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Climate change, migration and voice

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Abstract
Climate change is frequently predicted to result in dramatic increases in international migration, yet current research has largely failed to identify such movements in practice. This paper sheds light on this apparent paradox. Drawing on Hirschman's treatise on Exit, Voice and Loyalty, we provide empirical evidence that voicing about climatic change, as captured through media reports, is associated with greater exposure to climate risks and lower emigration rates. Our finding is consistent with individuals' variously responding to climatic change either by emigrating or remaining and voicing about climatic change, with the aim of influencing current mitigation, adaptation or compensation policies. Our results, in turn, have implications for policies aimed at shaping international migration patterns and the ability of governments and residents to voice their concerns about climate change.

Keywords Emigration · Climate change · Voicing · Trapped populations

1 Introduction

We contribute to the understanding of the 'immobility paradox', the observation that fewer people emigrate due to current or future climatic changes than is otherwise expected (Government Office For Science 2011). We document an alternative adaptation mechanism, namely 'voicing against climate change'. By 'voicing', we mean the attempt by a population affected by climate change to voice their concerns to their governments (domestic voicing), or else by their government externally to the rest of the world (international voicing).

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Under-girding this voicing may be the hope of averting climatic change through changing the intensity of mitigation domestically or internationally by reducing greenhouse gas (GHG) emissions. Affected populations may alternatively hope to receive funding for adaptation, or compensation, from their government; in which case, voicing is similar to any other lobbying by a domestic interest group. Similarly, in the international arena governments may hope to receive adaptation or compensation assistance.

With voicing, individuals and governments may also attempt to create or generate momentum for the development of other multinational compensation mechanisms for climate change damages. These can take the form of international agreements (such as the UNFCCC's Warsaw International Mechanism for Loss and Damage) or legal judgements; for example through class-action lawsuits that target major emitters (such as multinational oil companies). All these voicing activities should be viewed as attempting to strengthen the bargaining power of affected populations or governments in any ongoing or future negotiations. What we ultimately provide some empirical evidence for is the fact that populations that are exposed to climatic change, and that are either unable or unwilling to emigrate, engage in voicing (about climate change), and that this is similarly evident for their representative governments.

Climate change manifests in various guises, ranging from the increased frequency of rapid-onset disasters to more intense slow-onset change, including sea-level rises, higher average temperatures and waning rainfalls. There is broad consensus that low-income countries will bear the brunt of the adverse effects of climate change, but while sea-level rises and higher average temperatures may not have been very consequential up to now (except for some specific communities and locations), there is a large extreme event attribution literature that suggests that many adverse impacts are already occurring because of climate change. This burgeoning attribution literature started with Stott et al. (2004). It identifies the current impact of climate change on the probability and intensity of extreme weather events and their impacts.[1]

The extensive empirical literature on environmentally driven migration, however, fails to provide compelling evidence of a clear-cut connection between climatic change and the displacement of people internationally. Adopting a plethora of alternative empirical specifications, with a particular emphasis on identifying the channels and mechanisms at play, some papers uncover evidence of a direct link (e.g. Cattaneo and Peri (2016), Beine and Parsons (2017), Wesselbaum (2021)), while others expose the existence of indirect links between climate change and emigration (e.g. Mueller et al. (2014), Beine and Parsons (2015)).

A significant number of papers, however, fail to uncover *any* emigration response to adverse and changing climatic conditions whatsoever.[2] In contrast, A UK Government publication, the 2011 Foresight Report (Government Office For Science 2011) introduced the concept of 'trapped populations'; noting that environmental change is as likely to decrease migration as it is to foster future flows. Indeed, across the world, we continue to observe far fewer emigrants than we would otherwise expect from countries most exposed to current changes in the climate. As originally conceptualised, 'trapped populations' are portrayed as comprising individuals with lower social/economic/political capital. These are the people most exposed to the onset of climate change and least able to migrate away from its

[1]For an elaboration on this distinction, see Otto et al. (2012).

[2]Please refer to Boas et al. (2019), Berlemann and Steinhardt (2017), Millock (2015) and Piguet et al. (2011) for recent literature reviews as well as the meta-analysis of Beine and Jeusette (2018).

consequences. Unable to surmount migration barriers, both financially and policy driven, they are thereby rendered doubly disadvantaged. Since the publication of the Foresight Report, numerous studies have reinforced its original arguments in a variety of contexts.[3]

Individuals and households unable to migrate internationally have little choice but to adapt, i.e. to become more climate resilient as defined in Carling (2002). Since migration costs in the absence of crossing an international border are considerably lower, however, one household adaptation strategy is for a family member to migrate internally. In many large developing countries, where climatic conditions are spatially heterogenous, this option likely remains attractive.[4] Alternatively, households and firms may implement adaptation strategies to better cope with adverse climatic shocks, the clearest evidence of which can be found in the agricultural sector. As detailed by Fankhauser (2017), farmers may respond by moving into non-farm activities (e.g. Kazianga and Udry (2006)). Mueller et al. (2020) find evidence that abor market participation rates decline in urban areas following weather fluctuations, in turn resulting in less rural-urban migration. These observations contribute to our understanding of relatively lower observed internal migration rates and contrast against the traditional narrative of a rural-urban migration in response to adverse climatic conditions.

Voicing likely represents one of the few available responses to adverse climatic conditions in many countries. This is most likely the case in some low- and middle-income countries characterised by: comparably homogeneous climatic conditions, few alternative economic adjustment mechanisms, restrictions on international mobility and geographical remoteness. Small Pacific islands threatened by sea level rises represent clear examples. Noy (2017) details the specific case of Tuvalu and argues that the preferred response to climate change of the residents and the Government of Tuvalu is to voice. This voicing is aimed to establish a claim for adaptation or compensation for any losses from those countries that have contributed most to climatic change; or those they perceive as responsible for their predicament.[5]

Building on Hirschman's treatise on Exit, Voice and Loyalty (Hirschman 1970), we proffer a complimentary explanation for the observed absence of large-scale international emigration, namely through the mechanism of voicing about climatic change. We subsequently test the potential substitution between voicing about climatic change and emigration, using cross-country panel data comprising the countries most exposed to climate change. Our voicing data is derived from press reports drawn from the online global news *Factiva* database. To alleviate concerns of endogeneity, we instrument the emigration rate, with instruments that capture the expected foreign income of origin country emigrants, in tandem with the degree to which origin countries are subject to restrictive emigration policies imposed on them by the rest of the world. Our fixed-effects panel models and our IV results suggest a causal and negative relationship between voicing and emigration, which holds across a broad range of specifications.

[3] See among others Black et al. (2011), Black et al. (2013), Penning-Rowsell et al. (2013), Adger et al. (2015), Gray and Wise (2016), Cattaneo and Peri (2016) and Nawrotzki and DeWaard (2018). Interested readers are also directed to Ayeb-Karlsson et al. (2018) for a discursive review of the literature on 'trapped populations'.

[4] See for instance (Dallmann and Millock 2017) or Mastrorillo et al. (2016) for recent evidence in India and South Africa.

[5] In the specific case of Tuvalu, the most important adaptation 'funding' they can receive is a change in the international maritime law, which will allow them to retain possession of their exclusive economic zone around their islands even if these disappear or are abandoned. For another example of this voicing from the Pacific Island atoll nations, see CANCC (2016).

Our paper nestles at the intersection of three distinct literatures. First, is the literature that examines the direct and indirect links between climate change and international migration and the mechanisms that underpin the climate change-migration nexus.[6] We contribute to this literature by documenting a new channel through which immobile populations respond to adverse climatic conditions, namely through voicing about climate change, in lieu of emigrating.

The second strand of literature the paper speaks to is that of climate change adaptation and/or mitigation.[7] This literature tends to challenge the traditional view of a direct relationship between climate change and mobility. Accordingly, mobility, especially when it involves crossing international borders, is often deemed the solution of last resort. We contribute to this literature by documenting voicing activity against climate change as an alternative adaptation mechanism for individuals and authorities in vulnerable countries.

