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Interfaces with Other Disciplines

Building a dynamic theory of citizens' awareness of European Cohesion Policy interventions

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ABSTRACT

Since more than thirty years, the European Cohesion Policy aims to reduce economic disparities and support regional development by funding local-orientated projects. However, the citizens' awareness of Cohesion Policy follows an unexpected longitudinal pattern characterised by a notable decrease after an initial increase. Although researchers have been investigating the relationship between policy implementation and public awareness, a lack of systemic comprehension of the underlying mechanisms is evident. Using system dynamics, we develop a causal model to explain the roots of the declining awareness towards policy interventions. The findings highlight how citizens initially manifest a high collective attention to Cohesion Policy that tends to decay over time. These dynamics, combined with the citizens' inherent tendency to lose information saved in their long-term individual memory, could elucidate the system's behaviour. This novel system dynamics application provides policy-makers with operational guidelines for developing efficient communication strategies to improve policy awareness.

1. Introduction

A negative perception of organisations may undermine the citizens' support and trust (Ecker-Ehrhardt, 2012; Mishler & Rose, 2001) and, overall, institutional legitimacy and acceptance (Mazerolle, Antrobus, Bennett & Tyler, 2013; Schmidt, 2013). Therefore, the citizens' perception of organisations is a complex and relevant issue that calls upon the durability of the public and political entities. Recently, the issue of perception is receiving worldwide attention since an increased number of people have mixed feelings or even mistrust towards public/private authorities and local/global actors (Carter, Weerakkody, Phillips & Dwivedi, 2016; Muro & Vidal, 2017; Semukhina & Reynolds, 2014). In particular, the European Union (EU) institutions are challenged on a daily basis by euroskeptical movements (Brack & Startin, 2015; Usherwood & Startin, 2013) to the extent that public support towards European institutions is drastically declining and the integrity of the Union is endangered (Leruth, Gänzle & Trondal, 2019; Vollaard, 2014; Webber, 2019). To this end, even if the EU has increased its communication effort (Barberio, Kuric, Mollona & Pareschi, 2017; Caliendo & Iannarino, 2009), the understanding of how to interact and communicate efficiently with the citizens is crucial (Verhaegen, Hooghe & Quintelier, 2017). Hence, emphasis has been placed on the manner in which public policies, especially in terms of public expenditure, and their communication (Barberio et al., 2017; Karens, Eshuis, Klijn & Voets, 2016) affect the citizens' perception and support towards institutions (Barberio et al., 2017; Barberio, Kuric, Mollona & Pareschi, 2018; Dellmuth & Chalmers, 2018).

In this paper, we explore the issue of policy awareness in the context of the EU Cohesion Policy (CP). CP is one of the main European schemes, the second largest budget expenditure (e.g. for the latest policy cycle 2014–2020, CP constitutes 32.5% of the EU budget corresponding to approximately 351.8 billion euros; European Commission, 2014), and the most important European redistributive policy mechanism for investments. Following a multilevel governance principle, CP is managed by local stakeholders, regions, member states, and the European Commission (Hooghe, 1996). The policy's aim is *"reducing disparities between the various regions and the backwardness of the least-favoured regions"* (Commission of European Communities, 1986, p.9). More specifically, the EU redistributes the allocated budget to the regions, based on their economic conditions, to improve citizens' well-being, overcome regional disparities, foster social and technological development, and

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support harmonic economic growth through the implementation of locally-orientated projects.

As CP has been active since 1988, it is expected that EU citizens are well aware of the policy. This fact might have affected to some extent their support to and their identification with the EU due to the benefits gained from locally-funded projects. In particular, this field has recently gathered the attention of research on: (i) the relationship amongst policy expenditure, public support towards the EU, and European identity (Borz, Brandenburg & Mendez, 2018; Capello & Perucca, 2019; Huggins, 2018; Pegan, Mendez & Triga, 2018; Willett, Tidy, Tregidga & Passmore, 2019), and (ii) the manner in which CP is communicated to the citizens (Barberio et al., 2017; 2018; Corchado, Fernández, Martín & Méndez, 2018). Nevertheless, despite the policy's duration, the locally-orientated aim, and the EU effort in communicating the results to the citizens, Europeans seem rather unaware of the existence of CP and its benefits in their region. In fact, in terms of awareness level, the average percentage of EU citizens declaring to know about the CP existence and the relevant actions in their region is approximately 35% (European Commission, 2017). The comprehension of CP awareness dynamics and their interconnection with policy expenditure and communication is crucial for investigating the CP impact on citizens' attitude (Huggins, 2018), as the state of being aware is a '*condition sine qua non*' that comes first before a personal opinion is formed. In this vein, awareness is a necessary step to build support around policy interventions.

Despite the importance of the citizens' awareness, an absence of a robust explanation of the dynamics, causes, and drivers of this social phenomenon is evident. In fact, although general studies on the relation between CP and citizens' EU awareness appeared recently, they mainly use static approaches (Barberio et al., 2018; Borz et al., 2018; Charron & Bauhr, 2017). Thus, the need of unveiling the fundamental cause-effect relationships of the system remains unaddressed (Meadows, 1980). To this end, since awareness can be conceptualised as a part of a complex system that changes over time, the scope of this paper is to explore the dynamics of public awareness of CP using system dynamics (SD) as our logic of enquiry (Forrester, 1961). By applying SD to the context of CP, this paper aims to explain the long-term pattern of policy awareness, which is an open issue for policy-makers. This paper contributes to the comprehension of the mechanisms that lay behind how citizens become aware and how they lose, or maintain, awareness about the outcomes generated by the implementation of policy schemes. In this way, this research could provide a general answer, not only for EU and national/regional institutions but also for diverse public and private organisations, concerning how the awareness of their actions spread out in the general public. This understanding is likely to support the improvement of dissemination capacity.

As a connected methodological contribution, this work presents a case of computational theory building in social sciences. Specifically, we use modelling and simulation to understand the root causes of the dynamics of citizens' awareness of CP regional interventions. In this light, the paper shows how SD offers a theoretical and methodological environment in which different theories may enter in dialogue amongst each other, considering the available empirical data. More specifically, we mobilise the Bass model that belongs in the repertoire of SD theories of behaviour, as well as we transform the concept of collective attention dynamics developed by Candia, Jara-Figueroa, Rodriguez-Sickert, Barabási and Hidalgo (2019) into an SD model. The remainder of this paper is structured as follows. First, the awareness behaviour over time is outlined based on existing quantitative evidence (Section 2). In Section 3, we describe the methodology utilised in the analysis. In Section 4, we present and discuss the sequential steps of the model building process. Finally, the article concludes with the major policy-making insights (Section 5) and recommendations for future research (Section 6).

2. Problem statement: awareness behaviour

The generation of a reference mode (i.e. the pattern under study) based on available real-world empirical evidence is the first step of our modelling process. To define the reference mode, we retrieved secondary data on awareness of CP from the EU Eurobarometer reports (European Commission, 1995; 2008; 2010; 2013; 2015; 2017), as the only data available over time. Notably, these reports are not annual, thus the collected data are unequally scattered along the time. This limited data availability renders the reference modes as 'discontinuous lines'; in reality, the behaviours are expected to be smoother. The first report is identified in 1992 (the related data are provided in the 1995 report) and the last one in 2017. Although the general question asked in the Eurobarometer surveys is stated as: *"Have you heard about any EU co-financed project that improves the region you live in?"*, slight differences in the statement exist over time. All surveys have been carried out at a national level including participants older than 15 years.[1] Following the approach provided by Charron and Bauhr (2017), the analysis in this article includes 15 EU nations. These countries represent over 85% of the EU population and exhibit a considerable variation in terms of geographical characteristics, population volume, and institutional quality. Some of the nations under study were not EU members in 1992, therefore data are available only after they joined the EU.

Fig. 1 illustrates the citizens' awareness of regional EU funded projects over time at a national level, according to the Eurobarometer reports. Each point of the lines constitutes the percentage of aware citizens, while all intermediate values amongst the documented ones are assumed to follow a linear trend. Although the citizens' awareness amongst the countries does not exhibit the same behaviour, the empirical data highlight that most countries demonstrate an initially increasing behaviour and then a decreasing one, following the average EU awareness pattern (i.e. average awareness of all members states – dashed thick red line; through the years, the number of EU members may differ).

