



# Opinion dynamics: Kinetic modelling with mass media, application to the Scottish independence referendum<sup>☆</sup>

Laurent Boudin<sup>a,b,c</sup>, Francesco Salvarani<sup>d,e,\*</sup>

<sup>a</sup> Sorbonne Universités, UPMC Univ Paris 06, UMR 7598 LJLL, Paris, F-75005, France

<sup>b</sup> CNRS, UMR 7598 LJLL, Paris, F-75005, France

<sup>c</sup> Inria, Équipe-projet Reo, BP 105, F-78153 Le Chesnay Cedex, France

<sup>d</sup> Université Paris-Dauphine, Ceremade, UMR CNRS 7534, F-75775 Paris Cedex 16, France

<sup>e</sup> Università degli Studi di Pavia, Dipartimento di Matematica, I-27100 Pavia, Italy

## HIGHLIGHTS

- A kinetic model for opinion dynamics has been proposed.
- The presence of mass media has been taken into account.
- The model has been applied to the Scottish independence referendum.

## ARTICLE INFO

### Article history:

Received 9 February 2015

Received in revised form 21 May 2015

Available online 23 October 2015

### Keywords:

Opinion formation

Mass media

Kinetic equations

## ABSTRACT

We consider a kinetic model describing some mechanisms of opinion formation in the framework of referendums, where the individuals, who can interact between themselves and modify their opinion by means of spontaneous self-thinking, are moreover under the influence of mass media. We study, at the numerical level, both the transient and the asymptotic regimes. In particular, we point out that a plurality of media, with different orientations, is a key ingredient to allow pluralism and prevent consensus. The forecasts of the model are compared to some surveys related to the Scottish independence referendum of 2014.

© 2015 Elsevier B.V. All rights reserved.

## 1. Introduction

The present work provides the study of some phenomena arising in social sciences by means of a statistical mechanics approach. This strategy was born in the eighties; the reader can check [1] and the references therein to know more about the topic. In particular, one can find there some discussions about the French referendum on the European constitution in 2005.

Forecasting the opinion evolution with respect to a binary question is crucial in many situations. A typical example consists in the anticipation of a referendum result or an electoral competition, by using poll data from surveys held some time before the vote.

<sup>☆</sup> This work was partially funded by the 2013–2014 French CNRS PEPS HuMaIn project *Kindymo*, headed by L. Boudin, the French ANR-13-BS01-0004 project *Kibord*, headed by L. Desvillettes, the French ANR-14-ACHN-0030-01 project *Kimega* and the Italian national institute of higher mathematics (INDAM), GNFM project *Kinetic description of collective phenomena: theory and numerical simulations*, both headed by F. Salvarani.

\* Corresponding author at: Università degli Studi di Pavia, Dipartimento di Matematica, I-27100 Pavia, Italy.

E-mail addresses: [laurent.boudin@upmc.fr](mailto:laurent.boudin@upmc.fr) (L. Boudin), [francesco.salvarani@unipv.it](mailto:francesco.salvarani@unipv.it) (F. Salvarani).

In this article, we give a contribution to this problem by studying a mathematical model based on a kinetic approach, and we provide both qualitative and quantitative comparisons with real data, in the case of the 2014 Scottish independence referendum.

Our model is based on the following hypotheses.

**Assumption 1.** The number of individuals in the population is constant. Of course, this is only relevant for short-term forecasts, as during a referendum campaign.

**Assumption 2.** The community is fully interconnected and all the members can somehow discuss with each other. By tuning the cross section of the model, however, it is possible to generalize our model to situations where the interaction probability between individuals depends on their own convictions, as in bounded confidence models [2,3].

**Assumption 3.** There are some mass media which can have an effect on the individuals.

Let us focus on the mass media, whose involvement is the most significant contribution of this work. Although the press freedom appears as a safeguard in a democracy [4], the media can also be used to influence the public opinion, by taking advantage of their possibility of easily reaching a wide audience and favour some interests, ideas or arguments inside a population [5]. In order to influence the population, many different tactics have been developed. Among them, we quote the distraction, in different forms (which is based on the assumption that the public has a limited attention span), the appeal to consensus and the fear mongering [6]. These techniques are used either separately, or combined between them, and can be applied to many different contexts. Mass media use diversified media technologies in order to reach a large audience and transfer concepts, ideas, etc. Among them, we can cite broadcast media (radio, television), print media (newspapers, books), outdoor media (posters), and digital media (Internet, mobile mass communication).

Mass media can use two different kinds of strategy. They can act either as observers, or as opinion carriers. In the latter case, they often simply spread out the opinions which they support into the population, without any other interest than the maximization of their audience. Unfortunately, these two strategies cannot be modelled in the same way. Manipulating media can be described as entities with a given external opinion, which aim to spread their own opinion inside the population. Wide audience media should be described with a more intricate approach: the opinions they carry can depend on the opinion distribution inside the population, and then the influence of the population on the media opinion is a part of the model itself. In this work, we only consider media with an *a priori* given opinion. This case can in fact be seen as a first rough approximation of the wide audience media, where the media opinion may not remain constant, but does not depend on the opinion distribution.

We here use a kinetic approach to describe and forecast the evolution of a system under the aforementioned effects. In this framework, a distribution function holds the information on the system, and its time evolution is governed by a partial differential equation with integral operators. This strategy is based on sophisticated mathematical tools and its interest is apparent when the number of individuals becomes very large, since it allows to handle collective behaviours.

Kinetic equations have been used to model social phenomena since the early 90s, when Helbing studied behavioural changes by using Boltzmann-like equations [7–9]. Subsequently, this approach has been the basis of several works, see the review article [10] and the references therein. Note that, in most part of the literature based on all the approaches, including the kinetic one, the key phenomenon is compromise, see Ref. [11–15].

The model we here investigate also owns this binary interaction feature: individuals follow the rule proposed by the authors in Ref. [16]. Taking into account the influence of mass media on the population, we are able to improve our previous results from Ref. [16], and recover some realistic behaviours.

The opinion variable of our model runs in a continuous way between two extreme values, from  $-1$  to  $+1$ . The model describes the time evolution of a distribution function  $f$  (depending on both opinion and time), which represents the density of individuals with respect to the opinion about the binary question. That kind of variable reflects the opinion formation process, which does not lead necessarily to strong opinions, since doubt and partial agreement are often predominant feelings.

The media action on the system is modelled by a kinetic operator which has a structure similar to the media operator introduced in Ref. [17], but with a different nonlinear effect in the post-interaction opinion. The structure of this linear (with respect to  $f$ ) term is well adapted to the coupling with the self-thinking.

At the end of the opinion formation process, the opinions must be translated into a decision. This issue is not tackled here, since it is often the result (at least in the case of reasonable and rational individuals) of a game-theoretical approach, especially when those individuals have intermediate opinions.

Since we work with a continuous opinion variable, it is difficult, in general, to get comparisons with real data. Indeed, polls usually have a binary (“yes”/“no”) or ternary (“yes”/“no”/“indifferent”) structure, since they are interested in forecasting the result of the final choice with respect to the binary question of the referendum. However, some more structured surveys have been built on a more complete scale (usually from 1 to 10). These polls can be a good tool for comparisons, which are essential to somehow validate our model. The last part of our study is consequently devoted to the qualitative comparison between the results of our model and three surveys performed by the polling corporation *ICM Unlimited*<sup>1</sup> about the Scottish

<sup>1</sup> See <http://www.icmunlimited.com/media-centre/polls/>.

Download English Version:

<https://daneshyari.com/en/article/7379179>

Download Persian Version:

<https://daneshyari.com/article/7379179>

[Daneshyari.com](https://daneshyari.com)