Our paper also speaks to the literature devoted to voicing and emigration in alternative settings. Docquier et al. (2016), for example show that the interaction between voicing and emigration is important for individuals from countries with weak economic and political institutions. In that context, emigration promotes democracy, while the interaction between exiting through emigration and voicing against the domestic regime helps rationalise the positive association between exiting and voicing that those authors document. More recently, Karadja and Prawitz (2019) examine the role of exit and voice in the context of historical mass migration from Sweden to the USA and find causal evidence that out-migration resulted in stronger demand for political change, better political organization, increased bargaining power with respect to local elites and ultimately to more inclusive political institutions resulting in more redistribution and inclusivity. Other related papers include (Spilimbergo 2009), which documents the links between student migration and the spread of democracy, Batista and Vicente (2011), who document the links between accountability and emigration in the context of Cape Verde, Chauvet and Mercier (2014) that highlights the links between return migration and participation rates and electoral competitiveness in Mali, and Barsbai et al. (2017) which documents the links between emigration from Moldova and votes for and against the local Communist Party.[8]

The paper is organized as follows. Section 2 presents the case for voicing as a potential adaptation mechanism for climate change. Section 3 introduces the data we use in our empirical assessment. Sections 4 and 5 describe our estimation strategy and our findings, respectively. In Section 6, we conclude with some policy implications.

2 Voicing as a mitigation or adaptation mechanism

Black et al. (2011) developed a framework for understanding environmentally induced migration, or its absence (the trapped population phenomenon). In their framework, a

[6]This literature is growing rapidly, resulting in more than 100 papers on the subject. Interested readers are directed to the surveys of Berlemann and Steinhardt (2017), Millock (2015) and Piguet et al. (2011).

[7]See among others the papers quoted before, Fankhauser (2017) and Mueller et al. (2020) among others. Bennonier et al. (2019) looks for instance at the adaptation effect of irrigation on the mobility adjustment mechanism. They show that access to irrigation can ameliorate the adverse effects of temperature on agricultural productivity. In turn, this might alleviate the negative impact of temperatures on emigration in low income countries, an effect that had been documented by Cattaneo and Peri (2016).

[8]For a recent literature review on the subject, readers are referred to Baudassé et al. (2018). Our paper contributes to the voicing literature by showing that the exit-voice trade-off contributes to the understanding of the climate-migration nexus.

decision to migrate is a function of macro considerations (such as the environmental conditions in the country of origin), micro considerations (such as the social identity and ties of the prospective migrant, and her specific exposure to environmental stressors) and a set of prevailing circumstances (such as legal, logistical or financial barriers to migration). Climate change can affect all three groups of considerations—macro, micro and circumstantial. Kaczan (2020) develop an analogous framework, differentiating between a household's capability to migrate (which may be very limited) and a household's vulnerability to staying put (which depends on the extent of its exposure to climatic change, among other things). In either case, and following (Hirschman 1970), the ability and willingness to voice is an intermediating phenomenon that affects the dichotomous choice as to whether to migrate or stay. We focus on this choice and examine the conditions that affect it.

Hirschman asks when the Exit option would prevail over the Voice option and when the choice could be reversed. Since international migration is costly, in a formal model (in the Appendix to this paper), we propose a modification to the basic choice framework, according to which the choice is sequential: whether to migrate or stay, and if migration is not possible, since it is too costly (when costs are broadly conceived), whether agents subsequently choose whether to voice or not. Of course, even in this sequential choice, whether people choose to migrate still depends on their ability to voice and on their perceptions regarding the efficacy of voicing. A voicing strategy can be chosen not only by individuals, but also by governments, as they represent these individuals interests and wants.[9]

In Hirschman's analysis, voicing is costly, as it can potentially lead to adverse social or political repercussions. This is less relevant in the case of voicing 'against climate change', especially when considering that significant voicing is directed, even if indirectly via the government, to the international community (the potential source of most compensation). But who voices and whether they have the cachet to have influence over any decisions clearly matters. In this case, it seems plausible to hypothesize that there is a clear correlation between the degree to which countries are exposed to climate change and their ability to generate a response to their voicing. The small atoll island countries (especially the largest one, the Maldives) have actually been quite successful in influencing the international conversation through voicing. The insertion of the aspirational 1.5 degrees as a safety 'guardrail' target for warming into the Paris Agreement and the follow-up IPCC report on 1.5 degrees (IPCC 2018) were both partially a result of the voicing efforts of the Alliance of Small Island States (AOSIS).

Overall, voicing should be viewed as a vital component of the menu of actions that people and governments can undertake when faced with the threats posed by climate change. These actors use voicing in the hope of increasing prevention and mitigation efforts (e.g. by the imposition of higher carbon taxes or emission trading schemes), increasing the amount of support available for adaptation and even receiving more compensation for loss and damage that has already been incurred (e.g. through the Warsaw International Mechanism for Loss and Damage).

In principle, the decision to emigrate lies mostly at the individual level (though governments also have some influence over the circumstances guiding that choice). The decision to voice can either be taken individually, or by governments. This distinction between the emigrating entity (the individual) and the voicing entity (the individual or the government) is not as important as it might first appear. Ultimately, much of a government's voicing

[9] This is true even in countries without representative democratic regimes. Even in autocracies, the government is responsive to its citizens, though maybe to a more limited extent.

activity in the international arena is conditioned by its perception of the impact of climate change on its citizens, their actions, and their wants.

Recent analyses have documented the increasing presence of green parties in the political sphere as a direct response to voters' interests (e.g. Grant and Tilley (2019)). The emergence of these green parties further shifts the entire political system toward a more 'environmentally friendly' policy position,; even in places where 'green' parties represent niche political interests (e.g. Abou-Chadi (2016)).

In our formal model (as detailed in the Appendix), our assumption is that voicing only occurs in emigrants' origins (where climate change is felt and from which emigration might ensue). This is implicitly also our assumption for our data collection since we restrict our measures of voicing activity to domestic voicing (as opposed to emigrants voicing at destination). In doing so, we implicitly strengthen the analogy between individuals' and government voicing. While it would be possible to assume that voicing is simply less effective from abroad, as opposed to impossible, this would not substantively change any of our fundamental arguments. Diasporas rarely voice concerns about climate change at their origins. This is largely true, for example for Pacific Island communities living in Australia, New Zealand, and the USA.

In our framework, effective voicing ameliorates adverse income shocks. It does so through the various mitigation and compensation mechanisms we detail, which constitutes the main motivation for individuals to voice. The primary motivations to migrate are higher destination-country incomes and the absence of climate risks (else reduced climate-change risk). Formally, for given migration costs and destination country incomes, movers will be those most affected by the climatic shocks. An increase in migration costs or similarly a decrease in the attractiveness of destinations results in less emigration.

Some of those who may have had an incentive to migrate will no longer move. By reducing the expected loss of income from the climate shock, voicing increases the threshold over which people have an incentive to emigrate. Voicing therefore results in a decrease in the total adverse effect of the climatic shock on global emigration, thereby highlighting the trade-offs that exist between voicing and emigration.

Voicing increases, along both the extensive and the intensive margins, when emigration is infeasible or undesirable any reason (distance, costs, etc.). Along the extensive margin, the number of individuals who stay and voice increases. Those who stay, while they would perhaps have emigrated in the absence of being able to voice, increase voicing efforts as the benefit from the activity increases, or when the costs of not doing so increase.

There are other ways in which we might consider what the impact of evolving circumstances on the migration choices made will be. For example, if an effective collective action that manages to keep global warming within the 1.5°C target set in the Paris Agreement proves beyond the world's political capacities, as almost everyone predicts, this may change the dynamics of the choice between voice and emigration. There are several channels through which this nexus could be affected.

When residents of climate-change-vulnerable countries decide that voicing is no longer a viable option to avert climate change or receive timely compensation, migration becomes a more attractive alternative. In this view, migration is a 'last resort' so the flow of migrating climate 'refugees' that until now have not materialized, will start to increase irrespective of existing legal barriers.

In contrast, if the monetary or non-monetary costs of migration start to decrease, for example with the UN recognizing 'climate refugee' status and its associated entitlements, then voicing 'against climate change' may, ironically, decrease. On the other hand, equally plausible is a hardening of views against, for example the granting of ‘climate-refugee status’. This may increase the likelihood and intensity of future voicing and even to an increased potency to that voicing.

There are also potential distributional considerations tied to this interplay between voicing and emigration. Although not explicitly investigated here, it is usually those in the upper echelons of society that are able to migrate and so too is it likely that this group will voice more effectively. Hirschman (1978) discusses these kinds of dynamics with an examination of the tensions not only between private and public schooling in many American cities but also in relation to citizens and their governments. According to his portrayal of the schooling decision, the flight of more educated elites to suburbia, resulted in dynamics in which the quality of education deteriorated. This occurred since those that moved were also those that had the ability to advocate for stronger public actions. These dynamics thus lead to a ‘voice drain’ that is analogous to the brain-drain that afflicts many lower income countries. If elites migrate, the voicing from vulnerable countries may be lost, as the disadvantaged and trapped communities that remain are less likely to have their concerns heard.

Our overarching arguments, (as formalised in our theoretical model in the Appendix), result in two testable propositions. First, voicing about climate change should be positively correlated with countries’ exposure to climate change. Secondly, a trade-off should exist between emigration and voicing, since voicing should be indicative of both higher exposure to adverse climatic shocks and greater observed levels of immobility. In the next section, we develop an empirical strategy to test these propositions using original data on voicing and climate change exposure.

3 Data

To empirically examine the relationship between voicing, emigration and exposure to climate change, we estimate a voicing (*about climate change*) function for a sample of developing countries that have been identified as being most affected by adverse climatic conditions:

$$V_{it} = \alpha + \alpha_t + \beta m_{it} + \gamma' C_{it} + \lambda' X_{it} + u_{it} \tag{1}$$

where V_{it} is a measure of voicing intensity, either internally or internationally, in country i at time t. m_{it} is the emigration rate of country i to the rest of the world. C_{it} is a vector of various measures, which capture exposure to adverse climatic shocks (i.e. natural disasters, sea level rises and temperatures). X_{it} is a vector of voicing controls. α_t are time fixed effects. This equation is estimated on a panel of 87 selected countries, from 2000 to 2015, at 5-year intervals.

While we could consider including origin country fixed-effects in our specification, doing so necessarily removes much of the variation from our measures of slow-onset climate change, which change little over time. In other words, much of our identifying variation in voicing is between countries as opposed to within countries over time.[10] We therefore decided against expanding our sample to either include countries that are not currently subject to significant adverse effects of climatic change, else to include data going further back in time that we deem too unreliable, both of which would serve to strengthen our results; we rather address this potential source of omitted variable bias, in three ways. First, we

[10]Notably, though, our non-instrumented results are robust to the inclusion of country fixed effects.

control for some key country characteristics in our benchmark specifications, which origin fixed effects would otherwise capture, for example origin country income and an island dummy variable. Secondly, we implement an instrumental variable strategy (please see below) in which our exogenous identifying variation in our instruments, derived from *destination* country characteristics, must necessarily be orthogonal to any omitted variable in the origin time (i.e. origin country fixed effect) dimension. Finally, all estimation results are robust to dynamic specifications, i.e. to the inclusion of one-period lagged values of voicing measures.[11] Such an approach has often been proposed when the cross-sectional variation clearly dominates the time variation as in our context.

Our choice of countries is based on the Climate Change Vulnerability Index.[12] This composite index uses several dimensions to measure climate change and is widely used by organisations to identify areas of risk associated with the climate. We use the latest version from 2011 and rank countries based on the mean index, provided the mean involves at least two sub-indexes. Appendix A provides further details. We include the 100 most exposed countries in our sample according to this index. To that list we append a set of small island developing countries that do not feature in the database, or for which there is only one sub-index due to their small size. A large number of these countries are obviously highly exposed to climate change, especially to sea level rises.[13] Due to data availability constraints, our final sample comprises 87 countries that are currently the most exposed to the direct and indirect adverse effect of climate change.

The Appendix provides the list of countries included in our analysis. Before discussing econometric issues relative to the estimation of Eq. 1, we present the data used to measure V_{it}, X_{it}, m_{it} and C_{it}.

3.1 Voicing

We capture the extensive and intensive margins of voicing about climate change using press reports retrieved from the Dow Jones *Factiva* Online database. The database comprises approximately 36,000 primary sources from 200 countries including newspapers, journals, magazines, television and radio transcripts, 74% of which are gated. Material is searchable by publication, *language* and date. Importantly for our purposes, the *Factiva* database can be used to provide both local and global insights on the same issues, such that we can use the information contained therein to distinguish between internal and international voicing.[14] Press reports on voicing are identified using a set of keywords associated with climate change or climatic shocks. Any press report containing one or more of those key words or phrases is flagged. Each press report is then filtered in order to attribute each act of voicing to specific actors, individuals or governments, an approach that also serves to avoid double counting.

[11] The results of these dynamic estimations are not reported for the sake of brevity but are available upon request to the authors.

[12] This index has been computed by the firm Maplecroft and the variables on which it is based do not change much over short horizons. See https://maplecroft.com/about/news/ccvi.html.

[13] These countries are: Cape Verde, Comoros, Dominica, Fiji, Grenada, Jamaica, Kiribati, Maldives, Marshall Islands, Mauritius, Micronesia Fed. States, Nauru, Palau, Samoa, Sao Tome and Principe, Seychelles, Solomon Islands, Timor Leste, Tonga, Tuvalu and Vanuatu.

[14] Given the fact that *Factiva* relies not only on a select set of newspapers but also other sources like information agencies, an article published in a local newspaper is likely to be captured through referencing by other sources.

Searches for press reports in the *Factiva* database are conducted in three international languages: English, French and Spanish.[15] In each language, we search for the same combination of keywords associated with climate change (with only minor adjustments made to account for the specificities of each language). Appendix A provides an example of the code used to retrieve press reports from *Factiva* in the case of Bangladesh. Press reports are retrieved for each year from 1995 to 2015. Data are then aggregated over 5-year periods. Since these data are based on historical internet data, the quality of the reports and the efficiency of tracking them increases over time. In particular, the reports after 2000 tend to be far more precise and less subject to spurious reporting (see Table 1). In order to avoid capturing news that are not related to voicing or lobbying against climate change, each selected news is subject to a manual filtering procedure. If the news is for instance simply a report mentioning general features about climate change, the news is not selected. The procedure also allows to adjust for duplicated instances of of the same news event being reported. This measure of voicing we term the 'filtered measure', as opposed to an unfiltered or aggregate approach. Across all countries in our sample period, we obtain respectively 3628 unfiltered articles and 2931 filtered ones. Our filtering procedure therefore discards approximately 20% of the news articles originally selected by *Factiva*. All subsequent regressions results are based on the filtered measures of voicing throughout the paper.

We recognise that alternatives to *Factiva* are available (e.g. *Lexis Nexus* and *Thomson One*), although we have no reason to believe alternatives will yield differing or superior material. *Factiva* was chosen for several reasons. First, the use of *Factiva* is easy and transparent, especially in relation to honing our various searches. While we could have expanded our search in terms of the number of languages we rely upon, without knowledge of all specific differences of additional languages in relation to the three we rely upon, such an approach could have introduced additional bias when comparing reports from across languages. In the absence of news reports in other languages, however, we recognise that our results serve as lower bounds.[16]

A second advantage over alternative databases, is the minimisation of bias due to language or due to limited coverage. Indeed, as emphasized by Öberg and Sollenberg (2011), most alternative databases do not include local news sources, either because of language barriers, or because they are not distributed internationally. Large databases such as *Factiva* and *LexisNexis* include news items from news organisations and news agencies around the world, which ensures an expansive coverage. Notably, *LexisNexis* has a superior coverage in terms of legal documentation, but is less comprehensive in terms of newspaper coverage. The emphasis of *LexisNexis* is also on the English language as opposed to *Factiva* that has a far broader multilingual coverage. *Factiva* further includes both the transcripts of local radio and TV broadcasts in addition to press and internet reports provided by the BBC Monitoring Service for more than 100 languages. These transcripts are available in English, ensuring that our search strategy does not yield biased estimates of voicing, even in countries speaking a language other than English, French or Spanish.[17] In short, the variety of sources included in *Factiva*, as well as the translation in English from a very large number of languages make us confident that the estimation of voicing activity is not biased significantly in favour of certain languages or countries.

[15] In our samples, out of the 87 countries, 15 (resp. 19) have Spanish (resp. French) as their official language.

[16] Google Trends is unsuitable for our purposes due to the patchy coverage in developing countries.

[17] The Appendix provides an example of news retrieved from foreign newspapers written in another language than English (the most widespread language in Bangladesh).

Table 1 Voicing about climate change: descriptive statistics

	All years	2000	2005	2010	2015
Total voicing about climate change (filtered)	3.80	0.28	0.63	8.63	5.65
	(14.47)	(0.90)	(2.10)	(25.83)	(11.08)
Official	2.71	0.275	0.551	7.76	4.89
	(0.465)	(0.84)	(1.95)	(24.01)	(10.14)
Domestic	2.45	0.241	0.517	6.62	4.80
	(9.99)	(0.82)	(1.95)	(19.37)	(9.21)

Average value by country and period. Standard error in parentheses

We also distinguish between two main types of voicing. First, we capture domestic or internal Voicing, voicing from residents about climatic change to their governments, else voicing from NGOs located in affected countries. Second, we capture Official or International Voicing, voicing by governments to the rest of the world. The Appendix details the key word searches relied upon and the samples of reports retrieved by *Factiva* for each type of voicing.

Ultimately, post filtering, our voicing measure captures the number of unique press reports of each type and country over 5-year periods. Aggregating both measures of voicing, we obtain our overall filtered measure of voicing intensity, in country i at time t. Table 1 reports the average value by period for the three categories.[18]

3.2 Emigration

The emigration rates for all countries in our sample are calculated using the estimates of total emigrants and total populations, at 5-year intervals, provided by the United Nations' Population Division.[19] Emigration rates are calculated as:

$$m_{it} = \frac{Emig_{it}}{Emig_{it} + Pop_{it}} \tag{2}$$

such that the emigration rates are bounded between 0 and 1. Our emigration rates are therefore calculated using official data of long-run stocks, as opposed to short-run flows, for two reasons. First, it is unclear over what time horizon agents might respond to the onset of climate change through migrating. Second, no comprehensive dataset exists of observable migration flows. The existing datasets rather focus on the countries of the OECD as destinations.[20] If instead we were to rely on such a restricted database, we would therefore omit many important destination countries, especially given our sample of origin countries who will likely send a large proportion of emigrants to developing countries (the so-called South-South mobility phenomenon). As a robustness check, we conduct our analysis on a dataset of *imputed* flow data (see Section 4.4).

Emigration rates vary significantly across the countries in our sample. These reflect a variety of determinants including country size (internal alternative option), preferences for

[18] Note that a given press report can be classified at the same time as a report on Official and Domestic voicing. This explains why the average filtered voicing reports are not the sum of Official and Domestic voicing reports.

[19] See: https://www.un.org/en/development/desa/population/migration/data/estimates2/estimates15.asp.

[20] See, for example the DEMIG C2C dataset: https://www.imi-n.org/data/demig-data/demig-c2c-data.

remaining sedentary, income at origin, natural emigration costs such as isolation, and policy and emigration costs. Appendix Figure B4 depicts the variation in emigration rates of countries in our sample.

3.3 Exposure to climate change

We rely upon three different measures of exposure to climate change. Our first, captures fast-onset change as captured by natural disasters. The remaining two measures capture slow-onset exposure to climate change as measured by sea level rises and warming temperatures.

Disasters We capture exposure to rapid-onset weather events using a recent version of the EMDAT database using a count variable for the number of events recorded in the database. EMDAT is the only available database of disasters associated with natural hazards with a global coverage. Data in EMDAT have been collected for disasters going back many decades, but is widely perceived to be reliable from the early to mid-1990s. It has been used in many research projects examining various aspects of disasters, and is also used by the international multilateral organisations (e.g. World Bank) when they assess disaster risk.

We implement a particular measure of disasters that captures the average proportion of people affected by natural disasters (of meteoroligical, hydrological and climatological origin). This variable captures the magnitude of the consequences of such events allowing us to better capture populations' exposure risk as when compared to say an alternative measure that might otherwise capture the raw number of disasters over a particular period. Strictly speaking, this measure does not control for the impact of climate change on sudden-onset extreme weather events. While there is substantial evidence to suggest that one can associate the impact of these events with climate change (Frame et al. 2020b; Frame et al. 2020a), we are unable to derive commensurate measures for a large group of countries. Figure B3 in the Online Appendix maps these extreme weather events for the countries in our sample for the year 2015.

Sea level rises Sea levels rises are often considered one of the most detrimental consequences of climate change, especially in relation to climate-induced migration. Projections of sea level rises are particularly apposite for small island nations, some of which are already experiencing significant challenges. Tuvalu and Kiribati, both atoll nations, may completely disappear underwater in the coming decades. Populations located near to the coast are particularly exposed to such risks.

To capture exposure risk to sea level rise, we compute the share of the nations' populations that live in the Low Elevation Coastal Zone (LECZ), using data from the SEDAC Center from NASA's Earth Observing System. These data provide estimates of urban and rural populations (as well as land areas) for 202 countries at three junctures (1990, 2000, 2010) in contiguous coastal elevation levels. LECZ's are defined using elevations ranging from 1 to 20 metres above sea level. We employ a variable that pertains to an elevation of 1 metre above sea level.[21] We interpolate the data for the years 1995 and 2005. For 2015, we replicate the value observed in 2010.

[21] See: www.sediac.ciesin.columbia.edu/data/set/lecz-urban-rural-population-land-area-estimates-v2. This measure has been used, for example by Burznski et al. (2019) to compute the share of the population that would be forced to leave under several scenarios of sea level rise in a quantitative model, which predicts the total displacement of populations affected by climate change. We are grateful to Michal Burzynski for providing access to these data.

Our measure of exposure to sea level rises reveals important heterogeneity across countries. The distribution of the share of populations at risk is highly skewed. Over the period 1995–2015, the mean proportion of exposed populations is 1.46% (standard deviation equal to 3.44%), with a median equal to 0.28%. The 10th, 20th, 30th, 40th, 50th, 60th, 70th, 80th and 90th percentiles are respectively equal to 0, 0, 0.08, 0.18, 0,28, 0.50, 0.87, 1.46 and 3.83%. The maximum proportion of people leaving in a coastal zone under 1 metre above sea level is 20.26% in the case of Tuvalu.

Warming For temperature data, we use the World Bank's Climate Data API, which provides access to historical temperature data at the country level. These data are based on gridded climatologies from their Climate Research Unit, averaged over the grid cells in each country. The data are extrapolated estimates for temperature, as only some parts of the world have continuous and reliable measurements of temperature over the whole of the past century. Modelling has been used to extrapolate estimates where weather-station data were unavailable else unreliable. We use the 5-year (weighted) average temperature for each country and its deviation from its long-term mean.[22]

3.4 Additional controls and instruments

We control for additional covariates of voicing X_{it} in Eq. 1. We first control for population size, using population data from the United Nations. We also control for freedom of speech. This is captured by the Freedom of the Press Index which is drawn from an annual survey conducted by the Freedom house. This index is composed of sub-indices, which capture freedom of printing and broadcasting and includes values ranging from 0 (free press) to 100 (no press freedom). This covariate should account for voicing restrictions imposed by authoritarian governments. In particular, we expect it to explain part of the domestic/internal component of voicing.

Given that press articles are retrieved in three international languages, we account for the official language used in the country. The reference level is English and we capture the fact that the official languages can be either French (19 countries in our sample) or Spanish (16 countries in our sample) to account for the fact that these languages are less international and can potentially lead to fewer press reports in the *Factiva* database.

In our theoretical model detailed in the Appendix, we simply consider the trade-off between internal voicing and international emigration. Nevertheless, in reality, internal migration generates a third option to cope with the consequences of climate change. While, for many small islands, this option is of little value, moving to another area is often a viable solution in other developing countries. Unfortunately, there is no direct measure of internal mobility comparable across countries and over time. Following the earlier literature, we proxy the possibility of internal migration by the change in urbanization rate in each country.[23]

Finally, to account for unobserved heterogeneity in the panel of countries and as an alternative to the inclusion of country fixed effects, we introduce income dummies based on the World Bank Classification of countries. Countries are ranked in four different groups: low

[22] More details are available at: https://datahelpdesk.worldbank.org/knowledgebase/articles/902061-climate-data-api.

[23] This proxy has been used especially in samples involving developing countries for which internal migration data are often unavailable. See for instance (Barrios et al. 2006).

income (22 countries), lower middle income (32 countries), upper middle income (28 countries) and high income (5 countries). We also include a dummy, which captures if a country is an island.

4 Empirical strategy

Count data model Our dependent variable, our measure of voicing, captures the number of press reports concerning climate change in each origin country over 5-year periods; which is therefore suited to count data models. As emphasized by Cameron and Trivedi (2013), OLS is clearly inappropriate in this context since the OLS estimator specifies a conditional mean function that can take negative values. Exponential regression models are better suited to the nonnegative and integer-values of our voicing variable. Model Eq. 1 is therefore estimated by maximum likelihood estimation using the Poisson Pseudo Maximum Likelihood (PPML) estimator.

Endogeneity Unbiased estimation of specification Eq. 1 is likely to be confounded by endogeneity. There are two major sources of threats to identificaiton. First, as suggested by the model in the Online Appendix, specification Eq. 1 is the result of a two-equation system, according to which exogenous variations in emigration (voicing) will subsequently influence voicing (emigration). Reverse causality is therefore a natural ingredient of the empirical analysis and has to be accounted for. This issue is tackled through employing instrumental variable estimation.[24]

Secondly, beyond reverse causality, it is possible that a correlation exists between emigration and an unobserved determinant of voicing. While our specification comprises a rich set of measures capturing exposure to climate change, one could proffer candidates of some unobserved climatic condition at origin, which could potentially result in both increased emigration and voicing (about climate change) concurrently, thereby inducing a correlation between the error term of Eq. 1 and our emigration variable. In this case, the bias in the estimation of γ would be positive, biasing our results toward a complementarity between emigration and voicing, in other words diametrically opposed to our hypothesis. All in all, these various sources of endogeneity means that the direction of the bias in the estimation of the interaction between voicing and emigration and therefore the adjustment in the IV procedure are unknown beforehand.

We therefore adopt an instrumental variable approach, exploiting exogenous variations in emigration rates, which are uncorrelated with climatic conditions at origin. Our theoretical framework provides a useful guide in that respect: variations in y_m and c_m in Eq. 1 directly impact the emigration rate, but since they are destination specific, will be uncorrelated with climatic conditions at origin. Our first instrument mimics y_m in Section 3 and is the income earned abroad of emigrants of country i weighted by the proportion of each origin country's diaspora in country i. Data on GDP per capita were obtained from the World Bank Development Indicators. Our approach captures the idea that higher incomes at destination likely prove valuable to potential emigrants either on immediately on arrival, else prior to emigrating by reducing the migration costs of prospective emigrants.

The second instrument is based on variations in migration costs c_m, as captured by immigration policy restrictions imposed on origin countries by migrant destinations. We

[24]Related to that point, our IV estimations can be regarded as the estimation of the underlying 2-equation system of Section 3, with exogenous variations in the emigration rates.

construct a general index of visa restrictions faced by residents of country i and imposed by all other countries worldwide. The index is constructed using data on bilateral visa restrictions collected by the Determinants of Migration (DEMIG) project, which capture the existence or absence of visa requirements for people traveling between all countries worldwide, on an annual basis.[25] Our instrument is computed as the proportion of visa requirements faced by each origin country with respect to all the other countries of the world, over each 5-year period.[26]

An Appendix figure maps the proportion of visas restrictions for each origin country for the year 2013. Unsurprisingly, developing countries are subject to far greater restrictions when compared to developed nations.[27]

The control function approach is used to estimate Eq. 1, allowing us to combine a Poisson approach with instrumentation. The control function approach usefully provides information on the first stage and the respective contributions of the two instruments to the prediction of emigration rates. To the best of our knowledge, there are no corresponding statistics to the F-stat in the linear case, the coefficients and their significance of the two instruments in the first stage allow to assess whether these exogenous variations generate some predictive power of emigration rates. Finally, as a complementary strategy, we also use one-period lagged emigration rates (5-year lagged rates). We also combine this lagging procedure with the IV approach described above.

5 Results

5.1 Total voicing

Tables 2 and 3 report the results for total voicing. Table 2 reports the results obtained with PPML and use contemporaneous emigration. Table 3 includes the results obtained with our IV strategy. Appendix tables report comparable results to Tables 2–3 but with one-period lagged emigration rates to further ameliorate the possible remaining concern of reverse causality.

Voicing activity is related to climate change exposure. In particular, exposure to natural disasters and to sea level rises results in more voicing. The evidence is much less clear in regards to the absolute level of temperature. This is not totally surprising given the uncertainty around the ability of this measure to capture slow onset climatic change.[28] In contrast,

[25] The visa restrictions have been collected by the DEMIG project at Oxford University. They are drawn manually from the International Air Transport Association manuals capturing each year the bilateral requirements in terms of tourist visas within any pair of countries in the World. The data span the period 1995–2013. These data have been recently used by Czaika and de Haas (2017) and Czaika and Neumayer (2017). An earlier version of the data specific to the year 2004 has been also used by Neumayer (2006) and (Bertoli and Fernández-Huertas Moraga 2015) among others. Since the original data are annual, we average the restrictions over 5 years. For the last sub-period (2010–2015), we assume no changes between 2013 and 2015.

[26] Given missing data, this index computes the proportion of visa requirements with respect to all destinations for which data are available. In other terms, the proportion is adjusted for missing data and we treat missing data agnostically.

[27] As an illustration, in 2013, about 40% of all destinations request a visa for people from Luxembourg to be admitted. This proportion was more than double for countries like Tuvalu (78%) and Kiribati (81%).

[28] The literature typically lacks some clear agreement about how to capture slow onset climatic change, such as gradual warming.

Table 2 Total voicing, climate and emigration: benchmark estimations

Dependent variable: total voicing about climate	(1)	(2)	(3)	(4)	(5)	(6)
Emigration	–5.301***	–4.892***	–4.856***	–5.148***	–5.295***	–5.404***
	(1.448)	(1.168)	(1.120)	(1.239)	(1.218)	(1.219)
Nat. disasters	1.653***	1.617***	1.610***	1.254**	1.356**	1.377**
	(0.465)	(0.477)	(0.471)	(0.493)	(0.417)	(0.422)
Sea level rise	0.080***	0.082***	0.081***	0.086***	0.048**	0.049**
	(0.013)	(0.013)	(0.013)	(0.013)	(0.020)	(0.020)
Temp	0.022	0.026**	0.026**	–	0.029	0.028
	(0.017)	(0.012)	(0.012)		(0.019)	(0.019)
Population	0.0023***	0.0023***	0.0023***	0.0021***	0.0021***	0.0022***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0002)	(0.0002)
Freedom	–0.002	–	–	–	0.001	0.001
	(0.005)				(0.005)	(0.005)
French	–0.992***	–0.992***	–1.000***	–0.996***	–0.808***	–0.813***
	(0.230)	(0.235)	(0.224)	(0.236)	(0.220)	(0.218)
Spanish	0.046	0.040	–	–	–0.276	–0.296
	(0.258)	(0.259)			(0.309)	(0.311)
Island	–	–	–	–	0.239	0.228
					(0.248)	(0.247)
Intern. mobility	–	–	–	–	–	–0.020
						(0.050)
Constant	0.899	0.691*	0.702*	1.387***	–0.829	–0.750
	(0.769)	(0.392)	(0.381)	(0.175)	(0.798)	(0.800)
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Income dummies	No	No	No	No	Yes	Yes
Observations	344	346	346	348	344	344
Number of countries	87	87	87	87	87	87
Pseudo–R^2	0.893	0.893	0.893	0.870	0.899	0.900

PPML estimation. Estimation period: 2000–2015

In column (5), regional dummies are based on the World Bank classification

Robust standard errors in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

the two other variables provide more straightforward measures of climatic conditions that are more easily observed.

Secondly, we find consistent evidence of a trade-off between emigration and voicing. Lower emigration rates, resulting in greater numbers remaining at origin leads to more voicing against adverse climatic conditions. Our PPML estimates imply that a 1% decrease in the total emigration rate leads to an increase of about five voicing events, reflecting concerns about climate change in a period of 5 years. This result is stable across specifications, including one with income dummies that capture differing levels of economic development across countries and to a set of controls including possibilities of internal mobility.

Table 3 Total voicing, climate and emigration: PPML IV estimations

Dependent variable: total voicing about climate	(1)		(2)		(3)		(4)		(5)		(6)	
	(1st)	(IV)	(1st)	(IV)	(1st St)	(IV)	(1st St)	(IV)	(1st St)	(IV)	(1st St)	(IV)
Emigration		–26.42**		–28.46**	–	–11.87**	–	–12.02**	–	–7.49*	–	–19.38**
		(11.05)		(12.25)		(5.13)		(4.894)		(4.064)		(7.827)
Nat. disasters	–0.024	0.492	–0.042*	0.331	–0.034	1.603**	–0.039	1.624**	–0.040	1.739***	–0.040*	0.754
	(0.023)	(0.937)	(0.023)	(0.992)	(0.024)	(0.672)	(0.025)	(0.660)	(0.025)	(0.657)	(0.025)	(0.896)
Sea level rise	–0.001	0.097	0.001	0.107*	0.0021	0.141***	0.0015	0.139***	0.003**	0.159***	0.0006	0.114**
	(0.001)	(0.057)	(0.002)	(0.060)	(0.0014)	(0.037)	(0.0014)	(0.034)	(0.001)	(0.032)	(0.001)	(0.045)
Temp	–0.0016***	–0.046	–0.0017***	–0.046	–0.0013**	–0.007	–	–	–	–	–	–
	(0.0005)	(0.035)	(0.0006)	(0.036)	(0.0005)	(0.026)						
Population	–0.0001***	0.0002	–0.0001***	0.0002	–0.0002***	0.0019***	–0.0002***	0.0019***	–0.0002***	0.0020***	–0.0002***	0.0018***
	(0.00005)	(0.001)	(0.00005)	(0.001)	(0.0000)	(0.0005)	(0.0000)	(0.0004)	(0.0000)	(0.0004)	(0.0000)	(0.0004)
Freedom	–0.0006***	–0.022*	–0.0008***	–0.023*	0.0011***	–0.017*	–0.0011***	–0.017*	–	–	–	–
	(0.0001)	(0.013)	(0.0002)	(0.014)	(0.0002)	(0.010)	(0.0002)	(0.009)				
French	–0.021**	–2.148***	–0.019**	–2.144***	–0.023***	–1.567***	–0.029***	–1.591***	–0.029***	–1.429***	–0.026***	–2.053***
	(0.007)	(0.383)	(0.008)	(0.392)	(0.007)	(0.415)	(0.007)	(0.419)	(0.010)	(0.429)	(0.007)	(0.363)
Spanish	–0.020	–1.135***	–0.010	–1.088***	–0.015	–0.808**	–0.017*	–0.818*	–0.022*	–0.802*	–0.018*	–1.072***
	(0.014)	(0.381)	(0.008)	(0.386)	(0.010)	(0.365)	(0.009)	(0.368)	(0.012)	(0.321)	(0.009)	(0.341)
Island	0.044***	2.392***	0.045***	2.448***	–	–	–	–	–	–	0.055***	2.115***
	(0.013)	(0.859)	(0.013)	(0.891)							(0.012)	(0.713)
Intern. mobility	–	–	–0.008***	–0.177	–	–	–	–	–	–	–	–
			(0.002)	(0.151)								

Table 3 (continued)

Dependent variable: total voicing about climate	(1)		(2)		(3)		(4)		(5)		(6)	
	(1st)	(IV)	(1st)	(IV)	(1st St)	(IV)	(1st St)	(IV)	(1st St)	(IV)	(1st St)	(IV)
Foreign income	0.187**	–	0.244**	–	0.359***	–	0.381***	–	0.430***	–	0.262***	–
	(0.094)		(0.108)		(0.092)		(0.094)		(0.092)		(0.107)	
Visa restrictions	–0.006	–	–0.053**	–	–0.054**	–	–0.043*	–	–0.128***	–	–0.101***	–
	(0.036)		(0.026)		(0.02)		(0.025)		(0.038)		(0.028)	
Constant	0.191***	5.446***	0.210***	6.083***	0.214***	3.32**	0.177***	2.717***	0.187***	1.817***	0.155***	2.666***
	(0.028)	(2.011)	(0.026)	(2.345)	(0.029)	(1.278)	(0.027)	(1.363)	(0.033)	(0.398)	(0.027)	(0.609)
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	344	344	344	344	344	344	346	346	348	348	348	348
Number of countries	87	87	87	87	87	87	87	87	87	87	87	87
Income dummies	Yes	Yes	No	No	No	No	No	No	No	No	No	No

PPML IV estimation, control function approach. Estimation period: 2000–2015

Instruments:average income abroad and proportion of destinations with visa restrictions

LHS column: first-stage estimation results. RHS column: PPML IV results

Robust standard errors in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The PPML IV estimates, however, are far larger in magnitude as when compared to our baseline results. The estimated number of press reports in response to a 1% decrease in the total emigration rate lies between 7 and 19.[29] This could imply that our baseline PPML regression estimates are significantly upward biased. The correction of the IV estimates towards more negative values of the impact of emigration, is in line with the omission in the voicing equations of a measure of climatic conditions that is positively (or negatively) correlated both with voicing and emigration. These results hold both with contemporaneous and lagged values of the emigration rate.

Our IV estimates suggest that (average) foreign income and visa restrictions are strong instruments. The first stage equations of Table 3 and its lagged-version show that both instruments have predictive power for emigration rates, and with the expected sign. Higher foreign income is associated with increased volumes of emigration, while visa restrictions conversely deter emigration.[30]

The estimated values for the coefficient of the controls are in line with the expected signs. Voicing is proportional to population. Voicing in French is significantly lower than voicing in English. This is less clear for Spanish, although the IV estimations support a negative effect of the Spanish language, too. Freedom of speech tends to affect positively voicing as evidenced by the IV regressions of Table 3 and the lagged-version. Internal mobility does not have a (direct) effect on voicing in any regression.

Domestic and international voicing Total voicing comprises two distinct categories: (i) Official or International voicing, i.e. voicing done by the local authorities of the country in question, and (ii) Domestic or Internal voicing, i.e. voicing done by residents or by private organisations such as NGOs or commercial entities. Tables 2 and 3 report the results regarding Official voicing while Tables 4 and 5 report the same information for domestic voicing. Voicing about climate change is also found to substitute for emigration, both by authorities and by residents adversely affected by climatic conditions. The degree of substitution of private voicing is found to be slightly higher than that of official voicing. In line with our expectations, private voicing depends on freedom of speech, while it is less the case for official voicing, at least in the benchmark estimations. Our results therefore demonstrate that even in authoritarian regimes, voicing by the authorities can be an option to offset the pressure from a low emigration rate.

5.2 Robustness: Alternative measure of emigration

For our benchmark results we computed emigration rates based on migration stock data provided by the United Nations Statistical Division, since these data are comprehensive and because of the uncertainty in the timing of any emigration response to climate change.

[29]Note that in the PPML IV estimations, income dummies are no longer significant such that they are omitted in the final specification (col. 5 of Table 3). In contrast, the island dummy becomes significant and is included in the final specification. Also an interesting feature of the PPML IV first stage regressions is the negative and highly significant coefficient of internal mobility. This suggests that our estimations capture the usual trade-off between internal mobility and international emigration.

[30]It should be emphasized that this relationship would likely be stronger in a larger sample of countries. Our selection of countries based on the climate change index lead to a sample of mostly developing countries. Most of our included countries are therefore subject to higher visa restrictions compared to developed countries. The coefficients of visa restriction in the first stage regressions of Table 3 are therefore estimated on a sample with limited variability along this dimension.

Table 4 Official voicing, climate and emigration: PPML IV estimations

Dependent variable: official voicing about climate	(Emigration)						(Lagged emigration)			
	(1)		(2)		(3)		(4)		(5)	
	(Emig)	(IV)	(Emig)	(IV)	(Emig)	(IV)	(L.Emig)	(IV)	(L.Emig)	(IV)
Emigration	–	–10.16*	–	–10.38**		–17.54**	–	–10.98*	–	–18.23**
		(5.553)		(5.270)		(8.537)		(5.706)		(9.034)
Nat. disasters	–0.034	1.680**	–0.039	1.682**	–0.048	0.800	–0.044*	1.565**	–0.053*	0.671
	(0.024)	(0.677)	(0.025)	(0.666)	(0.024)	(0.971)	(0.024)	(0.650)	(0.024)	(0.989)
Sea level rise	0.0021	0.149***	0.0015	0.145***	0.0015	0.124***	0.001	0.146***	0.0016	0.131***
	(0.0014)	(0.036)	(0.0014)	(0.033)	(0.0017)	(0.045)	(0.001)	(0.034)	(0.0016)	(0.045)
Temp	–0.0013**	–0.012	–	–	–	–	–	–	–	–
	(0.0005)	(0.028)								
Population	–0.0002***	0.0021***	–0.0002***	0.0021***	–0.0002***	0.0023***	–0.0002***	0.0020***	–0.0001***	0.0020***
	(0.0000)	(0.0005)	(0.0000)	(0.0004)	(0.0000)	(0.0005)	(0.0000)	(0.0004)	(0.0000)	(0.0005)
Freedom	–0.0011***	–0.016*	–0.0011***	–0.016*	–	–	–0.0009***	–0.016	–	–
	(0.0002)	(0.010)	(0.0002)	(0.010)			(0.0002)	(0.010)		
French	–0.023***	–1.509***	–0.028***	–1.535***	–0.024***	–1.950***	–0.023***	–1.518***	–0.019***	–1.908***
	(0.007)	(0.425)	(0.007)	(0.432)	(0.007)	(0.359)	(0.008)	(0.420)	(0.008)	(0.351)
Spanish	–0.015	–0.640*	–0.017*	–0.659*	–0.013*	–0.936*	–0.021**	–0.692*	–0.017**	–1.053***
	(0.010)	(0.367)	(0.009)	(0.371)	(0.008)	(0.349)	(0.009)	(0.376)	(0.008)	(0.358)
Island	–	–	–	–	0.052***	2.009***	–	–	0.043***	1.895***
					(0.012)	(0.725)			(0.012)	(0.679)

Table 4 (continued)

Dependent variable: official voicing about climate	(Emigration)						(Lagged emigration)			
	(1)		(2)		(3)		(4)		(5)	
	(Emig)	(IV)	(Emig)	(IV)	(Emig)	(IV)	(L.Emig)	(IV)	(L.Emig)	(IV)
Intern. mobility	–	–	–	–	0.009***	–0.125	–	–	0.008***	–0.133
					(0.002)	(0.124)			(0.002)	(0.122)
Foreign income	0.359***	–	0.381***	–	0.279***	–	0.357***	–	0.260**	–
	(0.092)		(0.094)		(0.111)		(0.091)		(0.107)	
Visa restrictions	–0.054**	–	–0.043*	–	–0.087***	–	–0.043*	–	–0.082***	–
	(0.02)		(0.025)		(0.028)		(0.025)		(0.026)	
Constant	0.215***	3.014**	0.177***	2.718***	0.162***	2.522***	0.169***	2.740***	0.157***	2.645***
	(0.029)	(1.363)	(0.027)	(1.363)	(0.027)	(0.834)	(0.026)	(0.935)	(0.026)	(0.878)
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	344	344	346	346	348	348	345	345	347	347
Number of countries	87	87	87	87	87	87	87	87	87	87

PPML IV estimation, control function approach. Estimation period: 2000-2015

Instruments:average income abroad and proportion of destinations with visa restrictions

LHS column: first-stage estimation results. RHS column: PPML IV results. Cols (1)-(3): contemporaneous emigration. Cols (4)-(6): One-period lagged emigration

Robust standard errors in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5 Domestic voicing, climate and emigration: PPML IV estimations

Dependent variable: domestic voicing about climate	(Emigration)						(Lagged emigration)					
	(1)		(2)		(3)		(4)		(5)		(6)	
	(Emig)	(IV)	(Emig)	(IV)	(Emig)	(IV)	(L.Emig)	(IV)	(L.Emig)	(IV)	(L.Emig)	(IV)
Emigration	–	–12.13**	–	–12.11**	–	–30.83**	–	–13.05**	–	–12.32**	–	–31.74**
		(5.893)		(5.579)		(14.85)		(6.040)		(6.521)		(15.42)
Nat. disasters	–0.034	2.183**	–0.039	2.123**	–0.047**	0.730	–0.039	2.083**	–0.040*	2.045**	–0.052*	0.563
	(0.024)	(0.867)	(0.024)	(0.855)	(0.024)	(1.209)	(0.024)	(0.854)	(0.024)	(0.829)	(0.024)	(1.123)
Sea level rise	0.0021	0.162***	0.0015	0.151***	0.0001	0.109*	0.0021	0.164***	0.0015	0.151***	0.0001	0.117*
	(0.0015)	(0.036)	(0.0015)	(0.033)	(0.0010)	(0.062)	(0.0014)	(0.037)	(0.0014)	(0.033)	(0.0015)	(0.062)
Temp	–0.0013**	–0.027	–	–	–	–	–0.0016***	–0.033	–	–	–	–
	(0.0006)	(0.030)					(0.0006)	(0.030)				
Population	–0.0002***	0.0020***	–0.0002***	0.0021***	–0.0002***	0.0019***	–0.0002***	0.0018***	–0.0002***	0.0020***	–0.0002***	0.0024***
	(0.0000)	(0.0006)	(0.0000)	(0.0004)	(0.0001)	(0.0007)	(0.0000)	(0.0006)	(0.0000)	(0.0005)	(0.0001)	(0.0007)
Freedom	–0.0011***	–0.027*	–0.0011***	–0.025**	–0.0007***	–0.030*	–0.0010***	–0.027**	–0.0009***	–0.023**	–0.0007**	–0.029*
	(0.0002)	(0.011)	(0.0002)	(0.010)	(0.0002)	(0.017)	(0.0002)	(0.011)	(0.0002)	(0.010)	(0.0002)	(0.017)
French	–0.024***	–1.314***	–0.028***	–1.355***	–0.024***	–2.108***	–0.018**	–1.294***	–0.023***	–1.336***	–0.019***	–2.006***
	(0.008)	(0.426)	(0.007)	(0.430)	(0.007)	(0.470)	(0.008)	(0.415)	(0.008)	(0.410)	(0.008)	(0.444)
Spanish	–0.015	–1.168***	–0.017*	–1.211***	–0.011	–1.598***	–0.015	–1.200***	–0.020**	–1.247***	–0.015*	–1.766***
	(0.010)	(0.349)	(0.009)	(0.350)	(0.008)	(0.406)	(0.009)	(0.354)	(0.009)	(0.349)	(0.008)	(0.442)

Table 5 (continued)

Dependent variable: domestic voicing about climate	(Emigration)						(Lagged Emigration)					
	(1)		(2)		(3)		(4)		(5)		(6)	
	(Emig)	(IV)	(Emig)	(IV)	(Emig)	(IV)	(L.Emig)	(IV)	(L.Emig)	(IV)	(L.Emig)	(IV)
Island	–	–	–	–	0.038***	2.539***	–	–	–	–	0.030**	2.341***
					(0.013)	(0.965)					(0.013)	(0.877)
Intern. mobility	–	–	–	–	0.009***	–0.280	–	–	–	–	0.008***	–0.283
					(0.002)	(0.197)					(0.002)	(0.194)
Foreign income	0.359***	–	0.381***	–	0.291***	–	0.332***	–	0.396***	–	0.287***	–
	(0.092)		(0.094)		(0.110)		(0.089)		(0.094)		(0.106)	
Visa restrictions	–0.054**	–	–0.043*	–	–0.039*	–	–0.054**	–	–0.055*	–	–0.037	–
	(0.02)		(0.025)		(0.024)		(0.030)		(0.029)		(0.026)	
Constant	0.215***	4.153**	0.177***	3.417***	0.165***	5.647***	0.222***	4.030***	0.174***	3.357***	0.161***	5.711***
	(0.029)	(1.392)	(0.027)	(0.974)	(0.028)	(2.296)	(0.026)	(1.427)	(0.029)	(0.936)	(0.027)	(2.339)
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	YES
Observations	344	344	346	346	346	346	343	343	345	345	345	345
Number of countries	87	87	87	87	87	87	87	87	87	87	87	87

PPML IV estimation, control function approach. Estimation period: 2000-2015

Instruments:average Income ibroad and proportion of destinations with visa restrictions

LHS column: first-stage estimation results. RHS column: PPML IV results. Cols (1)-(3): contemporaneous emigration. Cols (4)–(6): one-period lagged emigration

Robust standard errors in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Nevertheless, the computed emigration rates might fail to capture short- run variations in emigration.[31]

An obvious alternative to using migrant stocks is to use migrant flows. Comprehensive datasets of observable migrant flows comprising all destinations in the world are unavailable however. Therefore, for the sake of robustness, we instead compute emigration rates on the basis of a comprehensive data base of migrant flows as presented in Abel (2018), which are imputed from two sources of migrant stock data, either (Özden et al. 2011) else the United Nations Population Division, in other words from the stock data that we otherwise rely upon in our baseline regressions.

We implement two alternative measures. The first is based on the average dyadic migration flow, based on all non missing observations. This measure includes zero migration flows when calculating the averages. Our second measure implicitly assumes that zero reported migration flows constitute missing data, such that the computed migration flows are the averages across all positive values.[32] For both measures, we compute the global emigration flow for each origin country in each time period and calculate the emigration rate as a ratio of this computed emigration flow to the population at origin. Computing the correlation of the two measures with the emigration rate used in the benchmark analysis, we find correlations of 55% and 52% respectively.

In the Appendix, we present estimation results using our two alternative measures of emigration rates. Results are reported for total voicing, using PPML and PPML-IV, again using similar instruments as in our benchmark analysis. Our two key findings, namely the positive influence of climatic change on voicing, as captured by natural disasters and sea level rises and the substitution between emigration and voicing still hold. The IV results, however, are more negative by an order of magnitude. Our main result is qualitatively robust to the use of another measure of migration.

6 Conclusion

The existing empirical research literature generally observes far less climate-change-driven emigration than most observers predict. Drawing on Hirschman's treatise on Exit, Voice and Loyalty, we provide causal evidence of a yet undocumented phenomenon in which natives of origin countries—those either unable or unwilling to emigrate—respond by voicing against climatic change in an attempt to strengthen the bargaining power of affected populations.

Thus, in situations in which populations emigrate less than we might otherwise expect given the adverse climatic conditions they face, because, for example they are prevented to do so by migration restrictions imposed by destinations countries, they tend to voice more. This is true for two different components of voicing. Less emigration implies both increased domestic voicing, i.e. voicing done by private agents such as the residents or NGOs who voice towards their government, as well as more official voicing, i.e. voicing from the governments of affected countries abroad.

There are several implications from our analysis. First, in the presence of restrictive immigration policies imposed by destination countries, one can expect more voicing and

[31] Neither do we attempt to proxy bilateral migrant flows based on the differences in bilateral migrant stocks, due to the high proportion of negative values that result.

[32] If for a given dyad and a given period there is no positive values but well reported zero values, we ascribe a zero value to this observation.

maybe even civil unrest in countries subject to adverse consequences of climate change. Once they overcome the standard collective action problems inherent in any political voicing, residents of such countries will inevitably put additional pressure on their governments to find suitable adaptation strategies to climate change. In the extreme, this pressure could lead to civil strife. Second, emigration from countries affected by climatic change may be viewed as a safety valve that serves to decrease the public's concerns. Destination countries that refuse to issue visas permitting 'climatic migrants' to find opportunities elsewhere will likely exacerbate these political tensions on the international stage. The proposed experimental visa for 'climatic migrants' from Pacific Islands, for example considered by the New Zealand authorities in 2017, was eventually put on hold.[33] Our work implies that the decision to decline granting refugee status on the basis of climate change will increase the voice of protest from families living on Pacific Islands and their governments to countries such as New Zealand and will potentially undermine cooperation on climate change mitigation policies in that part of the world. Needless to say, these dynamics are by no means unique to Oceania and the risk of instability induced by the creation of further barriers to emigration or voicing are as real elsewhere around the world.

Hirschman later expressed some doubt about the "fundamental antagonism between private exit and public voice" (Hirschman 1993). He observed, for example that "the German story of 1989 (the collapse of the Berlin Wall and German re-unification) should stand as a reminder of Sportin' Life's maxim, "It ain't necessarily so"—a principle in theoretical modesty that social scientists disregard at their peril. "In some momentous constellations, so we have learned, exit can cooperate with voice, voice can emerge from exit, and exit can reinforce voice." (p. 202). It is therefore possible that the explosion of both exit and voice that transpired in East Germany in the wake the collapse of its Communist regime may also be replicated in a climate change crisis, one that can potentially be triggered by a large scale weather event such as a prolonged drought in many regions, or an especially intense tropical cyclone season in several basins.

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Author contribution IN conceptualised the choice, while MB and CP conceptualised the research approach. All authors were involved in the conduct of the research and the writing of the paper.

Data availability The data that support the findings of this study are available from the corresponding author upon reasonable request.

[33] See: https://devpolicy.org/new-zealands-climate-refugee-visas-lessons-for-the-rest-of-the-world-20200131

Code availability The code used for the econometric estimations that support the findings of this study is available from the corresponding author upon reasonable request.

Declarations

Ethics approval No ethics approval was required to conduct this research.

Consent to participate No one participated in the research.

Consent for publication The authors have full copyright, and are not using any other sources.

Competing interests All authors declare no competing interests.

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