In more detail, a number of peculiarities in the Eurobarometer data behaviours have been identified:

- The 'old' member states, such as Austria, Spain, Italy, the Netherlands, Germany, and France exhibit a similar pattern, namely an initially increasing awareness followed by a significant decrease that, for some of them, ultimately turns in a fluctuant behaviour.
- Amongst 'old' member states, Sweden and the United Kingdom (UK) demonstrate differentiated trends. Sweden has a rather constantly low awareness (around 20–25%) over time, unlike the EU average trend. Notably, this evidence is in line with the existing literature; according to Barberio et al. (2017), while an increase in the EU budget for raising public awareness could lead to higher consciousness about CP on average, this process may have a negative impact in the Swedish context. Swedish citizens possibly perceive such spending on advertisement as wasteful, thus the positive perception about the CP funds is reduced. On the other hand, the UK follows an interesting pattern, considering the Brexit vote in 2016; awareness is initially increasing similarly to the rest old EU members. Then, it is slowly decreasing till 2015 (reaching less than 10%, which is the

[1] Detailed technical specifications about the sampling procedure can be found in the Eurobarometer reports (European Commission, 1995; 2008; 2010; 2013; 2015; 2017).

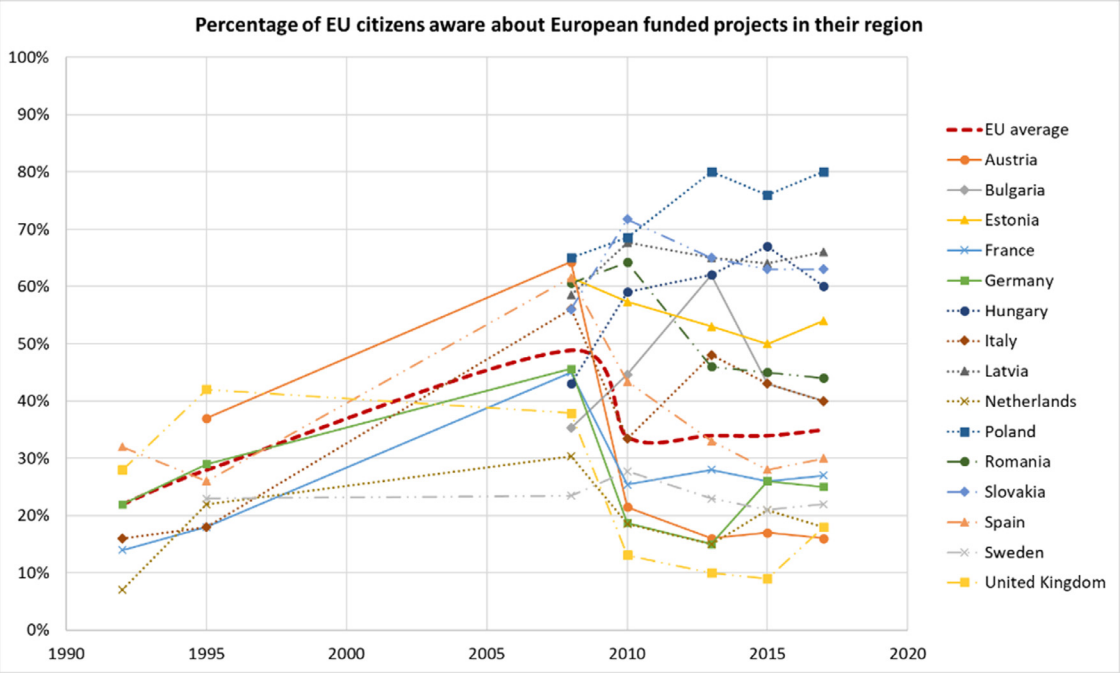

Fig. 1. Citizens' awareness of regional local projects funded by the EU over time (Own elaboration based on the Eurobarometer reports).

lowest value amongst the analysed members) and finally rises considerably in 2017.

- The newer member states, such as Poland, Estonia, Romania, Hungary, Latvia, Slovakia, and Bulgaria, follow a different pattern. Initially, since they enter in EU, they exhibit an augmenting awareness. Then, their trends slightly differentiate. For some countries, such as Romania, Bulgaria, and Slovakia, after awareness reaches a peak, it starts decreasing as it happens in the old member states. Estonia starts at a high level and then it exhibits a decreasing pattern. Finally, Hungary, Poland, and Latvia increase to a point in which they stabilise and fluctuate.

Overall, based on the available data, the EU citizens' awareness of CP follows a rather surprising path compared with the accumulating number of projects completed and the communication efforts within the CP scheme. For most countries, in general, awareness increases over time till it reaches a peak and then it usually tends to decrease and, in some cases, to fluctuate slightly.

3. Methodological approach

3.1. Why system dynamics

The analysis of the reference modes elicits a puzzle: if CP has been implemented continuously, and the related funds have been regularly allocated to the regions generating a continuous accumulation of implemented projects, why the citizens' awareness fluctuates and decreases rather than accumulating as well? Our assumption is that several underlying dynamics affect the citizens' awareness of CP funds. In this context, we adopt SD as a methodological environment that facilitates the investigation of the mechanisms (i.e. cause-effect relationships) behind the dynamic behaviour of the citizens' awareness. We advocate that SD is an appropriate method to tackle such problems since it is orientated towards complex systems, highlighting unexpected behaviours over time (Forrester, 1961; Sterman, 2000). From a technical perspective, an SD model captures the structure of a system by representing its major cause-effect links and feedback mechanisms (Sterman, 2000). Arrows indicate the links that connect a cause to its effect. The causal impact of each relationship is presented with either a positive (i.e. both cause and effect increase or decrease) or a negative (i.e. when cause increases (or decreases), effect decreases (or increases)) polarity. The stock variables (symbolised by rectangles) represent the states of a system in a given point in time and capture the accumulation processes (i.e. mathematical integrations) within the system, while the flow variables (symbolised by valves) are the rates filling or emptying the stock variables. In addition, a feedback loop is a circular sequence of causes and effects that is either balancing or reinforcing. If an initial increase in a variable leads to an eventual decrease (or increase) in the same variable, then the feedback loop is considered as balancing (or reinforcing). A balancing feedback loop demonstrates stabilising goal-seeking behaviour over time, while a reinforcing feedback loop leads to exponential growth or decay.

Notably, to the best of our knowledge, the use of a modelling approach to explain the citizens' awareness constitutes the first research effort of this kind in the field of CP communication. Given the dearth of literature and numerical data in the field of CP awareness and communication, which constitutes a rather new research area, the SD methodology is utilised as a theory building approach (de Gooyert & Größler, 2018; Forrester, 1994; Schwaninger & Grosser, 2008). More specifically, an SD model is built to explain the fluctuations in the citizens' awareness (De Gooyert, 2016). Notably, SD has been already used for exploratory purposes, in both qualitative (e.g. Azoulay, Repenning & Zuckerman, 2010) and quantitative ways (e.g. Rahmandad & Repenning, 2016). The awareness model is developed following logical steps and robust theories of relevant research areas. Specifically, principles from the Bass diffusion model (Bass, 1969) and ideas from the Candia et al. (2019) modelling effort on collective attention have been retrieved and integrated. Therefore, through the formalisation of these steps using the SD language, a formal theory capable of explaining the awareness pattern is developed.

3.2. Modelling procedure

The aim of our modelling is to develop a candidate explanation of the empirically observed pattern of the citizens' awareness. Our assumption is that the observed pattern is an epiphenomenon

produced by an underpinning causal structure. To develop a hypothesis on the causal structure, we develop an abductive inference; abduction is an inference that goes from the observation of a fact to the hypothesis of a principle that explains the observed fact (Burks, 1964; Fann, 1970). The model is a candidate theory; had the world crystallised into the theory to be true, observed patterns of behaviours would be reasonable. The modelling follows the eight guiding principles suggested by Schwaninger and Grosser (2008): issue orientation, formalisation, generalisation, validation, explanation, falsification, process design, and concept of learning. The model building process is presented step by step, similarly to Rahmandad and Repenning (2016), in order to provide *"an interaction between modellers and model – a dialogue through which the theory is created and enhanced"* (Schwaninger & Grosser, 2008, p.461) and increase transparency, replicability, and confidence in the modelling procedure.

To quantify the model, Italy was used as a reference case. The selection of Italy was attributed to the fact that two Italian regions constituted major partners of the Horizon 2020 project PERCEIVE,[2] in the context of which this research has been performed. Officers of the respective regional authorities were eager to provide us with data sources and willing to participate in interviews and workshops. To improve the model's generalizability to other European regions, we presented the model in several workshops with officers of other EU regions. It is noteworthy that no fundamental structural changes of the model were required. Thus, this model can be considered as sufficiently general. To perform our simulation analysis, we parametrised the model using the case of Italy. The stock and flow model has been developed using the software Vensim® and provided along with detailed documentation (as supplementary material) to facilitate the reproduction of the results. The documentation has been organised following the guidelines provided by Martinez-Moyano (2012) and Sterman and Rahmandad (2012).

Overall, the reliability of the model relies upon the transparent building approach. In addition, formal validation tests on the model structure have been performed (Barlas, 1996): direct structure theoretical tests (i.e. unit consistency, extreme condition and structure confirmation) and structure-orientated behaviour tests (extreme-condition test, behaviour sensitivity test). Moreover, the model presents behaviour validity (i.e. it reasonably replicates real-world data), significantly increasing the confidence in both the structure and the outputs. Specifically, the model's ability to generate adequate patterns has been assessed qualitatively through observation (Sterman, 2000) by comparing curves' trends, slopes, and heights. Given the reference modes' behaviours and the model's purpose, this method is considered as sufficient since it reaches the validation cessation threshold (Groesser & Schwaninger, 2012).

To perform the structural validation, we followed the group model building approach (Lane, Munro & Husemann, 2016; Scott, Cavana & Cameron, 2016; Vennix, 1996). More specifically, the conceptual model was presented and discussed in: (i) a workshop, organised in the context of the project PERCEIVE, attended by 26 experts (i.e. 9 policy-makers, 16 researchers and a journalist), and (ii) two interviews with officers in charge of communication from an Italian regional authority that acted as a key project partner. More specifically, during the workshop, each participant received an enlarged printed causal loop diagram (CLD) of the developed CP awareness system. After the description of the main principles of the SD methodology and the major components of a CLD, the participants were asked to scrutinise all variables and connections of the CP awareness map and provide written comments on the CLDs. Then, a discussion session allowed for investigating all potential insights, as well as for validating the structure of the model. In addition, the interviews with the regional authority's officers were performed before and after the workshop in order to receive feedback about the model and confirm its structural validity based on official information.

4. The system dynamics model

4.1. Awareness stock and inflow

In the context of this research, a citizen is considered aware if they have heard about any EU co-financed project implemented in their area. This choice was made in terms of consistency with the general question posed by Eurobarometer surveys. To this end, the number of citizens aware can be presented as a stock ("*Citizens aware of EU role in cohesion policy*"), since it can be conceptualised as an accumulation of aware people over time. To initialise this stock, it has been assumed that the EU citizens started to be aware of CP right after its major reform in 1988, that made CP the way it is today. Therefore, the simulation starts in 1988 and the stock has been initialised to zero.

Given that the available awareness data are expressed as percentages, the number of citizens aware of the stock is divided by the total citizens ("*total citizens population in the region*"), generating the "*percentage of citizens aware of the EU role on cohesion policy*" which is the main variable under study. The dynamic behaviour of awareness implies that the stock of awareness, which determines the percentage of people aware, is influenced at least by one inflow since at the beginning it is empty and over time it takes values higher than zero. Thus, an inflow that accumulates into the aforementioned stock, namely the "*total citizens getting aware of EU role in cohesion policy*", has been assumed. Fig. 2 provides a representation of the aforementioned concepts. In the ensuing analysis, all following systemic maps are simplified versions of the full stock and flow diagram; to facilitate comprehension, we focused on the key variables that are necessary for understanding the underlying dynamics.

This mapping of the system can be interpreted in the following manner: citizens are being continuously informed and accumulate in the stock of aware people depending on the 'speed' of the inflow (i.e. the higher the inflow is, the faster the accumulation is). The behaviour obtained from the simulated structure is presented in Fig. 3. To some extent, the simulation results (thin blue line) are able to replicate the real data (thick red line). However, this representation of the system is only able to replicate the initially increasing phase of awareness.

4.2. Susceptible citizens

Obviously, the awareness flow is not sufficient to replicate the observed pattern. Except for this inability, if the inflow of "*total citizens getting aware of EU role in cohesion policy*" is increased considerably, the "*percentage of citizens aware of the EU role on cohesion policy*" might exceed 100%, which constitutes an unrealistic situation. Thus, a stock of unaware people ("*Citizens unaware of EU role in cohesion policy*"[3]) should be considered. This stock has been initialised with the real number of total people in the region under study (i.e. Italy), which was about 57 million in 1988 (United Nations, Department of Economic & Social Affairs, 2017), given that initially all people have been considered as unaware. In fact, the stock of unaware people will act as a starting point for the inflow

[2] PERCEIVE websites: https://www.perceiveproject.eu; https://cordis.europa.eu/project/id/693529

[3] All new variables of each step are highlighted in bold for the readers' convenience.

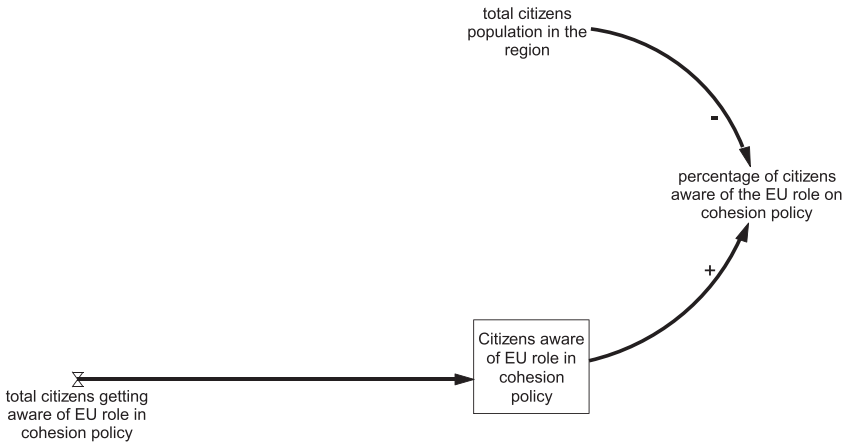

Fig. 2. Citizens' awareness main stock and inflow (Step 1).

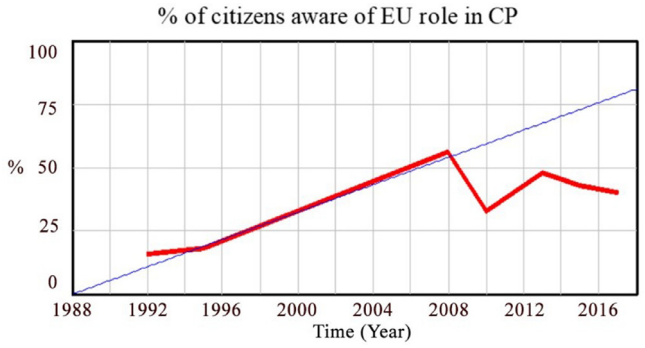

Fig. 3. Percentage of citizens aware of EU role in CP (thick red line – reference; thin blue line – simulated) (Step 1). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

of "*total citizens getting aware of EU role in cohesion policy*". Aware citizens accumulate if only there is a pool of unaware citizens in order not to exceed the total population level.

To implement this idea, the unaware citizens' density (i.e. the susceptible potential) is considered. This is a grounded approach adapted from the Bass diffusion model (Bass, 1969; Sterman, 2000). This density ("*percentage of citizens unaware of the EU role on cohesion policy*") is calculated as the ratio of the number of unaware citizens over the total population. Then, it is multiplied by the "*total number of citizens informed on EU role in cohesion policy*" to generate the previously unaware citizens that are reached by the information regarding EU funded projects in their region and thus become aware ("*total citizens getting aware of EU role in cohesion policy*"). Fig. 4 provides a conceptual representation of this step. Notably, this new structure generates a self-stabilising mechanism (balancing loop), since the more unaware citizens become aware, the lower is the density of the potentially susceptible ones and, consequently, the flow of people getting aware decreases.

The "*total number of citizens informed on EU role in cohesion policy*" represents the citizens that get informed about the EU role in CP through communication activities, such as public advertising of results, usage of explanatory plaques and symbols on implemented projects, as well as word of mouth due to beneficiaries and recipients of EU funds. These activities represent the tools that European, national, and regional policy-makers tend to use as leverage to improve the state of the system (i.e. they try to increase and/or improve the communication activities in order to

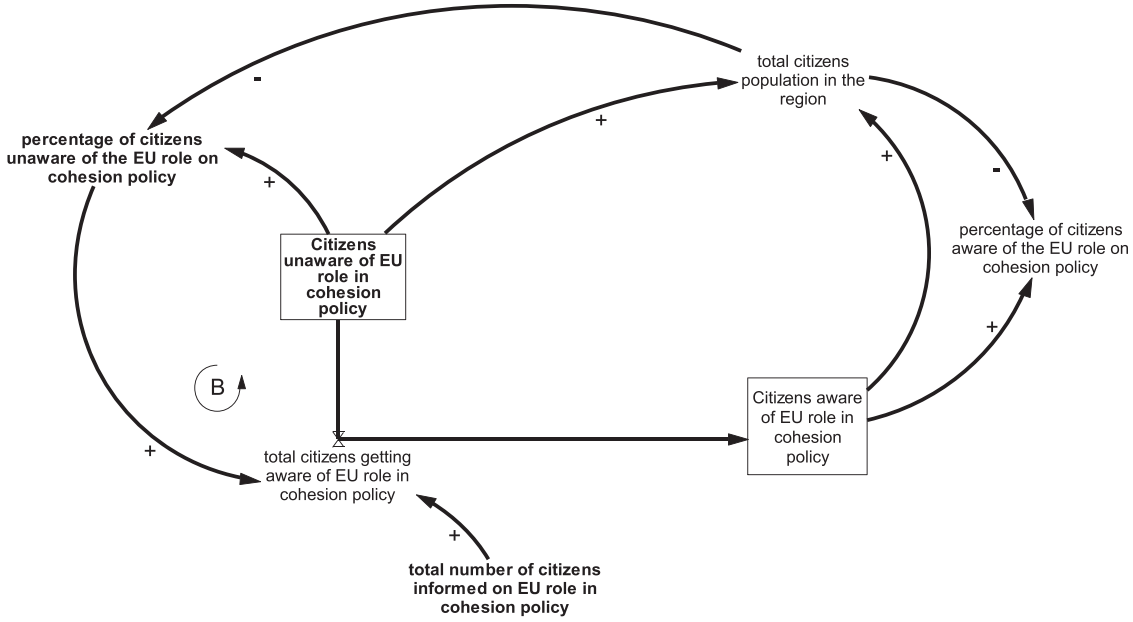

Fig. 4. The adapted Bass diffusion model (Step 2).

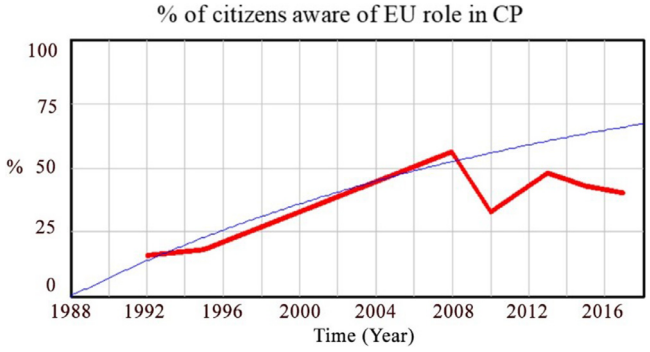

Fig. 5. Percentage of citizens aware of EU role in CP (thick red line – reference; thin blue line – simulated) (Step 2). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

raise awareness). The "*total number of citizens informed on EU role in cohesion policy*" is considered as exogenous and constant during the whole simulation procedure. More specifically, determining the structure that generates the number of people informed by diverse communication channels is beyond the model's scope, which refers to the manner in which citizens become aware and forget and not how they get informed (exogenous variable). In addition, despite the institutions' efforts to increase CP communication recently (Barberio et al., 2018), at the moment, there is no real-world evidence that these efforts were effective resulting in more citizens informed about CP implementation (constant variable).

The resulting behaviour of the new structure is illustrated in Fig. 5. Although the simulated results (thin blue line) and the real data (thick red line) overlap less than before, the simulated curve was a much more reasonable behaviour for the whole simulation period.

4.3. Demographic dynamics

The effect of demographic changes in society could be a possible explanation of the awareness behaviour. In Fig. 6, the new system conceptualisation is reported. It is reasonably assumed that all new-borns ("*births*") are unaware. At the same time, death rates work in a proportional manner for aware and unaware citizens ("*aware citizens deaths*" and "*unaware citizens deaths*"). More specifically, deaths are distributed according to the percentage of people in a stock with respect to the total population (e.g. if the unaware people constitute 60% of the total population, then the total deaths will be distributed as follows: 60% will regard unaware citizens and 40% the aware ones), since death is assumed to occur in the same way for both groups of citizens. In the analytical stock and flow diagram, all new-borns accumulate into an intermediate stock of unaware under-15-years-old citizens, which become "*Citizens unaware of EU role in cohesion policy*" when they turn 15. This choice was made for two reasons; children are usually not interested in any political-related topic, thus they are excluded from the analysis, while Eurobarometer surveys take into account respondents only over 15 years old. For simplicity reasons, the variables related to the unaware juvenile citizens are not included in the system map.

To implement these new structural changes, real demographic data were used. To replicate the Italian case, real data about historic crude fractional death and birth rates were retrieved from the United Nations, Department of Economic and Social Affairs (2017). To provide a general idea on the magnitude of the demographic figures, the birth rate decreases from 10 babies every 1000 people in 1988 to 7.6 babies in 2018. The death rate increases from 9.6 death every 1000 people in 1988 to 10.6 deaths in 2018. The simulation results are presented in Fig. 7. Although the shape of the simulated curve (thin blue line) is slightly different compared to the previous simulation step, the main trend seems the be the same due to the fact that the population variations are not robust enough to justify the awareness behaviour. Given that birth and death values are of similar magnitude, they are not sufficient to explain awareness fluctuations.

To support this claim further, experiments were performed. First, sensitivity analyses confirmed that there is not any real constant value for the crude birth and death rates able to reproduce a simulation that matches the real data. Only a sudden increase in the birth rate could explain the reduction in awareness. Indicatively, an increase from 9 babies per 1000 people in 1993 to 50 babies could explain diminishing awareness after 2008 (Fig. 8, dotted blue line). Another extreme case replicating the real data is the one in which deaths after 2008 are only happening in people who

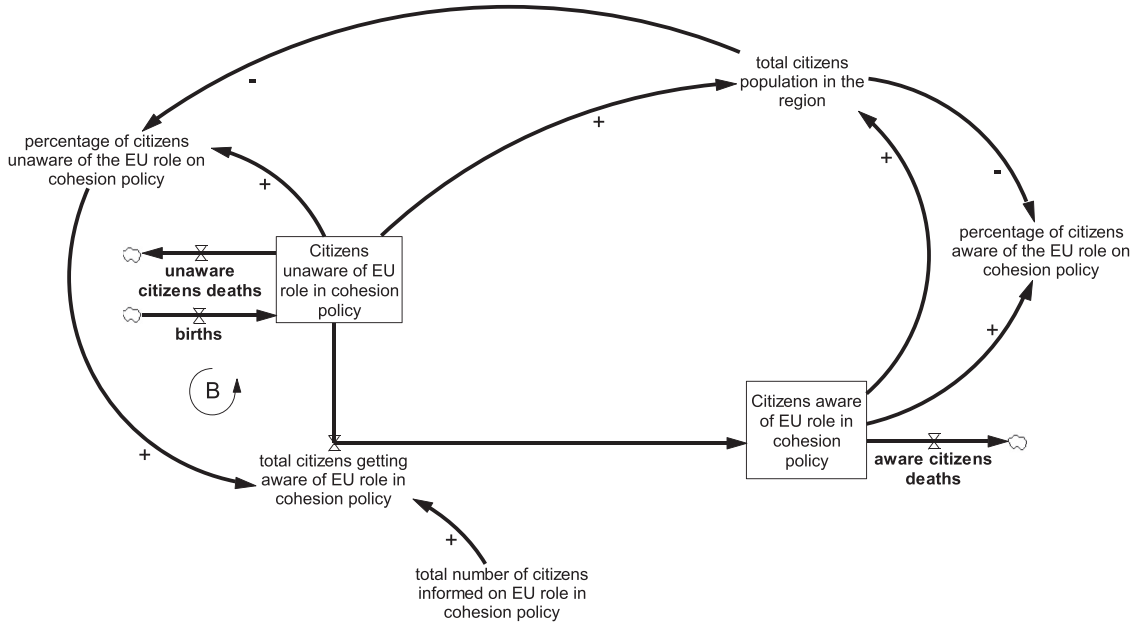

Fig. 6. The demographic flow variables (Step 3).

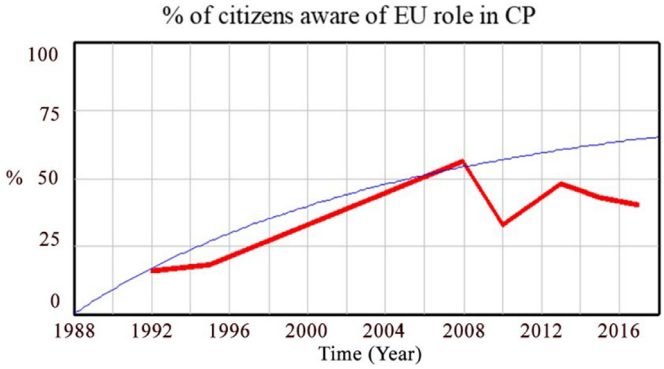

Fig. 7. Percentage of citizens aware of EU role in CP (thick red line – reference; thin blue line – simulated) (Step 3). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

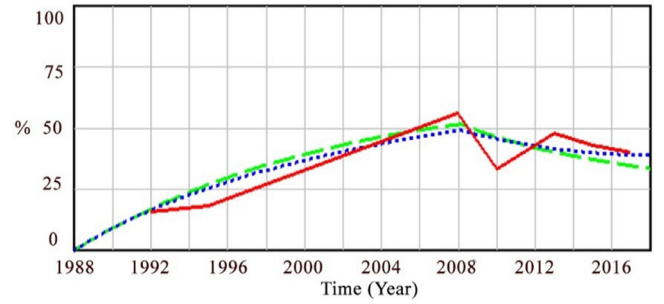

Fig. 8. Percentage of citizens aware of EU role in CP (solid red line – reference; dotted blue line – birth rate increase; dashed green line – death rate increase) (Step 3). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

are aware, while the crude death rate suddenly increases to 140 deaths per 1000 people (dashed green line). However, given that both cases were considered as unrealistic, they were rejected.

4.4. Forgetting outflow

Given that the population dynamics have a limited influence on the state of the system, they are not sufficient to explain the system trends. Thus, after rejecting the case of the natural demographic dynamics, the only possible explanation is that there is another outflow that decreases the level of the aware people stock. A possible additional outflow is the one capturing the idea that people, once aware, might forget that the EU contributed to local projects in the context of CP ("*citizens 'forgetting' of EU role in cohesion policy*"). At the same time, this outflow is also an inflow to the unaware citizens' stock, since people can only be either aware or unaware (Fig. 9).

This forgetting rate represents an intrinsic characteristic of any individual citizen that refers to the loss of memory; each person after a certain time tends to forget the information they know, and in this specific case, about any CP interventions in the area where they live. Thus, this outflow depends on the time it takes for the citizens to forget ("*citizens average forgetting time of EU role in cohesion policy*"). In fact, this variable constitutes an inner human characteristic, thus it is not influenced by the elements of the system and constitutes an exogenous factor. In addition, as human nature does not change quickly, it is unrealistic to assume that people, for example, retain their memory for 10 years in 2000 and 20 years in 2005. Hence, the forgetting time is assumed to be constant. This mechanism has been built as a first-order linear balancing feedback loop (Sterman, 2000, p.274–275); specifically, the stock value is divided by the forgetting time, which represents the average time that people remain aware, while the outflow's strength depends directly on the stock value. Overall, this structure expresses that, after a certain number of years, aware people tend to forget, thus returning to the unaware state through the forgetting flow.

Fig. 10 shows the results obtained from this simulation step. The model reproduces results (thin blue line) more similar to the real data (thick red line) compared to the previous simulation step. However, this explanation of the awareness tendency is still not adequate, as it cannot explain the decrease observed in the empirical data. More specifically, the outflow of forgetting can only be lower (i.e. awareness stock value increases) or equal (i.e. awareness stock value remains constant) to the inflow of citizens becom-

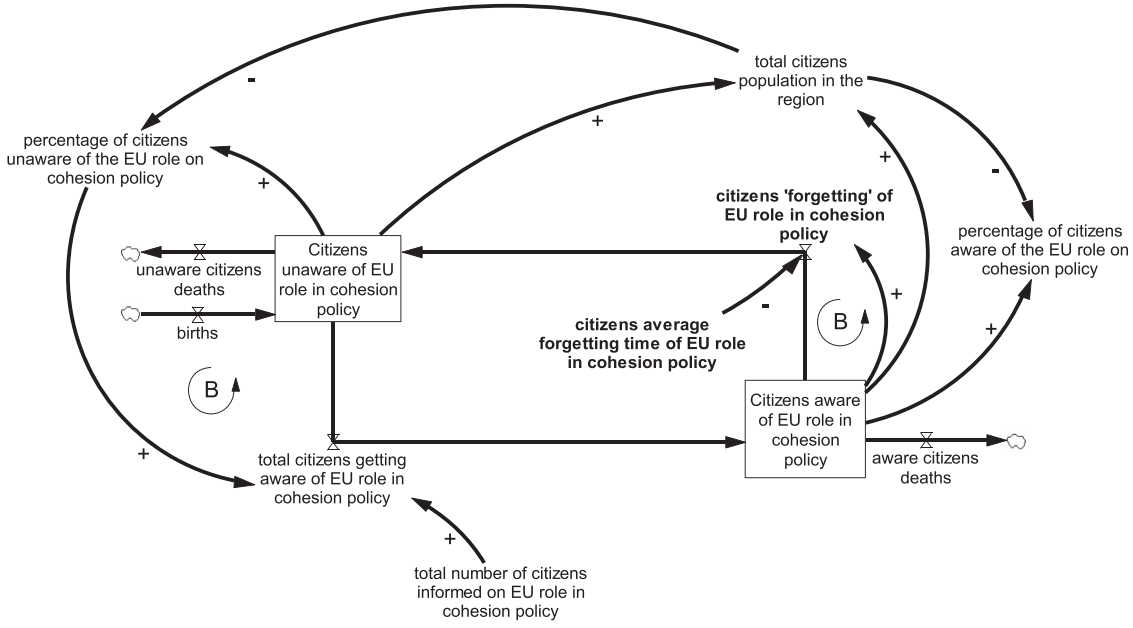

Fig. 9. The outflow variable of citizens' forgetting (Step 4).

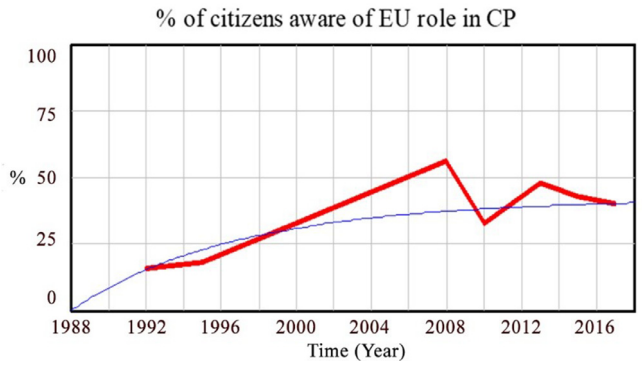

Fig. 10. Percentage of citizens aware of EU role in CP (thick red line – reference; thin blue line – simulated) (Step 4). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

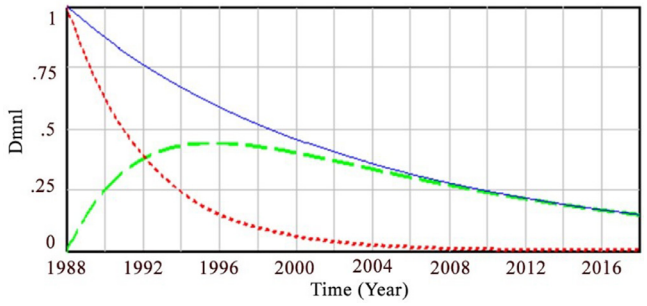

Fig. 12. Dynamic behaviour of collective attention (dotted red line – communicative attention; dashed green line – cultural attention; solid blue line – collective attention) (Step 5a). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

ing aware. This occurs due to the balancing action of the two loops in place and the initialisation of the aware citizens' stock to zero. In fact, the outflow is initially null (given that the aware stock is empty), and if it rises until it is equal to the inflow, then it cannot increase further because the stock of aware people (i.e. the only dynamic item from which the outflow depends) reaches equilibrium as the inflow and the outflow are equal.

4.5. Universal decay of collective attention

Given that there are no other plausible outflows related to the stock of citizens aware except for death and forgetting, the reason behind the decrease in the awareness stock value should be further explored. In the current model structure, the inflow of people getting aware is the only other systemic item directly affecting the stock and it depends on a constant number of citizens informed and on the balancing loop that takes into consideration the susceptible unaware citizens. However, this structure, along with the initialisation of the stocks, prevents the inflow from taking values below the forgetting outflow. Indicatively, if the forgetting outflow increases, the number of potential unaware susceptible rises and, subsequently, the inflow of people getting aware grows as well. Therefore, in order to explain the decrease in the awareness stock, we need to investigate which additional factors may influence the inflow and its strength over time, leading it to values lower than those of the outflow.

Notably, the recent research work of Candia et al. (2019) regarding the decrease of collective attention provides a theoretical explanation, along with connected formalisations, of the dynamics influencing the inflow of people getting aware. The main idea is that the collective attention that people pay to an object depends on the time. More specifically, a new social item (in this case the CP scheme) receives initially high attention, which then decreases with a certain speed, based on the typology of the object itself and on societal contexts. To provide a palpable example, people can get excited about a new song but, after a certain period of time, they do not pay attention anymore and they might also forget it (e.g. due to the 'obsoleting' effect). In addition, this description has come up spontaneously during the workshop. Specifically, an expert journalist described his personal experience in Italy in the 80s-90 s when there was a general excitement for the EU funds and the related projects, while nowadays people do not have the same initial interest and thus do not pay much attention anymore.

More specifically, Candia et al. (2019, p.1) report that *"the literature on knowledge diffusion models the adoption and diffusion of cultural content as a combination of two processes: preferential attachment and temporal decay"*. Grounding on the work of Candia et al. (2019), the temporal decay mechanism has been translated into an SD model (Fig. 11 depicts the manner in which the mechanism

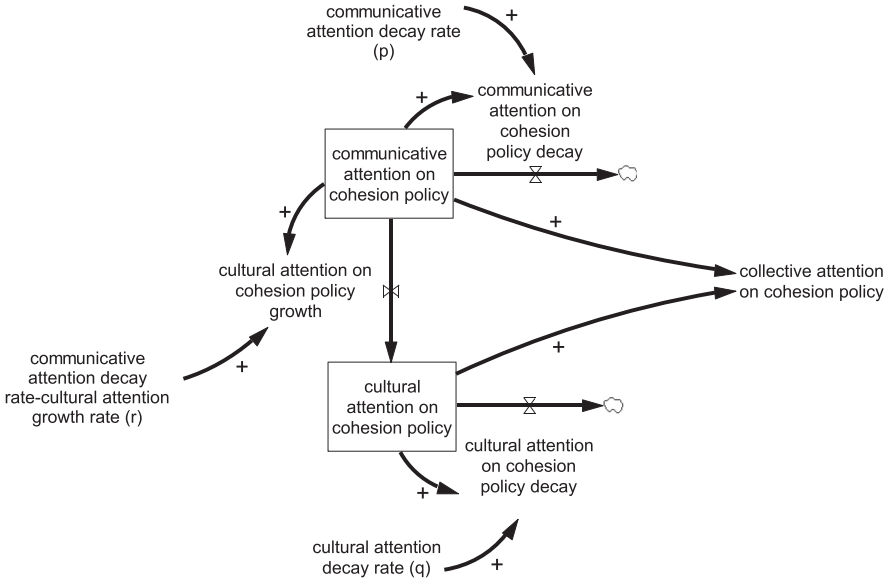

Fig. 11. Stock and flow diagram of collective attention (adapted from Candia et al. (2019)) (Step 5a).

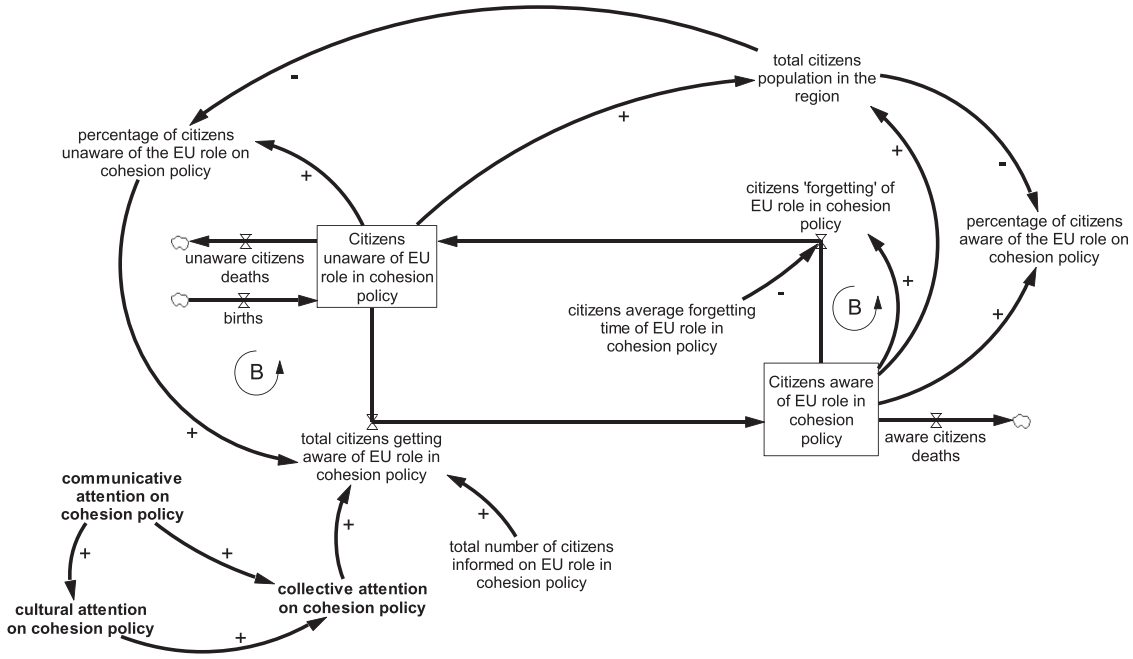

Fig. 13. Collective attention on Cohesion Policy (Step 5a).

has been transformed into a stock and flow diagram). In the model, communicative attention (i.e. the first type of attention that society provides to a new object) is reported as a stock initialised at its maximum value (i.e. 1; based on Candia et al. (2019), attention can take dimensionless (Dmnl) numerical values between 0 and 1) at the start of the simulation. This in practice means that in 1988, the communicative attention on CP funds was high since it was a rather new topic and thus society was reactive to pay communicative attention to it. Then, this stock decreases at specific rates (p) and (r), as described by Candia et al. (2019). The decrease due to the rate (r) is also the inflow of the stock of cultural attention (i.e. a more robust, constructed, and long-term attention), which has been initialised to 0. This stock also decreases based on a specific rate (q). In detail, p represents the decay of the initial attention that a group of people give to a cultural item (i.e. communicative attention), r stands for the transfer of this primary and less deep attention into a more solid and long-term directed attention (i.e. cultural attention), while q captures the fact that also this robust attention will eventually fade away at some point (Candia et al., 2019). Although the parameters p, r, and q are assumed as constants (to generate linear effects for the modelling purposes), they attempt to capture complex social processes. The sum of the stocks of communicative and cultural attention generates the collective attention of the society. The dynamics of the collective attention and its components are presented in Fig. 12, as reported by Candia et al. (2019).[4]

The described mechanism constitutes a 'verbatim' structure integrated into the underlying stock and flow model, while Fig. 13 portrays the integration of this structure into the system map in a simplified manner. As already explained, the *"communicative attention on cohesion policy"* positively influences the *"cultural attention on cohesion policy"*, while they both sum to the *"collective attention on cohesion policy"* of the local community. Then, the *"collective attention on cohesion policy"* positively influences the flow of

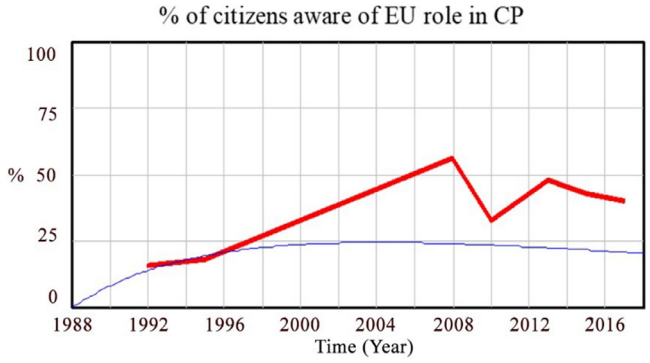

Fig. 14. Percentage of citizens aware of EU role in CP (thick red line – reference; thin blue line – simulated) (Step 5a). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

people getting aware (*"total citizens getting aware of EU role in cohesion policy"*); although citizens receive constant inputs of projects funded by the EU (*"total number of citizens informed on EU role in cohesion policy"*), their receptivity to these inputs changes dynamically, depending on the *"collective attention on cohesion policy"*. Thus, if society tends to pay much attention to the CP, it is more likely citizens become aware. On the contrary, when this attention fades away, the inputs' effectiveness is lower. Overall, the collective attention renders the inflow of people getting aware more dynamic, since the equation of this flow is formally calculated as the multiplication of the fraction of unaware citizens by the number of the informed ones per year and by the collective attention.

The new, more complex, structure generates the behaviour presented in Fig. 14. Notably, for the first time, the model can simulate a decreasing trend after having reached a peak (thin blue line). Although the structure does not replicate yet the real data (thick red line), this decreasing trend constitutes a notable step forward.

Following the dynamics of collective attention, the preferential attachment effect (i.e. the second mechanism that affects collective attention) has been further investigated. Candia et al. (2019, p.1) state that the *"preferential attachment, or cumulative advantage,*

[4] According to Candia et al. (2019), the collective attention S(t) is the sum of the communicative attention u and the cultural attention v; thus, at any given time $S(t) = u(t) + v(t)$. The communicative attention decays as $u(t+1) = (1-p)u(t) - ru(t)$ and the cultural attention as $v(t+1) = (1-q)v(t) + ru(t)$.

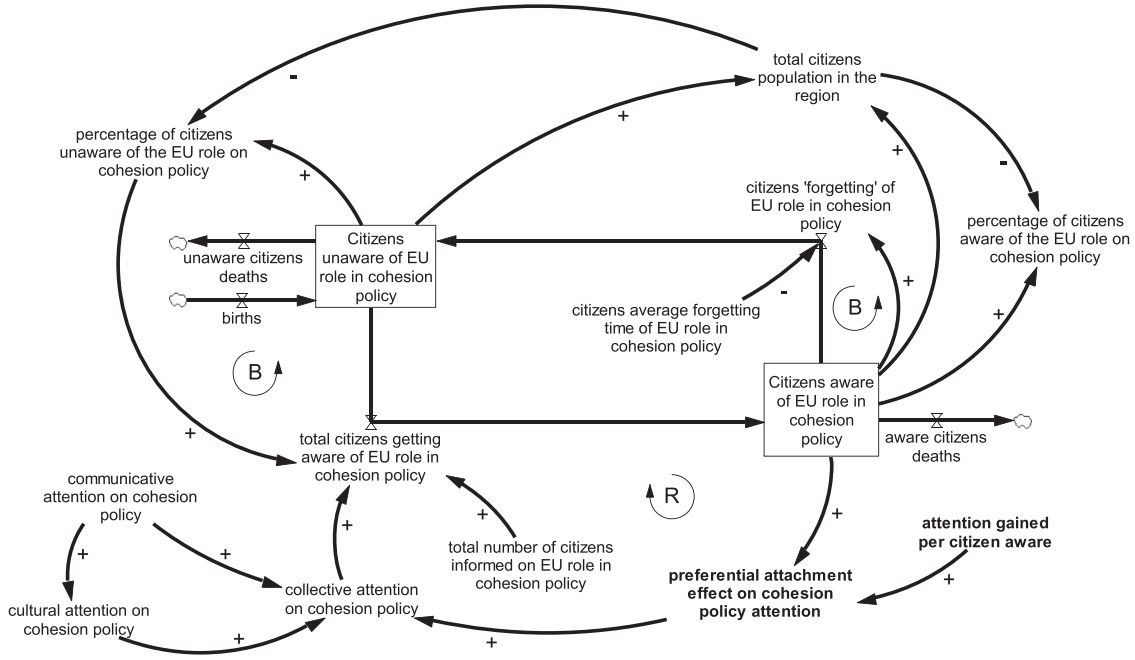

Fig. 15. Collective attention on Cohesion Policy (Step 5b).

refers to a process in which attention begets attention". To provide a more plausible example, we can consider the case of two scientific papers, one with 10,000 citations and another one with 100. The probability that the first paper receives a new citation is larger than the second one, simply because more people already know about it. This preferential attachment process needs to be properly discounted to measure temporal decay". The process described constitutes a self-reinforcing mechanism (i.e. reinforcing loop) in an SD model. In fact, the more interest in a topic exists (in this case in CP), the more it catalyses attention (which is similar to a traditional word-of-mouth loop). Thus, each citizen aware contributes towards increasing attention further ("*attention gained per citizen aware*"), while the generated reinforcing effect ("*preferential attachment effect on cohesion policy attention*") is combined with the "*collective attention on cohesion policy*", increasing the awareness even more (Fig. 15).

The calibration of the model's parameters offers the possibility to test whether the model can replicate the real awareness behaviour reasonably or not. The automatic optimisation function embedded in the software Vensim® was used to calibrate the model. This approach allows for a standardised and transparent calibration, which would be difficult to be achieved with a manual one. The optimisation specifies the parameters that the software should adjust, along with the related ranges, in order to obtain the best fit between the data and model behaviour. Specifically, Vensim® performs a considerable number of simulations (i.e. 2000 runs in our case given the small model size) in which the selected adjustable parameters can receive any value between an upper and a lower limit. Finally, the software searches for the parameter combination that provides the best fit between the model output, namely the "*percentage of citizens aware of EU role in cohesion policy*", and the real data (i.e. reference mode). The best fit is calculated as the largest cumulative payoff.[5] Table 1 reports the six playable parameters of the model, the optimised values obtained,

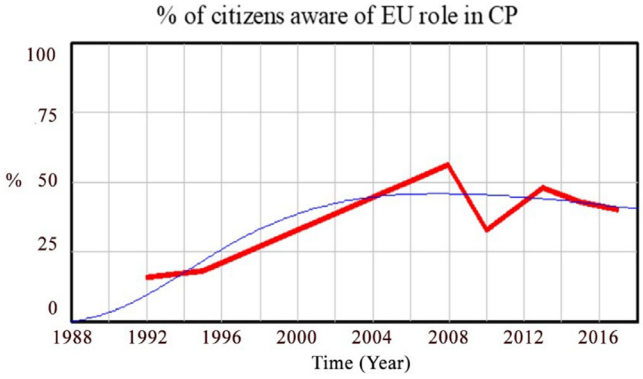

Fig. 16. Percentage of citizens aware of EU role in CP (thick red line – reference; thin blue line – simulated) (Step 5b). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

and the two realistic extreme values adopted. Further information can be found in the supplementary material.

The optimal simulated behaviour is depicted in Fig. 16 (thin blue line). It seems that, finally, the goal is reached; this structure can explain the awareness pattern to a sufficient extent only by combining acknowledged concepts and theories (Bass, 1969; Candia et al., 2019). Moreover, the parameters' values that optimise the model appear to be all plausible and reasonable.

4.6. Salience of cohesion policy in public debate

Although the aforementioned structure can adequately explain the decrease in awareness, it cannot offer an explanation of a new increasing trend, which is particularly evident in the case of the UK (Fig. 1). Notably, given that the Brexit referendum took place in 2016, we have considered that the vote and the related debate may have driven public attention to the EU and probably to CP, thus leading to an increased awareness in 2017. Therefore, Brexit probably worked as a new additional 'fuel' for collective attention, increasing the citizens' awareness. To this end, the variable "*salience of cohesion policy in public debate*", which positively af-

[5] Conceptually, the payoff is the sum of the weight*(model results-real data)^2 over time. In our case, since there is only one variable that should fit one data series, the weight equals 1.

Table 1
Awareness model optimised parameters (Step 5b).

Parameter (*units*)	Optimised value	Lower limit	Upper limit
Communicative attention decay rate (p) (*units of attention decay per unit time*)	0.235228	0.001	1
Communicative attention decay rate-cultural attention growth rate (r) (*units of attention decay per unit time*)	0.143331	0.001	1
Cultural attention decay rate (q) (*units of attention decay per unit time*)	0.0213264	0.001	1
Informed citizens on EU role in Cohesion Policy (*people/year*)	423,507	0	1,000,000
Time for citizens to forget (years)	6.29542	0	45
Attention gained per citizen aware (*dmnl/people*)	2.74881e-006	0	1

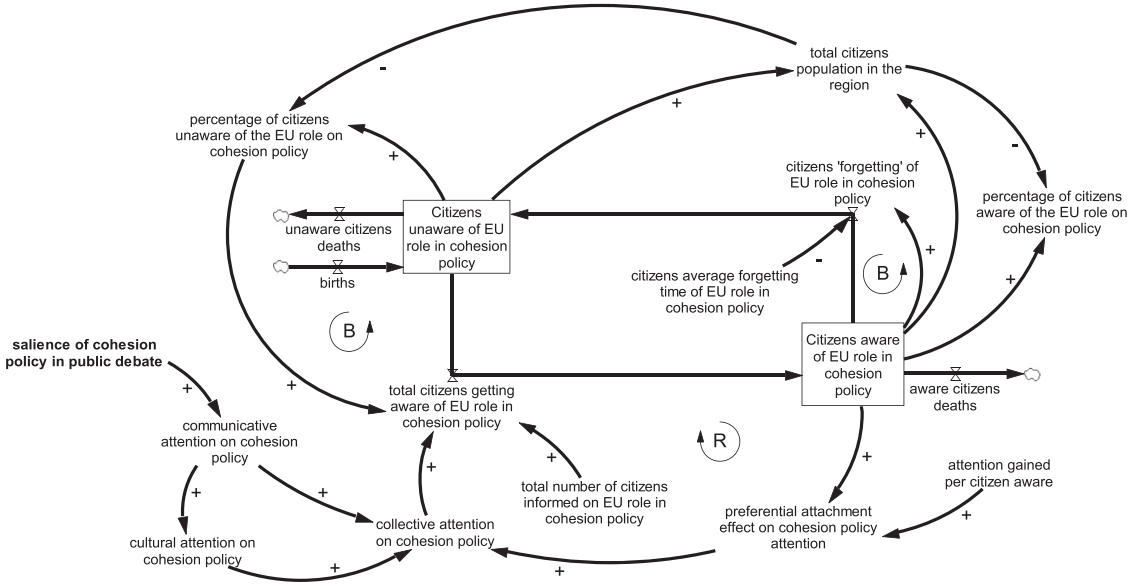

Fig. 17. Impact of CP salience in public debate on attention (Step 6).

Table 2
Awareness model optimised parameters (UK case) (Step 6).

Parameter (*units*)	Optimised value	Lower limit	Upper limit
Communicative attention decay rate (p) (*units of attention/unit time*)	0.71913	0.001	1
Communicative attention decay rate-cultural attention growth rate (r) (*units of attention per unit time*)	0.312444	0.001	1
Cultural attention decay rate (q) (*units of attention/unit time*)	0.134485	0.001	1
Informed citizens on EU role in Cohesion Policy (*people/year*)	965,656	0	1,000,000
Time for citizens to forget (years)	8.21559	0	45
Attention gained per citizen aware (*units of attention/person*)	2.74881e-006	0	1

fects the "*communicative attention on cohesion policy*", was added in the model (Fig. 17).

To represent the CP salience in the public debate due to Brexit, a PULSE equation has been used, indicating an increased salience around 2015. The PULSE function that expresses the "*salience of cohesion policy in public debate*" variable is set to start in 2015 (since the debate for Brexit is assumed to have begun before the referendum took place), has a length of 1 year (a debate is assumed for the whole year before the vote), a dimensionless unit (such as the attention), and a magnitude of 0.25 (calibrated value using the available data). In fact, the idea is that Brexit vote reactivated for a short period the attention mechanism on the EU (and thus potentially on CP). Using the UK data as reference (thick red line), the simulation results of this structure are presented in Fig. 18 (thin blue line), in which there is a rise in the percentage of the citizens' awareness after 2016. As in the previous step, the calibration parameters were obtained performing an optimisation using the software Vensim® (Table 2). Notably, the salience function, along with the optimised parameters, is able to reproduce this increasing pattern observed in the UK data. Overall, it seems that, even if the consistency of the "Leave" movement determined the Brexit outcome (Shaw, Smith & Scully, 2017), the related public debate

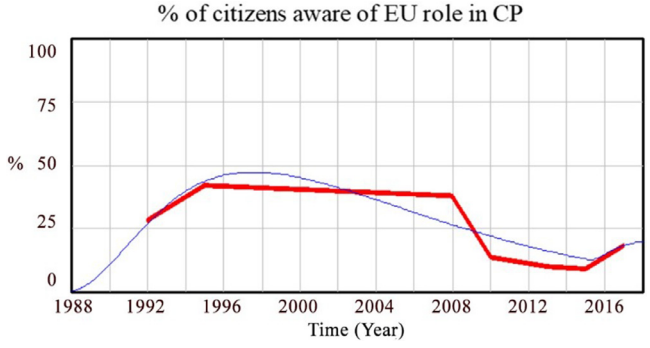

Fig. 18. Percentage of citizens aware of EU role in CP (UK case) (thick red line – reference; thin blue line – simulated) (Step 6). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

potentially provided a stronger impact on attention, and thus on awareness, compared to CP campaigns. More specifically, when the EU role becomes the centre of public debate, as assumed in the Brexit case, people seem to pay, in general, more attention to CP.

Table 3
Awareness model optimised parameters (Swedish case).

Parameter (*units*)	Optimised value	Lower limit	Upper limit
Communicative attention decay rate (p) (*units of attention/unit time*)	0.110868	0.001	1
Communicative attention decay rate-cultural attention growth rate (r) (*units of attention per unit time*)	0.374304	0.001	1
Cultural attention decay rate (q) (*units of attention/unit time*)	0.058174	0.001	1
Informed citizens on EU role in cohesion policy initial effort (*people/year*)	218,037	0	1,000,000
Informed citizens on EU role in cohesion policy base effort (*people/year*)	50,000	0	50,000
Time for citizens to forget (years)	25.7774	0	45
Attention gained per citizen aware (*units of attention/person*)	2.74881e-006	0	1

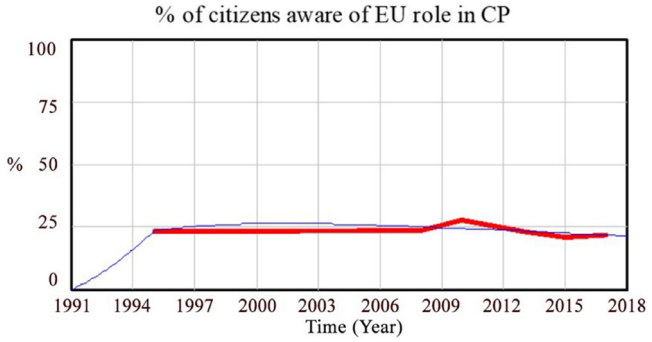

Fig. 19. Percentage of citizens aware of EU role in CP (Swedish case) (thick red line – reference; thin blue line – simulated) (Step 7). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

4.7. Swedish awareness behaviour simulation

Compared to the EU average trend, Sweden exhibits a particular behaviour, namely a constantly low awareness (around 20–25%) over time (Fig. 1). As mentioned in Section 2, the existing literature highlights that Swedish people perceive public budget expenditure for policy results' advertisement as wasteful (Barberio et al., 2017). Therefore, in Sweden, CP awareness campaigns are expected to be limited. Thus, it could be interesting to test whether the developed model is capable of simulating this unique behaviour. In more detail, the simulation starting time is set to 1991, when the Swedish government formally submitted their application to become an EU member. In this year, we have further assumed that the political debate on the EU and its policies, including CP, started to be relevant in the country. To replicate the Swedish social context, a minor structural variation has been implemented. Specifically, the number of the "*informed citizens on EU role in Cohesion Policy*" is divided into two different components: (i) an high initial effort in communication ("*informed citizens on EU role in cohesion policy initial effort*") from 1991 until 1995, a period in which CP was under the spotlight due to country's accession to the EU, and (ii) a subsequent low base effort that showcases the low Swedish appreciation of the communication campaigns ("*informed citizens on EU role in cohesion policy base effort*"). This approach practically entails the two different upper limits for the optimisation of the abovementioned variables during the model calibration (Table 3). Finally, the "*salience of cohesion policy in public debate*" structure has been deactivated since events similar to the Brexit debate, which are able to reactivate communication attention, have not occurred. The simulation results are depicted in Fig. 19.

The fit between the real data and the model output seems to be satisfactory. This outcome offers an additional behavioural validation of the developed model structure. In addition, the calibration provides a considerably different value (i.e. 25 years) for the average time before the citizens forget compared to Italy (i.e. 6 years) and the UK (i.e. 8 years). The increased value stems from the lower base effort to inform citizens; if the inflow of people getting aware is lower, the outflow of citizens' forgetting is reduced to produce an almost flat behaviour. In this direction, a higher time to forget is the only possible explanation. Notably, although the upper limit of the base effort directly restricts the related optimised value, we have considered to keep it considerably lower compared to the limit of the initial effort to validate the general idea about the longer memory retention (flat curve over time) of the Swedish society compared to other EU countries.

5. Discussion and insights

5.1. Structural and modelling insights and limitations

Overall, the model seems to be able to replicate reasonably the reference modes of EU countries with different behaviours. In fact, it captures the curves' trends, slopes, and heights with relative accuracy. Specifically, the developed model is capable of reproducing the behaviour of three different countries (i.e. Italy, UK and Sweden), thus providing additional confidence on the structural validity. Minor fluctuations in some countries' behaviours (Fig. 1) are explained by small-scale and temporary variations in the public attention towards EU and CP or in the communication efforts; they generate small bounces in the percentage of citizens aware followed by reductions due to the general tendency of the system.

In addition, although the real data showcase a rather abrupt decline in some countries, the model generally produces gradual declines. This discrepancy stems from the fact that the real data are scattered over time rendering the reference modes as 'discontinuous lines', while the actual dynamic changes in social systems, such as those regarding awareness and memory, usually evolve smoothly. Despite the uneven data distribution due to the periodic EU reporting that limits the preciseness of the curves, the data still provide important insights on the main trends. Although awareness initially increases, following the locally implemented CP project accumulation, it starts decreasing and fluctuating unexpectedly. This important aspect of the system constitutes the behaviour that the model primarily aims to explain, necessitating the use of SD. