, might affect fertility behaviors. To construct this instrument we use the SPEI index, which combines data on precipitation and soil quality at a very detailed geographical level and aggregated to the country level (see details below). Since, to predict a transition at date t, we want to instrument the youth ratio (proportion of the population between 15 and 19 years old in the population aged over 15 years) in

[21] We consider the following regions: Western Europe, Northern Europe, Southern Europe, Eastern Europe, Northern Africa, Western Africa, Middle Africa, Eastern Africa, Southern Africa, Western Asia, Central Asia, East Asia, South-East Asia, South Asia, Oceania (including Australia and the Pacific), North America, Central America, South America and Caribbean.

$t-1$ we take the mean of the country-level SPEI indicator over the period $[t-17, t-21]$.[22] Climatic conditions between 17 and 21 years prior should be exogenous to contemporaneous institutional change. Finally, as we expect the relation to be stronger for countries that rely more on agriculture, we interact the SPEI indicator with a variable measuring the weight of the agricultural sector in the economy.[23] A large literature uses climatic shocks, like drought episodes or precipitation, to predict conflicts or institutional change, but with a strategy that differs significantly from ours as they use contemporary shocks which should decrease, in the case of a negative shock like a drought, the contemporaneous opportunity cost of engaging in conflict or a revolutionary movement.[24]

The first stage of the 2SLS procedure estimates the lagged youth ratio with the instrumental variable (denoted by $Z_{i,t}$).

$$youth\_ratio_{i,t} = \alpha + \beta \times Z_{i,t} + X'_{i,t-1}\Gamma + \delta_i + \epsilon_t + u_{i,t}. \quad (6)$$

Fitted values from equation (6) are then used to estimate the outcome variable in the second stage of the 2SLS procedure.

$$transition_{i,t} = \alpha + \beta^{2S} \times \widehat{youth\_ratio}_{i,t-1} + X'_{i,t-1}\Gamma + \delta_i + \epsilon_t + u_{i,t}, \quad (7)$$

where the error term from the estimation of equation (7) will be uncorrelated with instrumented variation in the youth ratio if the identifying assumptions are met. The identifying assumptions in the 2SLS regressions are that the instrument satisfies the relevance criteria and the exclusion restriction. The relevance criteria requires that the instrument can explain variation in the youth ratio in the first stage of the 2SLS procedure, i.e. in equation (6). In addition to being relevant, the instrument should satisfy the exclusion restriction, which requires that the instrument can explain democratic improvements only through its impact on the youth ratio. Regarding lagged fertility, its direct impact on the youth ratio 15 years later is noteworthy. However, it also has the potential to shape democratization through diverse indirect channels, including its effects on economic development and future economic volatility. In parallel, fertility in neighboring countries may lead to additional spillovers such as migration, potentially influencing economic volatility and the likelihood of a country undergoing transition. Furthermore, historical climatic shocks may shape the current state of democracy through their effect on past transitions, subsequently influencing the probability of future transitions. Following established practices in the literature, we incorporate essential control variables into our two-stage least square estimates to address potential confounding factors and shut off channels through which the exclusion restriction might be violated. Baseline specifications include controls for development (GDP per capita), economic instability (recession dummy), and political institutions (the lagged level of the polity index). The consistency of the 2SLS results across two distinct instrumentation strategies—utilizing past fertility rates and past climatic shocks—and their robustness in controlling for potential channels through which the instruments' variation could influence the outcome variable, instills confidence in the causal interpretation of our results. In Section 6.2, we also use a 2SLS procedure to investigate the role of riots as a transmission channel from a high youth ratio to political transitions

[22] A climatic variation occurring in $t-i$ would affect the net fertility in $t-i+1$.

[23] The same kind of interaction is used by Burke and Leigh (2010) to instrument economic growth.

[24] See for instance Aidt and Leon (2016) for the impact of drought on protests in an instrumental strategy to explain democratization episodes or Couttenier and Soubeyran (2014), Berman and Couttenier (2015) for the impact of drought on conflicts. A notable exception is Flückiger and Ludwig (2018) who also use past droughts in Sub-Saharan Africa to explain the contemporaneous proportion of youth in the population and its impact on conflicts.

(Prediction 4).

The availability of demographic data (youth ratio and fertility rate) for a large set of countries, including developing countries, restricts our initial analysis on the period from 1950 to 2017. In order to test our theory on a longer-run panel, we use the fact that net fertility is the highest at the peak of the fertility transition, when infant mortality is already low and fertility starts to decline. Delventhal, Fernández-Villaverde and Guner (2021) propose a dating of those peaks for a large set of countries that we use to infer the variation in the proportion of youth over a longer time period. In the longer-run analysis from 1800 to 2017, we first define a 15 year window around the peak of the transition. The net fertility should be substantially higher during these windows, as well the proportion of youth 15 years later, so we use its 15-year lag as regressor. We formally estimate this alternative multivariate panel regression with the following Linear Probability Model (LPM)

$$transition_{i,t} = \alpha + \beta \times peak\_window_{i,t-15} + \tilde{X}'_{i,t-1}\Gamma + \delta_i + \epsilon_t + u_{i,t}. \quad (8)$$

Due to data availability over this longer-run panel, we only use a subset of our benchmark control variables, namely macroeconomic fluctuations, per capita income levels and the Polity score, which are available for long time periods. This specification allows us to test the robustness of our prediction over a longer time span (1800-2017).

4 Data sources

In this section, we describe further the data we employ. We use the Polity2 score provided by Marshall, Gurr and Jaggers (2019) to construct our binary democratic improvement indicator, which covers the period from 1800 to 2018 for a large number of countries. The Polity2 score measures the degree of democracy in political regimes between -10 (total autocracy) and +10 (total democracy). Democracy is defined for this indicator by six institutional aspects: the regulation of the recruitment of leaders, the competitiveness of this recruitment, the openness of this recruitment, the constraints on the executive, the regulation of political participation and the competitiveness of this participation. Our binary democratic improvement variable equals 1 if the year-on-year difference of the Polity2 index is larger than or equal to 2, and takes a zero value otherwise. In our baseline sample the unconditional mean of the dependent variable is 0.039, meaning that about 4 percent of the country-year observations have such an improvement in their political institution. The variation of the Polity2 index has been widely used in the literature (see, e.g. Burke and Leigh 2010; Brückner and Ciccone 2011; Aidt and Leon 2016; Dorsch and Maarek 2020). In our robustness analysis (Section 7.2) we construct alternative measures of political transition based on Polity2. We also consider alternative indices, such as the *polyarchy* variable from the VDEM data set and the the Machine Learning Democracy Index proposed by Gründler and Krieger (2016, 2021).[25]

We mobilize two demographic data sources. First, we use the United Nations age-specific population data

[25] In some instance, the Polity2 score is based on coding rules that are not fully accurate to describe political transitions. In particular, a score of 0 is attributed to interregnum periods. This coding rule might lead us to falsely identify democratic improvements. To overcome this difficulty, we have opted for the conservative solution—already adopted by Brückner and Ciccone (2011); Aidt and Leon (2016)—which drops the observations corresponding to those interregnums periods. We also perform several robustness checks using alternative coding rules (see Appendix A).

Table 1: Summary statistics for baseline sample (since 1951)

	Obs.	Mean	Std.Dev.	Minimum	Maximum
transition	9,155	0.037	0.188	0	1
youth ratio (15 – 19)	9,324	0.151	0.045	0.038	0.268
youth ratio (15 – 24)	9,324	0.286	0.073	0.104	0.440
youth ratio (15 – 29)	9,324	0.406	0.090	0.164	0.567
youth ratio (15 – 34)	9,324	0.512	0.098	0.228	0.687
ln(GDP p.c.)	8,931	8.594	1.163	5.934	11.959
growth rate of GDP p.c.	8,928	2.313	6.558	-100	130.869
Polity2	9,281	0.922	7.491	-10	10

to create a variable relating the number of young people to the adult population.[26] We also use data on fertility rates and infant mortality rates to construct the net fertility rate indicator we use in regressions and to construct one of our instruments. The data is available for a large number of countries, however it is only available from 1951 to 2017. In order to extend our analysis over a longer panel, we use the data set built by Delventhal, Fernández-Villaverde and Guner (2021). Using various data sources[27], they estimate—for a large set of countries—the date at which mortality and fertility rate start to decrease. In accordance with the standard model of demographic transition, we argue that the peak of the transition, i.e. the date at which net fertility is the highest, corresponds to the date at which the fertility rate starts to decline. The Gross Domestic Product per capita data comes from the *Maddison Project Database* (2020). The population and urbanization data comes from the United Nations (2022) and Teorell et al. (2020) provide other country-level control variables. In order to instrument the proportion of youth through fertility decisions related to climate conditions, we use the Standardized Precipitation-Evapotranspiration Index (SPEI) developed in Vicente-Serrano, Beguería and López-Moreno (2010). It is a multiscalar index that combines several parameters to measure climatic conditions such as temperature and precipitation, but also soil water holding capacity. The SPEI is a monthly multi-timescale measure that allows capturing different potential effects of the accumulated water deficit. For our purpose, we use the twelve-month time-scale that covers the period 1901-2020. For further analyses and robustness, we use data on riots and revolutions from the Cross-National Time-Series data archive (Banks, 2020).

Table 1 provides summary statistics for our binary variable measuring political transitions, different definitions of the youth ratio as well as control variables that we include in our baseline analysis (since 1951).

5 Panel regression analysis

5.1 Baseline Linear Probability Model results

We begin with estimation of equation (3) using different measures of the youth ratio on panels that run from 1951 to 2017 (Table 2). In this exploratory analysis, we first consider the broadest conception of "youth" in calculating

[26] *World Population Prospects* 2022.

[27] United Nations data, Chesnais et al. (1992) and Mitchell (2013).

Table 2: Effect of youth bulges on democratic improvements — Decomposition by age groups

	Binary DV: Δ Polity2 ≥ 2				
	Ordinary Least Squares				
	(1)	(2)	(3)	(4)	(5)
youth ratio (15 - 34)$_{t-1}$	0.105**				
	(0.05)				
youth ratio (15 - 29)$_{t-1}$		0.138**			
		(0.06)			
youth ratio (15 - 24)$_{t-1}$			0.185***		
			(0.07)		
youth ratio (15 - 19)$_{t-1}$				0.350***	0.484***
				(0.11)	(0.15)
youth ratio (20 - 24)$_{t-1}$					-0.412
					(0.25)
youth ratio (25 - 29)$_{t-1}$					0.399
					(0.27)
youth ratio (30 - 34)$_{t-1}$					-0.325
					(0.26)
Country & year FE's	yes	yes	yes	yes	yes
N	9053	9053	9053	9053	9053
Countries	164	164	164	164	164
Within-R^2	0.020	0.021	0.021	0.021	0.021

Notes: Robust standard errors clustered by country are in parentheses. The panel runs from 1951 – 2017 for all specifications. *** / ** / * represent significance at the 0.01 / 0.05 / 0.10 levels, respectively.

the youth ratio, before looking at narrower age groups.[28] In column 1, we define the variable $youth\_ratio$ as the share of the population aged between 15 to 34 in the population aged over 15 years, and demonstrate that there is a positive and statistically significant effect of this ratio on the probability that a country experiences a democratic improvement. In columns 2 to 4, we consider narrower age tranches for the youth ratios, calculated with 15 to 29, 15 to 24 and 15 to 19 tranches, respectively. All the coefficients are significant and positive but the magnitude of the effect slightly increases as age tranches narrow.[29] In Column 6 we report the results obtained when we decompose the 15 to 34 ratio and we include in the same regression the 15 to 19, 20 to 24, 25 to 29, and 30 to 34 tranches. In that case, only the ratio calculated using the youngest cohort is significant.

Overall, the results reported in Table 2 are consistent with Prediction 1 of our model. It also confirms our intuition that the opportunity costs of participating in democratic movements is lower for very young adults

[28] We consistently define the youth ratio as the proportion of the youth cohort (defined alternatively as individuals aged 15-34, 15-24, 15-19, 20-24, 25-29, and 30-34) relative to the size of the adult population (individuals aged over 15 years). In existing literature, other operationalizations of the youth ratio have been utilized, in particular the size of the youth cohort relative to the total population. Urdal (2006) has demonstrated that this alternative definition suffers from several flaws, and therefore recommends adopting the share of youth within the adult population, aligning with our chosen approach. This choice is also more consistent with our theoretical framework.

[29] The mean and the standard deviation of the different youth ratios are provided in Table 1. The impact of one standard deviation increase of the youth ratio on the probability of observing a democratic improvement range to 1.6 points (i.e., a 30% increase relative to the unconditional probability) for the ratio youth (15-19) to 1 point (i.e., a 21% increase relative to the unconditional probability) for the ratio youth (15-34).

Table 3: Effect of youth bulges on democratic improvements — Regression with controls

	Binary DV: Δ Polity2 ≥ 2									
	Ordinary Least Squares									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
youth ratio (15 - 19)$_{t-1}$	0.350***	0.275**	0.419***	0.414***	0.350***	0.321***	0.346***	0.573***	0.355**	0.748**
	(0.11)	(0.12)	(0.12)	(0.13)	(0.11)	(0.11)	(0.12)	(0.22)	(0.15)	(0.36)
ln(GDP p.c.)$_{t-1}$		-0.013*							-0.015*	-0.004
		(0.01)							(0.01)	(0.03)
growth rate (GDP p.c.)$_{t-1}$			-0.002***						-0.002***	-0.003***
			(0.00)						(0.00)	(0.00)
Polity$_{t-1}$				-0.005***					-0.006***	-0.013***
				(0.00)					(0.00)	(0.00)
Urbanization rate$_{t-1}$					0.000					0.002
					(0.00)					(0.00)
ln(population)$_{t-1}$						0.008				0.084**
						(0.01)				(0.04)
Secondary school enrolment$_{t-1}$							-0.000			0.001**
							(0.00)			(0.00)
Gini coefficient$_{t-1}$								-0.002		-0.001
								(0.00)		(0.00)
Country & year FE's	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
N	9053	8634	8609	9053	9053	9053	7601	4929	8608	4240
Countries	164	154	154	164	164	164	135	160	154	131
Within-R^2	0.021	0.022	0.023	0.034	0.021	0.021	0.019	0.021	0.037	0.075
Panel length	'51 – '17	'51 – '17	'51 – '17	'51 – '17	'51 – '17	'51 – '15	'61 – '17	'51 – '17	'51 – '17	'61 – '15

Notes: Robust standard errors clustered by country are in parentheses. The unbalanced panel runs from 1951 – 2017 in the longest specification. *** / ** / * represent significance at the 0.01 / 0.05 / 0.10 levels, respectively.

than for any other age cohort.[30] Therefore, for the rest of our analysis, we define the youth ratio as the share of the population aged between 15 to 19 in the population aged over 15 years.[31]

In Table 3 we estimate equation (4) with additional time-varying controls. Data for the control variables comes from different data sources, so there is some variability in terms of country and time coverage. Balancing sample size concerns against omitted variable bias concerns, we settle on the specification in column 9 as our baseline set of controls. With the inclusion of this set of controls, the estimate for the effect of the youth ratio is quite stable compared to the bivariate regression which only included time and country fixed effects. All regressions that follow will include the baseline set of controls unless otherwise noted.[32]

Beyond the youth ratio effect, results reported in Table 3 show a negative effect of the growth rate of GDP on the likelihood of a democratic improvement. This is consistent with Prediction 2 of the model as well as existing literature (Brückner and Ciccone, 2011; Burke and Leigh, 2010). The level of the Polity score is also associated with a decrease in the likelihood of a democratic improvement as also demonstrated by Burke and Leigh (2010).

[30] This might come from the fact that the opportunity cost of revolting increases sharply at the age of entry into the labor market or into marriage (see Section 2.4). In the model, an individual chooses to participate or not to a revolutionary movement by comparing the benefits of a democratic improvements to the opportunity costs of revolting. The benefits decrease smoothly with age through the horizon effect. The results reported in Table 2 suggest that the opportunity costs increase sharply with age such that the benefits might exceed the costs only for the youngest age group.

[31] In Appendix B, we show that our results are robust to the use of a broader definition of the youth ratio. We also perform placebo tests in which we consider youth ratios calculated with younger age groups and old ratios calculated with older age groups (see Section 7.4). We confirm that they do not have any impact on the probability of democratic improvements.

[32] In Appendix B (Table 16) we replicate the results provided in Table 3 using the share of population aged 15 to 24 (instead of 15 to 19) in the population aged over 15 years as our measure of the youth bulge. The positive impact of the youth ratio on democratic improvement is preserved but the magnitude of the effect is smaller.

The effects of secondary school enrollment and the log of population size are both weakly significant and positive in the regression where all controls are included (column 10). Those two variables will not be included in our set of benchmark controls, however, as the school enrollment variable reduces our sample too much due to data availability. Population size has mainly been introduced as a confounder for the youth ratio (it appears at the denominator of this variable and periods of increase in the youth population are also periods during which the whole population is likely to increase). Results reported in columns 6 and 10 of the table reassure us that the effect of the youth ratio is not driven by population size. Finally, we also control for the urbanization rate and the Gini coefficient. As expected the effect of those two variables is positive, however, not statistically significant. This limited effect of the Gini coefficient is in line with the contrasting result found in the literature on the role of inequality for democratization (Knutsen and Wegmann, 2016). The effect of the Gini and the urbanization rate being not significant we have chosen not to include them in our baseline set of controls.[33]

The magnitude of the youth ratio effect is quite substantial. In our baseline estimates—reported in column 9— an increase of one standard deviation of the youth ratio increases the probability of observing a democratic improvement by 1.6 points, which roughly corresponds to a 43% increase relative to the unconditional probability. This is a sizable effect compared to the effect of economic recessions, which is the main factor identified in the *window of opportunity* literature. We estimate that economic contractions increase the probability of observing a democratic transition by 1.32 points.[34] Moreover, it should be noted that economic activity is much more volatile than the age structure of the population. In particular, during the demographic transition, the youth ratio might remain high for several years while a recession remains a relatively rare event. Hence the probability to observe at least one democratization episode during a 20 year period around the peak of the demographic transition could be quite substantial.

In Appendix C we provide additional results and perform sub-sample analyses. In Table 19 we check the robustness of our results when we exclude continents one by one. The youth bulge effect turns out to be non significant when African or Latin American countries are excluded (but the coefficient for the youth ratio remains positive and sizable). This is not surprising since, as reported on Figure 1, the bulk of transitions occur in those two continents. In Tables 20 and 21, we push the analysis further by excluding, one by one, sub-regions of Africa and South America in order to ensure that our results are not driven by a subgroup of countries within those continents. This does not appear to be the case.

5.2 Two-Stage Least Squares results

In this section we report the results of our instrumental variable strategy. Tables 4 and 5 present the results from when we use the lagged net fertility rate (in own country and in neighbors countries) and our climatic conditions indicator, respectively. In both tables we report reduced-form and 2SLS results. In Table 4 columns 1 – 4, we use the country's own net fertility rate lagged by 15 years as a predictor of the size of the youth cohort 15 years later,

[33]The inclusion of the Gini creates a problem of attrition while the urbanization rate is possibly a *bad control* as it might be heavily correlated with the demographic structure of the economy. The coefficients reported in column 10 show that our OLS results are robust to the inclusion of those two variables.

[34]This number is obtained by multiplying the coefficient of log GDP (0.002) by the standard deviation of this variable over the whole sample (6.6). Note that the magnitude of the effect is close to the one calculated from the baseline fixed effects LPM model from Burke and Leigh (2010).

Table 4: Effect of youth bulges on democratic improvements — Lagged fertility variables as instruments

	Panel A: Binary DV: Δ Polity2 ≥ 2									
	IV: Own net fertility rate (lagged 15 years)				IV: Neighbors' net fertility rate (lagged 20 years)					
	OLS		2SLS		OLS		2SLS			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Net fertility rate$_{t-15}$	0.002***	0.002***							0.004**	0.004***
	(0.00)	(0.00)							(0.00)	(0.00)
Neighbors' net fertility$_{t-20}$					0.003***	0.003**				
					(0.00)	(0.00)				
youth ratio (15 - 19)$_{t-1}$			0.674***	0.632***			1.173***	1.186**		
			(0.18)	(0.23)			(0.41)	(0.57)		
	Panel B: First stage of 2SLS									
			DV: youth ratio (15 - 19)$_{t-1}$				DV: youth ratio (15 - 19)$_{t-1}$		DV: net fertility$_{t-15}$	
			(3)	(4)			(7)	(8)	(9)	(10)
Net fertility rate$_{t-15}$			0.003***	0.003***						
			(0.00)	(0.00)						
Neighbors' net fertility$_{t-20}$							0.003***	0.002***	0.783***	0.725***
							(0.00)	(0.00)	(0.00)	(0.00)
Standard controls	no	yes	no	yes	no	yes	no	yes	no	yes
Country & year FE's	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
K-P F-stat on excl. IV's	–	–	353.343	285.159	–	–	95.882	64.671	137.844	82.690
N	7449	7080	7448	7080	6440	6094	6439	6093	6440	6094
Countries	164	154	163	154	163	154	162	153	162	153

Notes: Robust standard errors clustered by country are in parentheses. The net fertility rate lagged by 15 years is used as the instrumental variable for the ratio of youth in the 2SLS specifications. The standard set of controls includes once lagged values of: the log of GDP per capita, the growth rate of GDP per capita, and the Polity score. Referring to the Kleibergen-Paap (K-P) F-statistic, the test's null hypothesis is that the set of instruments is weak. The panel runs from 1968 – 2017 for the own net fertility rate specification and from 1973 – 2017 for the neighborhood net fertility rate specification. *** / ** / * represent significance at the 0.01 / 0.05 / 0.10 levels, respectively.

while in columns 5 – 10, we use the average net fertility rate in the country's region lagged by 20 years.[35] We present results with and without our standard battery of controls. Both fertility rate measures are statistically significant predictors of democratic improvements in reduced-form specifications (columns 1 – 2 and 5 – 6). When net fertility measures are used as instruments for the youth ratio, instrumented variation in the youth ratio is positively and statistically significantly associated with an improvement in democratic institutions in the second stage of the 2SLS procedure (Panel A). In Panel B, we present the first-stage results from the 2SLS procedure. First-stage F-statistics are far above the rule-of-thumb threshold of 10 for both instruments. In our view, the regional measure is more likely to satisfy the exclusion restrictions. Moreover, the first stage results give credence to spillover effects in fertility behaviors. The coefficient of the instrumented youth ratio appears to be bigger, by a factor of 2 when using own country lagged fertility rates and by a factor of 3 when using the country's neighborhood fertility rates, compared to the coefficient of the youth ratio in our OLS estimation. This might be due to the existence of unobservable factors affecting the youth ratio and the probability of experiencing a democratization episode in the opposite direction. Alternatively, it might be the case that our instruments—in particular the neighborhood fertility rate—picks up a local treatment effect which is stronger than the average treatment effect.[36]

In Table 5 we report the results from our second IV strategy, in which the youth ratio at date $t-1$ is instru-

[35]We lag the regional instrument by 5 more years to allow for spillover effects. Results are very similar when we also lag the regional instrument by 15 years. Moreover, the results reported in Table 4 still hold when we instrument the share of population aged 15 to 24 (instead of 15 to 19) in the population aged over 15 years (see Table 17 in Appendix B).

[36]We also test a specification where the net fertility lagged by 15 years is instrumented by the neighbor's fertility rate lagged by 20 years. The first stage results (columns 9 and 10 of Panel B) confirm the cross-border diffusion of fertility behaviors. The coefficient of the instrumented own country lagged fertility (columns 9 and 10 of Panel A) is significantly positive and two times higher than the OLS coefficient of the own country lagged fertility (columns 1 and 2 of Panel A).

mented by the mean of the SPEI indicator over the period $[t-21, t-17]$ interacted with the share of agriculture in GDP.[37] Reduced-form results are reported in columns 1 (without controls) and 2 (with controls) of Panel A. Our instrument has a significant and negative impact, meaning that in countries relying more on agriculture, better climatic conditions during one year reduce the probability of a democratic improvement 16 years later. Our interpretation of this result is as follows. In countries relying more on agriculture, a positive climatic shock (an increase in the the SPEI) induces a sizable positive income shock. This would increase the opportunity cost of raising children and decrease fertility (Becker and Tomes, 1976; Becker and Lewis, 1973; Becker et al., 1960; Rosenzweig, 1977). In turn, this fall in fertility might have a negative impact on the probability of democratic improvements 15 years later through its negative effect on the youth ratio. The 2SLS results (reported in columns 3 – 6) tend to confirm this interpretation. We instrument the youth ratio (in columns 3 and 4) and the 15 years lagged fertility rate (in columns 5 and 6). The first-stage results of the 2SLS procedure are shown in Panel B. First-stage F-statistics are close to the rule-of-thumb threshold of 10 (slightly below with controls and slightly above without controls). The first stage results confirm the negative impact of a positive climatic shock in countries relying heavily on agriculture on fertility. We see in Panel A that instrumented variation in the youth ratio and lagged fertility rate are consistently positively and statistically significantly associated with an improvement in democratic institutions. The magnitude of the coefficient is quite substantial (twice the magnitude of the coefficient for the 2SLS using the neighborhood fertility rate instrument).[38]

5.3 Results over a longer-run panel

As described in Section 4, our demographic variables come from the United Nations data set which covers the period from 1951 to 2017. In this section, we consider a longer time period (1800 – 2017) by following an alternative strategy. We use the fact that, in the course of the demographic transition, the net fertility rate rises and then falls. Hence, we can identify a period, around the peak of the demographic transition (that roughly corresponds to the date at which fertility rate starts to decrease), during which the net fertility rate is the largest. The youth ratio should then be the largest 15 years later.

We use two alternative definitions for the *period around the peak*. Denoting T the year of the peak, the variable $peak\_window$ takes the value one for all the years in the interval $[T-15, T+15]$ and zero otherwise. The variable $peak\_distance$ is a more continuous measure taking the value $|T-t|$ for all years t in the the interval $[T-15, T+15]$ and 15 otherwise. Since the net fertility rate—and accordingly the youth ratio 15 years after—should increase before the peak and decrease smoothly after that, we expect a positive coefficient for the variable $peak\_window$ and a negative coefficient for the variable $peak\_distance$.

In Table 6, we report results from panel regressions over this longer panel (1800 – 2017). We have GDP data and Polity data for the entire period, so we are able to control for the development level, business cycles, and status quo political institutions. We present results with and without these controls, as the country coverage

[37] We use the variable *Agriculture, forestry, and fishing, value added (% of GDP)* provided by the World Bank. For each country, we consider the value of this variable during the first year for which it is available and we interact this value with the SPEI index to construct our instrument. Hence, we do not take into account the temporal variations of the share of agriculture in the GDP. Indeed, a regime change might modify the share of agriculture in GDP. Considering a time-invariant indicator, measured as early as possible, limits this risk of endogeneity. Burke and Leigh (2010) have adopted a similar strategy to instrument contemporaneous variations in economic activity.

[38] While the instruments are, in some cases, not strong we can verify that the second-stage inferences are robust to estimation with weak instruments according to the Anderson-Rubin test for inference with potentially weak instruments.

Table 5: Effect of youth bulges on democratic improvements — Climatic variables interacted with the share of agriculture in GDP as instruments

	Panel A: Binary DV: Δ Polity2 ≥ 2					
	OLS		2SLS			
	(1)	(2)	(3)	(4)	(5)	(6)
youth ratio (15 - 19)$_{t-1}$			1.748**	2.827*		
			(0.85)	(1.53)		
net fertility$_{t-15}$					0.007**	0.010**
					(0.00)	(0.00)
spei_agr$_{t-16}$	-0.001***	-0.001***				
	(0.00)	(0.00)				
spei$_{t-16}$	0.020**	0.016*				
	(0.01)	(0.01)				
	Panel B: First stage of 2SLS					
			DV: youth ratio (15 - 19)$_{t-1}$		DV: net fertility$_{t-15}$	
			(3)	(4)	(5)	(6)
spei_agr$_{t-16}$			-0.000***	-0.000	-0.073***	-0.044**
			(0.00)	(0.00)	(0.02)	(0.02)
spei$_{t-16}$			0.001	-0.002	0.330	-0.311
			(0.00)	(0.00)	(0.60)	(0.60)
Standard controls	no	yes	no	yes	no	yes
Country & year FE's	yes	yes	yes	yes	yes	yes
K-P F-stat on excl. IV's	–	–	14.863	6.463	12.109	7.559
N	7106	6804	7105	6804	6883	6587
Countries	151	142	150	142	150	142

Notes: Robust standard errors clustered by country are in parentheses. The SPEI index and its interaction with the agricultural share of GDP, both lagged by 16 years, are used as instrumental variables for the ratio of youth and the 15-years-lagged net fertility rate in the 2SLS specifications. The standard set of controls includes once lagged values of: the log of GDP per capita, the growth rate of GDP per capita, and the Polity score. Referring to the Kleibergen-Paap (K-P) F-statistic, the test's null hypothesis is that the set of instruments is weak. The panel runs from 1951 – 2017. *** / ** / * represent significance at the 0.01 / 0.05 / 0.10 levels, respectively.

is somewhat reduced when we include controls that require GDP data. Using both ways of constructing the demographic transition variable, the results from Table 6 demonstrate that the positive effect of an increase in the youthfulness of a population on the likelihood for a democratic improvement is robust to estimation over this longer time period.

6 Further analysis

6.1 Youth bulge and the effect of recessions on democratic improvements

According to our Prediction 3, the effect of economic downturns on democratic improvements is magnified when the youth ratio is high. In order to test this prediction we have split our sample into two sub-samples, the first (respectively, second) gathering observations for which the youth ratio is below (respectively, above) it's median value in the sample.Then, we estimate the effect of different measures of the state of the economy on the probability of observing a democratic improvement in each of the two sub-samples. The results are reported in

Table 6: Effect of youth bulges on democratic improvements — Longer-run panel

	Binary DV: Δ Polity2 $\geq$ 2			
	Ordinary Least Squares			
	(1)	(2)	(3)	(4)
peak_window$_{t-15}$	0.020***	0.014**		
	(0.01)	(0.01)		
peak_distance$_{t-15}$			-0.002***	-0.001**
			(0.00)	(0.00)
ln(GDP p.c.)$_{t-1}$		-0.018***		-0.018**
		(0.01)		(0.01)
growth rate (GDP p.c.)$_{t-1}$		-0.001***		-0.001***
		(0.00)		(0.00)
Polity$_{t-1}$		-0.005***		-0.005***
		(0.00)		(0.00)
Country & year FE's	yes	yes	yes	yes
N	14964	11058	14964	11058
Countries	143	135	143	135
Within-R^2	0.024	0.041	0.024	0.041
Panel length	1800 - 2017	1800 – 2017	1800 - 2017	1800 – 2017

Notes: Robust standard errors clustered by country are in parentheses. *** / ** / * represent significance at the 0.01 / 0.05 / 0.10 levels, respectively.

Table 7 (Panel A for the low youth ratio sub-sample and Panel B for the high youth ratio sub-sample). In columns 1 and 2 we use the growth rate of GDP per capita as a proxy for the state of the economy. Then, in order to focus on recessionary periods, instead of the growth rate of GDP, we use a binary indicator of recession that takes value 1 if the country experienced a negative growth rate and 0 otherwise (columns 3 and 4). Finally, to take into account the size of the recession, we consider the effect of the truncated negative growth rate, which takes the value 0 if the growth rate is positive and the value of the growth rate otherwise. In all specifications and for both panels, the coefficient of the variable measuring the state of the economy has the expected sign: Recessions increase the likelihood of democratic improvements in the following period. Moreover, as predicted, the size and the significance of the coefficients are clearly greater in the high youth ratio sub-sample.

Similar conclusions might be reached by interacting our measures of the state of the economy with the youth ratio. The results of our OLS regressions when these interactions terms are added are provided in Table 22 in Appendix D. As expected, the sign of the interaction term between the growth rate and the youth ratio is negative (columns 1 and 2), the sign of the interaction term between the binary negative growth rate and the youth ratio is positive (columns 3 and 4) and the sign of the interaction term between the truncated negative growth rate and the youth ratio is positive (columns 5 and 6). Figure 2a provides a visualization of the conditional marginal effect of a recession (estimated in column 4). The plotted line shows the marginal effect of a recession in $t-1$ (binary negative growth rate in $t-1$ equals 1) on the probability of a democratic transition between $t-1$ and t as a function of the youth ratio in $t-1$. The plot is super-imposed over a histogram of the distribution of the youth ratio to provide a sense of the empirical relevance of the range of initial youth ratio levels for which the effect of a recession is statistically significant. Interestingly, this distribution is bi-modal with a bunch of observations characterized by a low youth ratio (around 0.09) and a second group characterized by a high youth ratio (around 0.18). The Figure 2a shows that the effect of a recession is only marginally significant for the first

Table 7: Effect of output contractions on democratic improvements — Differentiation by level of youth ratio

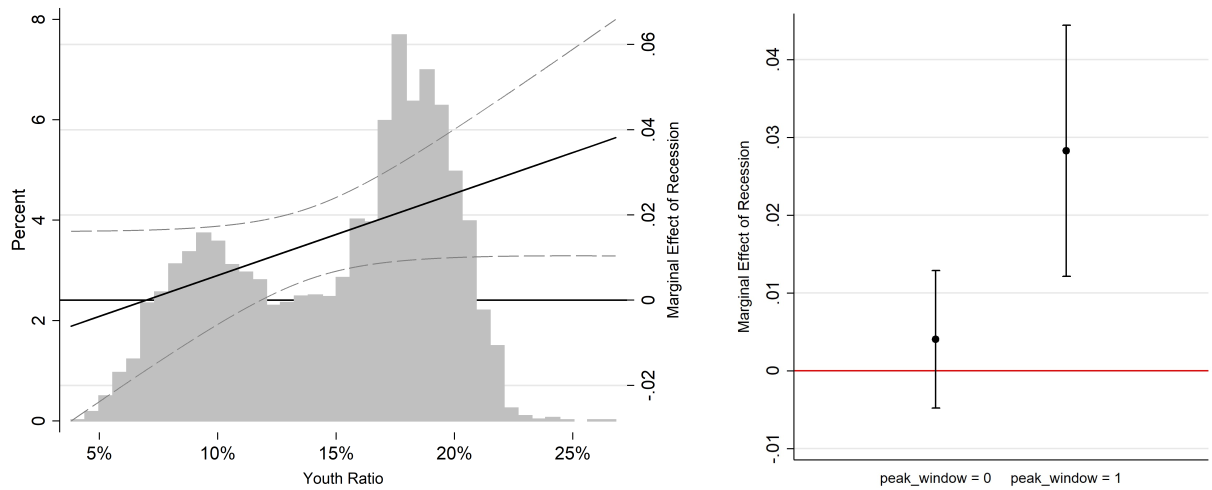
	Binary DV: Δ Polity2 ≥ 2					
	Ordinary Least Squares					
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: low youth ratio						
growth rate of GDP p.c.$_{t-1}$	-0.001	-0.001*				
	(0.00)	(0.00)				
binary negative growth rate $_{t-1}$			0.004	0.006		
			(0.01)	(0.01)		
truncated negative growth rate $_{t-1}$					-0.002	-0.003
					(0.00)	(0.00)
Standard controls	no	yes	no	yes	no	yes
Country & year FE's	yes	yes	yes	yes	yes	yes
N	4314	4313	4314	4313	4314	4313
Within-R^2	0.033	0.054	0.032	0.053	0.033	0.055
Panel B: high youth ratio						
growth rate of GDP p.c.$_{t-1}$	-0.002***	-0.002***				
	(0.00)	(0.00)				
binary negative growth rate $_{t-1}$			0.029***	0.027***		
			(0.01)	(0.01)		
truncated negative growth rate $_{t-1}$					-0.004**	-0.004*
					(0.00)	(0.00)
Standard controls	no	yes	no	yes	no	yes
Country & year FE's	yes	yes	yes	yes	yes	yes
N	4295	4295	4295	4295	4295	4295
Within-R^2	0.036	0.052	0.036	0.052	0.036	0.051

Notes: Robust standard errors clustered by country are in parentheses. The standard set of controls in this case includes once lagged values of: the log of GDP per capita and the Polity score. The panel runs from 1951 – 2017. *** / ** / * represent significance at the 0.01 / 0.05 / 0.10 levels, respectively.

group of observations while it is higher and statistically significant for the second.

We now investigate if this complementary between economic and demographic factors is also observable on our longer-run panel. Since we have information about the level of GDP, we are also able to identify periods of recessions (period during which the growth rate is negative) on this panel. Then, we run regressions where we interact the variable recession with our variables $peak\_window$ and $peak\_distance$, which identify the periods during which the youth ratio is likely to be the higher. The outcomes of these regressions are detailed in Table 23 of Appendix D. Both interaction terms exhibit significance: positive for $peak\_window$ and negative for $peak\_distance$. This implies that the impact of a recession is accentuated when the proportion of youth in the population is higher. A graphical representation of this outcome is presented in Figure 2b, which illustrates the marginal effect of a recession relative to the phase of the fertility transition. Figure 2b reveals that a recession consistently elevates the likelihood of a democratic improvement. However, this effect achieves significance specifically during a 30-year period, commencing 15 years after the peak of the fertility transition (i.e., when $peak\_window = 1$). This time frame corresponds to when the youth ratio is expected to be at its peak.

To sum up, the effect of a recession on the probability of a democratic improvement is amplified by the pres-



(a) (b)

Figure 2: Marginal effect of recessions on democratic improvements as a function of (a) the youth ratio and (b) the phase of the fertility transition. Dashed lines (in panel a) and bars (in panel b) represent 90% confidence intervals.

ence of a youth bulge in both of the long panels that we analyzed. This result is in line with our Prediction 3, which implies that a combination of economic and demographic conditions are key for the occurrence of democratic improvements. To that extent, our result generalizes the existing tests of the AR window of opportunity theory by showing that a window of opportunity is not exclusively defined in economic terms.

6.2 Riots as a transmission mechanism

We found in Section 5 robust evidence of a positive impact of the youth ratio on democratic improvements. Those findings are consistent with our theoretical predictions outlined in Section 2.4, where we posited that a youth bulge poses a revolutionary threat, compelling elites to make concessions. While the idealized—perfect-information—framework of our model establishes that a sufficiently high youth ratio invariably represents a credible threat of revolution, the complexities of reality may introduce additional nuances. In particular, a high youth ratio might not always be considered as a credible threat by the incumbents. In this context, events like riots, that have not yet escalated to a full-fledged challenge to the regime but carrying the potential to evolve into one, might serve as crucial indicators capable of prompting democratic concessions (Andrews and Jackman, 2005; Aidt and Franck, 2015; Aidt and Leon, 2016; Parente, Sáenz and Seim, 2022).[39]

[39] The findings presented by Aidt and Franck (2015); Parente, Sáenz and Seim (2022) align with this perspective. In the context of the Great Reform Act passed by the British Parliament in 1832, Aidt and Franck (2015) examine the impact of local riots on the likelihood of electing pro-reform members of parliament, revealing a substantial causal effect. Parente, Sáenz and Seim (2022) delve into the period from 1990 to 2018, demonstrating that countries successfully transitioning from autocratic to democratic regimes experienced a significantly higher incidence of protests compared to those undergoing no such transitions.

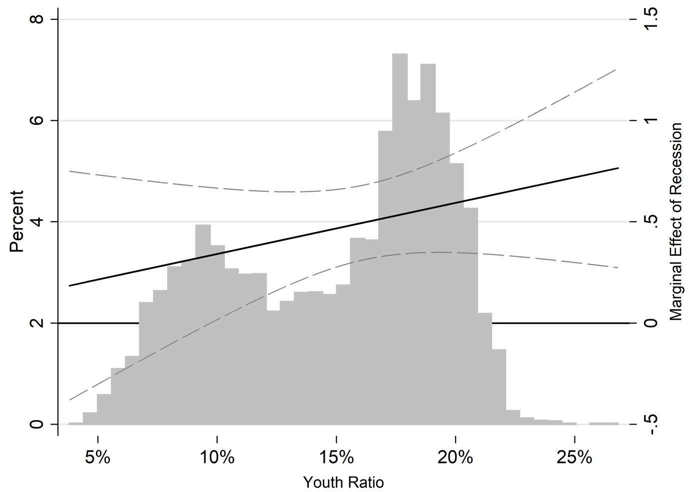


Figure 3: Marginal effect of recessions on riots as a function of the youth ratio

Przeworski (2009) and Aidt and Leon (2016) demonstrate that, as predicted by the AR theory, riots triggered by economic downturns could have facilitated the extension of the franchise.[40] Our theory suggests that riots prompted by youth bulges might play a comparable role (Prediction 4). In order to test this possibility, we proceed as follows. We first look at the impact of the youth ratio on riots and then we assess the effect of youth bulge induced riots on the democratic improvements. To that end, we use the variable *riots*, provided by Banks (2020), that counts (at the country-year level) the number of *violent demonstration or clash of more than 100 citizens involving the use of physical force*. As this number may be artificially influenced by the population size, we use log-transformations of the variable *riots*. To address the fact that this variable frequently assumes a zero value, we consider the following transformations: $\ln(1 + riots)$ and the inverse hyperbolic sine $\text{asinh}(riots)$.[41]

The effect of the youth ratio on our measures of riots are reported on Table 8. We conclude that the youth ratio has a positive impact on rioting. This result is confirmed when the youth ratio is instrumented by the net fertility rate lagged by 15 years (see Table 24 in Appendix D). We also find a a positive impact of an economic slowdown (i.e., a reduction in the growth rate) on rioting, which is consistent with results found in previous studies As (Przeworski, 2009; Chaney, 2013; Aidt and Leon, 2016; Waldinger, 2023). Finally, Figure 3 shows that the impact of a recession on riots increases with the youth ratio.[42] In particular, the positive impact of a recession on riots is significant only for a sufficiently high level of the youth ratio. This last result suggests that the threat of revolution becomes increasingly visible and, consequently, more credible when economic and demographic factors are converging.

It remains to be determined whether riots, driven by a high youth ratio, are indeed accountable for democratic changes, as proposed by our revisited *window of opportunity* hypothesis. To examine this question, we first

[40]Within the context of the French Revolution, Waldinger (2023) also demonstrates that communities subjected to severe drought conditions were more prone to peasant revolts against the feudal system.

[41]The inverse hyperbolic sine $\text{asinh}(y)$ is defined as $\ln\left[y + \sqrt{y^2+1}\right]$. This is now a widely used log-transformation (see, e.g. Bahar and Rapoport 2018; Aksoy, Özcan and Philipp 2021; Balboni et al. 2022).

[42]Table 25 (in Appendix D) reports the results used to draw the Figure 3. The variable recession is a binary variable taking the value 1 if the growth rate of GDP is negative and 0 otherwise. We use the *asinh* transformation for riots.

Table 8: Effect of youth bulges on riots — OLS regression

	Ordinary Least Square	
	DV:$\ln(1+\text{riots}_t)$	DV:asinh(riots_t)
	(1)	(2)
youth ratio (15-19)$_{t-1}$	1.362**	12.288***
	(0.58)	(4.53)
ln(GDP p.c.)$_{t-1}$	-0.022	-0.205
	(0.03)	(0.21)
growth rate (GDP p.c.)$_{t-1}$	-0.006***	-0.032***
	(0.00)	(0.01)
Polity$_{t-1}$	0.002	-0.035**
	(0.00)	(0.01)
Country & year FE's	yes	yes
N	8442	8442
Countries	154	154
Within-R^2	0.128	0.046

Notes: Robust standard errors clustered by country are in parentheses. The panel runs from 1951 – 2018. *** / ** / * represent significance at the 0.01 / 0.05 / 0.10 levels, respectively.

look at the impact of our measures of riots on the probability of occurrence of a political transition. The results, reported in Table 9 columns 1 and 4, reveal a significant positive impact, consistent with the conclusions drawn by Aidt and Franck (2015),Aidt and Leon (2016), Marino et al. (2020), or Parente, Sáenz and Seim (2022). Then, we employ a two-stage least squares procedure. In the first stage, we utilize lagged fertility rates as instruments for riots. In the second stage, we explore how fluctuations in riot intensity, influenced by changes in previous fertility rates, affect the likelihood of democratic improvements occurring.[43] The results of this 2SLS estimation are also reported in Table 9. Results reported in Panel B confirms the strong correlation between the lagged fertility rate and our two measures of riots. The F-statistics values instill confidence in the relevance of our instrument. We then find a significant second stage impact of (instrumented) riots on democratic improvements both without and with controls and for our two measures of riots (see Panel A).

The results presented in this section confirm Prediction 4, and suggest that low-intensity conflict, like riots, may serve as a transmission channel between a high youth ratio and democratic concessions by lending credibility to a latent threat of revolution. These results are consistent with AR's theory of political transitions, while also suggesting that the explanatory power of this theory could be augmented by incorporating demographic factors as crucial determinants of the threat of revolution, beyond economic variables alone.

[43] Formally, we use the net fertility rate in $t-16$ to instrument the level of riots (measured by $\ln(1+\textit{riots})$ or asinh$(\textit{riots})$) in $t-1$ and we estimate the impact of the instrumented level of riots in the probability of occurrence of a sizeable increase of the Polity 2 score between $t-1$ and t.

Table 9: Effect of riots driven by a high youth ratio on democratic improvements — Lagged fertility as instrument

	Panel A: Binary DV: Δ Polity2 ≥ 2					
		IV:$\ln(1+\text{riots}_{t-1})$			IV:asinh(riots_{t-1})	
	OLS	2SLS		OLS	2SLS	
	(1)	(2)	(3)	(4)	(5)	(6)
$\ln(1+\text{riots}_{t-1})$	0.034***	0.390***	0.373***			
	(0.01)	(0.14)	(0.15)			
asinh(riots_{t-1})				0.004***	0.037***	0.035***
				(0.00)	(0.01)	(0.01)
	Panel B: First stage of 2SLS					
		DV: $\ln(1+\text{riots}_{t-1})$			DV: asinh(riots_{t-1})	
		(1)	(2)		(3)	(4)
Net fertility rate$_{t-16}$		0.006***	0.006***		0.063***	0.062***
		(0.00)	(0.00)		(0.01)	(0.02)
Standard controls	yes	no	yes	yes	no	yes
Country & year FE's	yes	yes	yes	yes	yes	yes
K-P F-stat on excl. IV's	-	433.394	314.194	-	433.394	314.194
N	8347	8369	7020	8442	8369	7020
Countries	154	183	154	155	183	154

Notes: Robust standard errors clustered by country are in parentheses. The net fertility rate lagged by 15 years is used as the instrumental variable for the ratio of youth in the 2SLS specifications. The standard set of controls includes once lagged values of: the log of GDP per capita, the growth rate of GDP per capita, and the Polity score. Referring to the Kleibergen-Paap (K-P) F-statistic, the test's null hypothesis is that the set of instruments is weak. The panel runs from 1968 – 2017 for the IV specification. *** / ** / * represent significance at the 0.01 / 0.05 / 0.10 levels, respectively.

7 Robustness

7.1 Alternative demographic variables

In this section, we investigate the potential impact of other demographic changes. We consider alternative lag structures of the net fertility rate as well as the role played by the ratio of young males rather than the youth ratio in general.

Female fertility rates as alternative mechanism. Previous literature has pointed to the role of contemporaneous fertility rates in promoting democracy through a higher involvement of women in the public sphere and greater increases in the human capital of smaller numbers of children (Wilson and Dyson, 2017).[44] Here, we investigate the role of different lag structures of female fertility rates in order to examine these alternative channels through which features of demographic changes can impact the probability that democratic institutions improve (see Table 10). We consider once lagged, 5-year, 10-year, 15-year, and 20-year lagged net fertility rates in the table. As is clear from the table, and consistent with our previous results, fertility rates with 15-year lags are the strongest explanatory factor among the various lag alternative lag structures.

Isolating the ratio of young males. The exiting literature on the youth bulge particularly emphasises the role played by young males arguing that they are over-represented in revolutionary movements and conflicts

[44] In terms of the model presented in Section 2, the reduction of family sizes associated with a fertility decline might lowers the opportunity cost of participating in democratic movements.

Table 10: Effect of net fertility rates on democratic improvements

	Binary DV: Δ Polity2 ≥ 2					
	Ordinary Least Squares					
	(1)	(2)	(3)	(4)	(5)	(6)
net fertility rate$_{t-1}$	-0.000					0.001
	(0.00)					(0.00)
net fertility rate$_{t-5}$		0.000				-0.004*
		(0.00)				(0.00)
net fertility rate$_{t-10}$			0.001*			0.002
			(0.00)			(0.00)
net fertility rate$_{t-15}$				0.002***		0.002**
				(0.00)		(0.00)
net fertility rate$_{t-20}$					0.002*	-0.000
					(0.00)	(0.00)
Standard controls	yes	yes	yes	yes	yes	yes
Country & year FE's	yes	yes	yes	yes	yes	yes
N	8406	8092	7640	7080	6478	6478
Countries	154	154	154	154	154	154
Within-R^2	0.037	0.040	0.044	0.047	0.052	0.053

Notes: Robust standard errors clustered by country are in parentheses. The standard set of controls includes once lagged values of: the log of GDP per capita, the growth rate of GDP per capita, and the Polity score. The panel runs from 1951 – 2017 in column 1 and is trimmed by the number of lags included on the net fertility rate in the later columns. *** / ** / * represent significance at the 0.01 / 0.05 / 0.10 levels, respectively.

(Goldstone, 2002; Urdal, 2006; Apolte and Gerling, 2018; Weber, 2021). In Table 26 (Appendix D) we verify that our results hold when we consider the ratio of young males (instead of the overall youth ratio) as our main explanatory variable.[45] More precisely, the size of the coefficient of the ratio of youth male in roughly twice the size of the coefficient of the youth ratio in Table 3. However, by construction, the ratio of youth male is about twice as small as the youth ratio.

7.2 Different measures of political transition

In Table 11, we consider alternative operationalizations of the democratic improvement dependent variable. First, in columns 1 – 3, we consider a higher threshold (an increase in the Polity2 score of at least 3 points) for defining the binary transition variable. Results are robust to estimation with the higher threshold. In columns 4 – 6, we use continuous positive variation in the raw Polity2 data to examine the extent to which youth bulges explain the magnitude of the improvements in political institutions. Results are robust to estimation with the continuous variable. Then, we consider alternative democracy indicators. In columns 7 – 9 we consider the *polyarchy* variable from the VDEM data set. We generate a binary dependent variable for a discrete change in VDEM that corresponds to an increase in 10% of its range (0 to 1, whereas Polity2's range is from -10 to 10).

[45] We define the ratio of young males as the share of male population aged between 15 to 19 in the whole population (both male and female) aged over 15.

Table 11: Different measures of political transitions

	Binary DV: Δ Polity2 ≥ 3			Continuous DV: Δ Polity2 > 0			Binary DV: Δ VDEM ≥ 0.1			Binary DV: Δ ML Index ≥ 0.1		
	OLS	OLS	2SLS	OLS	OLS	2SLS	OLS	OLS	2SLS	OLS	OLS	2SLS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
youth ratio (15 - 19)$_{t-1}$	0.355***		0.476***	3.984***		4.163**	0.067		0.345**	0.380***		0.592**
	(0.12)		(0.18)	(1.34)		(1.92)	(0.14)		(0.16)	(0.13)		(0.24)
Net fertility rate$_{t-15}$		0.001**			0.012**			0.001**			0.002**	
		(0.00)			(0.01)			(0.00)			(0.00)	
Standard controls	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Country & year FE's	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
K-P F-stat on excl. IV's	–	–	285.16	–	–	285.16	–	–	267.93	–	–	293.95
N	8608	7080	7080	8608	7080	7080	8782	7336	7336	8606	7097	7097
Countries	154	154	154	154	154	154	160	160	160	154	154	154
Within-R^2	0.037	0.046	–	0.067	0.073	–	0.040	0.040	–	0.024	0.027	–

Notes: Robust standard errors clustered by country are in parentheses. The standard set of controls includes once lagged values of: the log of GDP per capita, the growth rate of GDP per capita, and the Polity score. Referring to the Kleibergen-Paap (K-P) F-statistic, the test's null hypothesis is that the set of instruments is weak. The panel runs from 1951 – 2017 for the specifications that do not include the 15-year lagged fertility rates and from 1968 – 2017 for the specifications that do include the 15-year lagged fertility rates. *** / ** / * represent significance at the 0.01 / 0.05 / 0.10 levels, respectively.

The LPM estimation with the youth ratio is positive but not significant. However, both reduced form and 2SLS estimations lead to positive and significant effects. In columns 10 – 12 we consider the Machine Learning (ML) Democracy Index proposed by Gründler and Krieger (2016, 2021). We generate a binary dependent variable for a discrete change in the ML Democracy Index that corresponds to an increase in 10% of its range. Again, our results are robust to the use of this alternative measure of democratic improvements.

7.3 Youth bulge, democratic reversal and violent transitions

According to our theory, a youth bulge puts pressure on the elites that induces them to make some concessions in the form of democratic improvements. We found in Section 6.2 that this threat of revolution, driven by a large youth ratio, manifests through riots. However, rioting could also contribute to political instability. In such a scenario, a high youth ratio not only enhances the likelihood of democratic improvements but also raises the probability of democratic reversals. In order to test this possibility, we have constructed an indicator of democratic reversal, taking the value 1 if the Polity2 score decreases by at least 2 points and 0 otherwise. In columns 1–3 of Table 12, we show the effect of the youth ratio on the probability of a democratic reversal. More precisely, we show LPM results using our baseline youth ratio variable (column 1), reduced form LPM results using the 15 years lagged fertility (column 2), and 2SLS results using the 15 years lagged fertility rate as instrument (column 3). We do not see a consistently statistically significant positive effect of youth bulge on democratic reversals. On the contrary, the effect of the youth ratio is always negative and is even significant at the 0.05 level in the OLS specification reported in column 1.

We interpret the positive influence of riots fueled by a substantial youth ratio on democratic progress as aligning with the AR theory, which asserts that a credible threat of revolution prompts the elite to make concessions towards democracy. In this perspective, instances of democratic improvement typically unfold relatively peacefully, giving rise to low-intensity conflicts only, such as riots, in the majority of cases. Nevertheless, these low-intensity conflicts may carry the risk of escalating into larger-scale events, such as revolutions, resulting in a potentially violent transition to democracy. We consider this possibility by analyzing the impact of the youth ratio on the occurrence of such violent events. To that end, we use the variable *revolutions*, provided by Banks

Table 12: Effect of youth bulges on democratic reversal

	democratic reversal Δ Polity2 $\leq$ -2			$\ln(1 + \text{revolution}_t)$			asinh(revolution$_t$)		
	OLS (1)	OLS (2)	2SLS (3)	OLS (4)	OLS (5)	2SLS (6)	OLS (7)	OLS (8)	2SLS (9)
youth ratio (15 - 19)$_{t-1}$	-0.287**		-0.114	-0.611*		-1.285**	-5.465		-10.673**
	(0.14)		(0.36)	(0.01)		(0.57)	(3.33)		(4.79)
Net fertility rate$_{t-15}$		-0.000			-0.004**			-0.032**	
		(0.00)			(0.00)			(0.01)	
Standard controls	yes	yes	yes	yes	yes	yes	yes	yes	yes
Country & year FE's	yes	yes	yes	yes	yes	yes	yes	yes	yes
K-P F-stat on excl. IV's	–	–	285.16	–	–	314.19	–	–	314.19
N	8608	7080	7080	8442	7020	7020	8442	7020	7020
Countries	154	154	154	154	154	154	154	154	154

Notes: Robust standard errors clustered by country are in parentheses. The standard set of controls includes once lagged values of: the log of GDP per capita, the growth rate of GDP per capita, and the Polity score. Referring to the Kleibergen-Paap (K-P) F-statistic, the test's null hypothesis is that the set of instruments is weak. The panel runs from 1951 – 2017 for the specifications that do not include the 15-year lagged fertility rates and from 1968 – 2017 for the specifications that do include the 15-year lagged fertility rates. *** / ** / * represent significance at the 0.01 / 0.05 / 0.10 levels, respectively.

(2020).[46] Results reported on Table 12 (columns 4 – 9) consistently show (both for OLS and 2SLS estimation and for the different log-transformations of the variable) that the impact of the youth ratio on the probability of occurrence of a revolution is negative. This finding supports the idea according to which political transition fueled by youth bulges are mostly the results of concessions made by the elite in place in response to what they perceive as a threat of revolution.

7.4 Placebo with the very young and the very old

In Table 13, we report results from a series of placebo tests that we have conducted over our baseline panel (1951–2017). We estimate the effect of increases in age tranche ratios of the very young and the old. For the very young, we consider ratios of tranches from 0–4 and 5–9 years old (in columns 1 and 2) and demonstrate that increases in the ratio of very young to the total population do not have an impact on the probability of democratic improvements. For the old, we consider ratios of tranches from 60–64, 65–69, 70–74, and 75–79 (in columns 3 – 6). We do not anticipate that the ratio of old to the rest of the population would have an impact on the probability of democratic improvements, and indeed it does not.

7.5 Time varying country fixed effects

In all the regressions presented so far we have added country fixed effects—to control for any time-invariant characteristics of countries that may affect their propensity to democratize—and year fixed effects—to control for global trends towards democratic governance. Since our data spans over a relatively long period of time (1951 to 2017 in our main specifications), we also test the robustness of our results to the introduction of time-varying country fixed effects. In this section we consider different ways to introduce those time-varying country fixed

[46] This variable counts (at the country-year level) the number of *illegal or forced change in the top government elite, attempt at such a change or successful or unsuccessful armed rebellion whose aim is independence from the central government.* Since this variable is a count variable we apply the same log-transformations as for the variable *riots*.

Table 13: Placebo tests: Alternative age tranche ratios with the very young and the old

	Binary DV: Δ Polity ≥ 2					
	Ordinary Least Squares					
	(1)	(2)	(3)	(4)	(5)	(6)
ratio very young (0 - 4)$_{t-1}$	-0.008 (0.07)					
ratio very young (5 - 9)$_{t-1}$		0.104 (0.09)				
ratio old (60 - 64)$_{t-1}$			0.391 (0.43)			
ratio old (65 - 69)$_{t-1}$				-0.048 (0.42)		
ratio old (70 - 74)$_{t-1}$					-0.549 (0.47)	
ratio old (74 - 79)$_{t-1}$						-0.918 (0.57)
Standard controls	yes	yes	yes	yes	yes	yes
Country & year FE's	yes	yes	yes	yes	yes	yes
N	8608	8608	8608	8608	8608	8608
Countries	154	154	154	154	154	154
Within-R^2	0.036	0.037	0.036	0.036	0.036	0.037

Notes: Robust standard errors clustered by country are in parentheses. The standard set of controls includes once lagged values of: the log of GDP per capita, the growth rate of GDP per capita, and the Polity score. The panel runs from 1951 – 2017 for all specifications. *** / ** / * represent significance at the 0.01 / 0.05 / 0.10 levels, respectively.

effects.

First, we split our time span into several sub-periods and we add country×sub-period fixed effects. Since the demographic structure is slow to evolve, the sub-periods we are considering must not be too short in order to have a sufficiently high level of variation of our main variable of interest (the youth ratio). We test three different time-lengths for those sub-periods that respectively correspond to the division of our entire time span (1951-2017) into four sub-periods of 16 years and a half, three sub-periods of 22 years and two sub-periods of 33 years. The results are reported in columns 1 – 3 of Table 14. Whatever the time length that is considered, the coefficient of the youth ratio remains significantly positive and the magnitude of the effect is larger than in our baseline estimation.

Then, instead of considering time-invariant country fixed effects associated with one unique time trend for all countries, we introduce country-specific time trends. Put differently, we allow country fixed effects to vary linearly over time. The results are reported in column 4 of Table 14. Again, the coefficient of the youth ratio remains significantly positive and its size is a bit higher than in our baseline estimation.

8 Conclusion

In this paper, we document the effect of demography on the likelihood of democratic improvements. Using detailed demographic data in a long country-year panel framework, we provide evidence of a robust empirical regularity—the proportion of the population aged 15 to 19 is positively correlated with the likelihood of demo-

Table 14: Time varying fixed effects

	Binary DV: Δ polity2 $\geq$ 2			
	Country x 16.5y FE	Country x 22y FE	Country x 33y FE	Country specific time trend
	(1)	(2)	(3)	(4)
youth ratio (15 - 19)$_{t-1}$	0.484*	0.602**	0.393**	0.532**
	(0.26)	(0.27)	(0.19)	(0.21)
Standard controls	yes	yes	yes	yes
Country FE's	yes	yes	yes	yes
Year FE's	yes	yes	yes	yes
N	8213	8335	8479	8608
Within-R^2	0.057	0.057	0.048	0.068

Notes: Robust standard errors clustered by country are in parentheses. The standard set of controls includes once lagged values of: the log of GDP per capita, the growth rate of GDP per capita, and the Polity score. The panel runs from 1951 – 2017 for all specifications. *** / ** / * represent significance at the 0.01 / 0.05 / 0.10 levels, respectively.

cratic improvements. Two instrumental variable strategies, using respectively lagged fertility rates in neighboring countries and past climatic variations, allow for a causal interpretation of the correlation. The effect is sizable, an increase in one standard deviation of the proportion of youth increases the probability of observing a democratization episode in a range from 1.6 to 5.3 points percentage when estimated by OLS and IV, respectively. We establish two further results: *i*) the youth bulge effect is amplified during periods of economic recession and *ii*) low intensity conflict, such as riots, might act as a transmission channel of the youth bulge effect. We view this set of results as supportive of the AR window of opportunity theory. As younger cohorts are those who have the most to gain from a regime change and the least to loose from participating in democratic movements, a temporary rise in the youth ratio induces a threat of revolution (especially during recessions as economic opportunities are more depressed). As a result of this threat, and to preempt large scale civil conflicts, the elite in place might be incentivized to concede democratic improvements (especially when riots lend credibility to the perceived threat). While the existing empirical literature has shown the role played by economic variables, e.g economic slowdowns, in the opening of a democratic window of opportunity, our paper demonstrates that demographic variables also play a crucial role and reinforce the economic forces. We believe that this result constitutes a useful step towards a more systematic investigation of all the factors conducive to democracy.

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Online Appendix – Not for Print Publication

Contents

A Alternative coding rules for the Polity2 variable

Table 15: Alternative coding rules for the Polity2 variable

	Binary DV: Δ polity2 ≥ 2						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
youth ratio (15 - 19)$_{t-1}$	0.355**	0.400**	0.371**	0.345**	0.269**	0.325**	0.303**
	(0.15)	(0.15)	(0.14)	(0.15)	(0.12)	(0.13)	(0.13)
Standard controls	yes	yes	yes	yes	yes	yes	yes
Country FE's	yes	yes	yes	yes	yes	yes	yes
Year FE's	yes	yes	yes	yes	yes	yes	yes
N	8608	8750	8724	8745	8406	8601	8571
Within-R^2	0.037	0.039	0.038	0.037	0.031	0.041	0.038

Notes: Robust standard errors clustered by country are in parentheses. The standard set of controls includes once lagged values of: the log of GDP per capita, the growth rate of GDP per capita, and the Polity score. The panel runs from 1951 – 2017 for all specifications. *** / ** / * represent significance at the 0.01 / 0.05 / 0.10 levels, respectively.

The Polity2 variable uses coding rules that could, in some specific cases, render the identification of democratic transitions difficult:

(i) As mentioned in footnote 25, a score of zero is assigned to interregnum periods (i.e., periods during which the rulers cannot exercise effective authority on at least half of their territory). In order to avoid to interpret as a democratic improvement the situation of a country having a Polity2 score lower or equal than -2 that falls into interregnum (so that its score jumps to 0), we have chosen to set the Polity2 score equal to missing in all interregnum periods.

(ii) In case of a multi-year transition (i.e., a multi-year period characterized by a variation in the degree of democracy between each successive year), the Polity2 index is linearly interpolated.

In Table 15 we test the robustness of our LPM estimations (with our standard set of controls) under alternative coding rules. In column 1, we replicate our baseline estimation (column 9 of the Table 3) where interregnum periods are excluded. In column 2, we report the results obtained under the original coding of the Polity2 variable (i.e., a score of zero is assigned to interregnum periods). In order to take into account democratic transitions that might have came out of interregnum periods, we also consider two alternatives coding rules for those periods. For the whole interregnum period, we set the Polity2 score equal to its pre-interregnum period level (the results are reported in column 3) or to its post-interregnum period level (the results are reported in column 4). We also test alternative coding rules for multi-year transition. First, we exclude the periods of multi-year transition (results are reported in column 5). Then, we set the Polity2 score equal to its pre-transition period level (the results are reported in column 6) or to its post-transition period level (the results are reported in column 7).[47] Over all specification, the coefficient of the youth ratio is significant and its size remains relatively stable.

[47] For all the estimations reported in columns 5 – 7, we exclude interregnum periods.

B Replication of the main results using the youth ratio (15-24)

Table 16: Effect of the share of population aged 15 to 24 on democratic improvements

	Binary DV: Δ Polity2 ≥ 2									
	Ordinary Least Squares									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
youth ratio (15 - 24)$_{t-1}$	0.185***	0.114	0.212***	0.232***	0.185***	0.163**	0.163**	0.223	0.181**	0.448**
	(0.07)	(0.08)	(0.07)	(0.08)	(0.07)	(0.07)	(0.08)	(0.14)	(0.09)	(0.20)
ln(GDP p.c.)$_{t-1}$		-0.015**							-0.017**	-0.015
		(0.01)							(0.01)	(0.02)
growth rate (GDP p.c.)$_{t-1}$			-0.002***						-0.002***	-0.002***
			(0.00)						(0.00)	(0.00)
Polity 2$_{t-1}$				-0.005***					-0.006***	-0.013***
				(0.00)					(0.00)	(0.00)
Urbanization rate$_{t-1}$					0.000					0.002
					(0.00)					(0.00)
ln(population)$_{t-1}$						0.009				0.063
						(0.01)				(0.04)
Primary school enrolment$_{t-1}$							-0.000			0.001*
							(0.00)			(0.00)
Gini coefficient$_{t-1}$								-0.002		-0.000
								(0.00)		(0.00)
Country & year FE's	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
N	9053	8634	8609	9053	9053	9053	7601	4929	8608	4240
Countries	164	154	154	164	164	164	135	160	154	131
Within-R^2	0.021	0.021	0.023	0.034	0.021	0.021	0.019	0.021	0.037	0.075

Notes: Robust standard errors clustered by country are in parentheses. The standard set of controls includes once lagged values of: the log of GDP per capita, the growth rate of GDP per capita, and the Polity score. The unbalanced panel runs from 1951 – 2017 in the longest specification. *** / ** / * represent significance at the 0.01 / 0.05 / 0.10 levels, respectively.

Table 17: Effect of the share of population aged 15 to 24 on democratic improvements — Lagged fertility variables as instruments

	Panel A: Binary DV: Δ Polity2 ≥ 2							
	Own net fertility rate (lagged 15 years)				Neighbors' net fertility rate (lagged 20 years)			
	OLS		2SLS		OLS		2SLS	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Net fertility rate$_{t-j}$	0.002***	0.002***			0.003***	0.003**		
	(0.00)	(0.00)			(0.00)	(0.00)		
youth ratio (15 - 24)$_{t-1}$			0.449***	0.413***			0.676***	0.655**
			(0.12)	(0.15)			(0.23)	(0.31)
	Panel B: First stage of 2SLS, DV: youth ratio (15 - 24)$_{t-1}$							
Net fertility rate$_{t-j}$			0.005***	0.004***			0.005***	0.004***
			(0.00)	(0.00)			(0.00)	(0.00)
Standard controls	no	yes	no	yes	no	yes	no	yes
Country & year FE's	yes	yes	yes	yes	yes	yes	yes	yes
K-P F-stat on excl. IV's	–	–	257.057	196.195	–	–	113.979	80.297
N	7449	7080	7448	7080	6440	6094	6439	6093
Countries	164	154	163	154	163	154	162	153

Notes: Robust standard errors clustered by country are in parentheses. The net fertility rate lagged by 15 years is used as the instrumental variable for the ratio of youth in the 2SLS specifications. The standard set of controls includes once lagged values of: the log of GDP per capita, the growth rate of GDP per capita, and the Polity score. Referring to the Kleibergen-Paap (K-P) F-statistic, the test's null hypothesis is that the set of instruments is weak. The panel runs from 1968 – 2017 for the own net fertility rate specification and from 1973 – 2017 for the neighborhood net fertility rate specification. *** / ** / * represent significance at the 0.01 / 0.05 / 0.10 levels, respectively.

Table 18: Effect of the share of the population aged 15 to 24 on democratic improvements — Climatic variables interacted with the share of agriculture in GDP as instruments

	Panel A: Binary DV: Δ Polity2 ≥ 2					
	OLS		2SLS			
	(1)	(2)	(3)	(4)	(5)	(6)
youth ratio (15 - 24)$_{t-1}$			1.041**	1.595**		
			(0.50)	(0.81)		
net fertility$_{t-15}$					0.007**	0.010**
					(0.00)	(0.00)
spei_agr$_{t-16}$	-0.001***	-0.001***				
	(0.00)	(0.00)				
spei$_{t-16}$	0.020**	0.016*				
	(0.01)	(0.01)				
	Panel B: First stage, DV: youth ratio (15 - 19)$_{t-1}$					
spei_agr$_{t-16}$			-0.000***	-0.000*	-0.073***	-0.044**
			(0.00)	(0.00)	(0.02)	(0.02)
spei$_{t-16}$			0.001	-0.004	0.330	-0.311
			(0.00)	(0.00)	(0.60)	(0.60)
Standard controls	no	yes	no	yes	no	yes
Country & year FE's	yes	yes	yes	yes	yes	yes
K-P F-stat on excl. IV's	–	–	14.718	8.397	12.109	7.559
N	7106	6804	7105	6804	6883	6587
Countries	151	142	150	142	150	142

Notes: Robust standard errors clustered by country are in parentheses. The standard set of controls includes once lagged values of: the log of GDP per capita, the growth rate of GDP per capita, and the Polity score. Referring to the Kleibergen-Paap (K-P) F-statistic, the test's null hypothesis is that the set of instruments is weak. The panel runs from 1951 – 2017. *** / ** / * represent significance at the 0.01 / 0.05 / 0.10 levels, respectively.

C Sub-sample regressions

Table 19: Effect of youth bulges on democratic improvements — Cut by continent

	Binary DV: Δ polity2 ≥ 2										
	Ordinary Least Squares										
	No Europe	No Europe	No Africa	No Africa	No Asia	No Asia	No North America	No North America	No South America	No South America	Jackknife
youth ratio (15 - 19)$_{t-1}$	0.372***	0.391**	0.045	0.121	0.574***	0.521***	0.351***	0.329**	0.339***	0.268*	0.355**
	(0.11)	(0.16)	(0.15)	(0.20)	(0.14)	(0.18)	(0.11)	(0.15)	(0.11)	(0.16)	(0.15)
Standard controls	no	yes	no	yes	no	yes	no	yes	no	yes	yes
Country & year FE's	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
N	6880	6574	6095	5841	6297	6123	8655	8336	7237	7014	8608
Countries	124	117	107	103	113	108	157	150	135	130	154
Within-R^2	0.024	0.042	0.020	0.037	0.034	0.051	0.022	0.038	0.027	0.041	0.037

Notes: Robust standard errors clustered by country are in parentheses. The standard set of controls includes once lagged values of: the log of GDP per capita, the growth rate of GDP per capita, and the Polity score. The unbalanced panel runs from 1951 – 2017 in the longest specification. *** / ** / * represent significance at the 0.01 / 0.05 / 0.10 levels, respectively.

Table 20: Effect of youth bulges on democratic improvements — Cut by region (Africa)

	Binary DV: Δ polity2 ≥ 2									
	Ordinary Least Squares									
	No Northern	No Northern	No Western	No Western	No Middle	No Middle	No Eastern	No Eastern	No Southern	No Southern
youth ratio (15 - 19)$_{t-1}$	0.372***	0.388**	0.285**	0.323**	0.371***	0.396**	0.239**	0.240	0.340***	0.357**
	(0.11)	(0.16)	(0.12)	(0.16)	(0.11)	(0.16)	(0.11)	(0.15)	(0.11)	(0.15)
Standard controls	no	yes	no	yes	no	yes	no	yes	no	yes
Country & year FE's	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
N	8687	8243	8172	7728	8640	8195	8265	7883	8805	8360
Countries	158	148	148	138	156	146	147	140	159	149
Within-R^2	0.023	0.039	0.017	0.033	0.019	0.035	0.021	0.036	0.022	0.038

Notes: Robust standard errors clustered by country are in parentheses. The standard set of controls includes once lagged values of: the log of GDP per capita, the growth rate of GDP per capita, and the Polity score. The unbalanced panel runs from 1951 – 2017 in the longest specification. *** / ** / * represent significance at the 0.01 / 0.05 / 0.10 levels, respectively.

Table 21: Effect of youth bulges on democratic improvements — Cut by region (America)

	Binary DV: Δ polity2 ≥ 2							
	Ordinary Least Squares							
	No Northern	No Northern	No Central	No Central	No South	No South	No Caribbean	No Caribbean
youth ratio (15 - 19)$_{t-1}$	0.339***	0.337**	0.335***	0.343**	0.359***	0.313**	0.344***	0.346**
	(0.11)	(0.15)	(0.11)	(0.15)	(0.11)	(0.15)	(0.11)	(0.15)
Standard controls	no	yes	no	yes	no	yes	no	yes
Country & year FE's	yes	yes	yes	yes	yes	yes	yes	yes
N	8917	8472	8580	8135	8278	7928	8747	8303
Countries	162	152	157	147	152	144	159	149
Within-R^2	0.021	0.038	0.024	0.040	0.022	0.036	0.022	0.038

Notes: Robust standard errors clustered by country are in parentheses. The standard set of controls includes once lagged values of: the log of GDP per capita, the growth rate of GDP per capita, and the Polity score. The unbalanced panel runs from 1951 – 2017 in the longest specification. *** / ** / * represent significance at the 0.01 / 0.05 / 0.10 levels, respectively.

D Additional results

Table 22: Effect of output contractions on democratic improvements — Interactions with the youth ratio

	Binary DV: Δ Polity2 ≥ 2					
	Ordinary Least Squares					
	(1)	(2)	(3)	(4)	(5)	(6)
youth ratio (15 - 19)$_{t-1}$	0.456***	0.381**	0.375***	0.302**	0.380***	0.331**
	(0.12)	(0.15)	(0.12)	(0.15)	(0.12)	(0.15)
growth rate of GDP p.c.$_{t-1}$	0.001	0.000				
	(0.00)	(0.00)				
growth rate × ratio youth$_{t-1}$	-0.014	-0.011				
	(0.01)	(0.01)				
binary negative growth rate $_{t-1}$			-0.015	-0.013		
			(0.02)	(0.02)		
binary negative growth × ratio youth$_{t-1}$			0.209*	0.192		
			(0.12)	(0.12)		
truncated negative growth rate $_{t-1}$					0.002	-0.001
					(0.00)	(0.00)
truncated negative growth rate × ratio youth$_{t-1}$					-0.029	-0.014
					(0.02)	(0.03)
Standard controls	no	yes	no	yes	no	yes
Country & year FE's	yes	yes	yes	yes	yes	yes
N	8608	8609	8608	8609	8609	8608
Countries	154	154	154	154	154	154
Within-R^2	0.024	0.037	0.023	0.037	0.023	0.037

Notes: Robust standard errors clustered by country are in parentheses. The standard set of controls in this case includes once lagged values of: the log of GDP per capita and the Polity score. The panel runs from 1951 – 2017 for all specifications. *** / ** / * represent significance at the 0.01 / 0.05 / 0.10 levels, respectively.

Table 23: Effect of output contractions on democratic improvements — Interactions with peak_window and peak_recession

	Binary DV: Δ Polity2 $\geq$ 2			
	Ordinary Least Squares			
	(1)	(2)	(3)	(4)
binary negative growth rate$_{t-1}$	0.006	0.004	0.057***	0.059***
	(0.00)	(0.01)	(0.02)	(0.02)
peak_window$_{t-15}$	0.017***	0.014**		
	(0.01)	(0.01)		
peak_distance$_{t-15}$			-0.001	-0.000
			(0.00)	(0.00)
bin neg g.r. $\times$ peak_window$_{t-15}$	0.022**	0.025**		
	(0.01)	(0.01)		
bin neg g.r. $\times$ peak_distance$_{t-15}$			-0.003**	-0.004**
			(0.00)	(0.00)
Standard controls	no	yes	no	yes
Country & year FE's	yes	yes	yes	yes
N	11058	11058	11058	11058
Countries	135	135	135	135
Within-R^2	0.029	0.041	0.030	0.042

Notes: Robust standard errors clustered by country are in parentheses. The standard set of controls in this case includes once lagged values of: the log of GDP per capita and the Polity score. The panel runs from 1951 – 2017. *** / ** / * represent significance at the 0.01 / 0.05 / 0.10 levels, respectively.

Table 24: Effect of youth bulges on riots — Lagged fertility as instrument

	Panel A: IV: Own net fertility rate (lagged 15 years)							
	$\ln(1 + \text{riots}_t)$				asinh(riots$_t$)			
	OLS		2SLS		OLS		2SLS	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Net fertility rate$_{t-15}$	0.006***	0.006***			0.064***	0.061***		
	(0.00)	(0.00)			(0.02)	(0.02)		
youth ratio (15-19)$_{t-1}$			1.959***	2.057***			19.591***	20.383***
			(0.59)	(0.70)			(4.53)	(5.41)
	Panel B: First stage of 2SLS							
			DV: youth ratio (15-19)$_{t-1}$				DV: youth ratio (15-19)$_{t-1}$	
			(3)	(4)			(7)	(8)
Net fertility rate$_{t-15}$			0.003***	0.003***			0.003***	0.003***
			(0.00)	(0.00)				
Standard controls	no	yes	no	yes	no	yes	no	yes
Country & year FE's	yes	yes	yes	yes	yes	yes	yes	yes
K-P F-stat on excl. IV's	–	–	433.394	314.194	–	–	433.394	314.194
N	8369	7020	8369	7020	8369	7020	8369	7020
Countries	183	154	183	154	183	154	183	154

Notes: Robust standard errors clustered by country are in parentheses. The net fertility rate lagged by 15 years is used as the instrumental variable for the ratio of youth in the 2SLS specifications. The standard set of controls includes once lagged values of: the log of GDP per capita, the growth rate of GDP per capita, and the Polity score. Referring to the Kleibergen-Paap (K-P) F-statistic, the test's null hypothesis is that the set of instruments is weak. The panel runs from 1968 – 2017 for the own net fertility rate specification and from 1973 – 2017 for the neighborhood net fertility rate specification. *** / ** / * represent significance at the 0.01 / 0.05 / 0.10 levels, respectively.

Table 25: Effect of output contractions on riots — Interactions with the youth ratio

	DV:asinh(riots$_t$)					
	Ordinary Least Squares					
	(1)	(2)	(3)	(4)	(5)	(6)
youth ratio (15 - 19)$_{t-1}$	14.781***	13.423***	13.921***	12.343***	13.716***	13.107***
	(4.46)	(4.44)	(4.47)	(4.44)	(4.43)	(4.41)
growth rate of GDP p.c.$_{t-1}$	-0.004	-0.004				
	(0.03)	(0.03)				
growth rate $\times$ ratio youth$_{t-1}$	-0.186	-0.186				
	(0.22)	(0.22)				
binary negative growth rate$_{t-1}$			0.123	0.089		
			(0.44)	(0.44)		
binary negative growth $\times$ ratio youth$_{t-1}$			2.301	2.523		
			(2.63)	(2.61)		
truncated negative growth rate$_{t-1}$					-0.075	-0.110*
					(0.07)	(0.07)
truncated negative growth rate $\times$ ratio youth$_{t-1}$					-0.032	0.137
					(0.44)	(0.43)
Standard controls	no	yes	no	yes	no	yes
Country & year FE's	yes	yes	yes	yes	yes	yes
N	8949	8907	8949	8907	8949	8907
Countries	161	160	161	160	161	160
Within-R^2	0.123	0.125	0.123	0.125	0.125	0.127

Notes: Robust standard errors clustered by country are in parentheses. The standard set of controls in this case includes once lagged values of: the log of GDP per capita and the Repression index. The panel runs from 1951 – 2017 for all specifications. *** / ** / * represent significance at the 0.01 / 0.05 / 0.10 levels, respectively.

Table 26: Effect of youth male bulges on democratic improvements

	Binary DV: Δ Polity2 ≥ 2									
	Ordinary Least Squares									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
male youth ratio (15 - 19)$_{t-1}$	0.663***	0.510**	0.784***	0.806***	0.663***	0.606***	0.614**	1.112**	0.689**	1.664**
	(0.21)	(0.24)	(0.23)	(0.26)	(0.21)	(0.22)	(0.24)	(0.44)	(0.29)	(0.69)
ln(GDP p.c.)$_{t-1}$		-0.013*							-0.016*	-0.012
		(0.01)							(0.01)	(0.02)
growth rate (GDP p.c.)$_{t-1}$			-0.002***						-0.002***	-0.002***
			(0.00)						(0.00)	(0.00)
Polity$_{t-1}$				-0.005***					-0.006***	-0.013***
				(0.00)					(0.00)	(0.00)
Urbanization rate$_{t-1}$					0.000					0.002
					(0.00)					(0.00)
ln(population)$_{t-1}$						0.010				0.067*
						(0.01)				(0.04)
Secondary school enrolment$_{t-1}$							-0.000			0.001*
							(0.00)			(0.00)
Gini coefficient$_{t-1}$								-0.002		-0.000
								(0.00)		(0.00)
Country & year FE's	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
N	9053	8634	8609	9053	9053	9053	7601	4929	8608	4240
Countries	164	154	154	164	164	164	135	160	154	131
Panel length	'51 – '17	'51 – '17	'51 – '17	'51 – '17	'51 – '17	'51 – '17	'51 – '17	'51 – '15	'51 – '17	'61 – '16

Notes: Robust standard errors clustered by country are in parentheses. The unbalanced panel runs from 1951 – 2017 in the longest specification. *** / ** / * represent significance at the 0.01 / 0.05 / 0.10 levels, respectively.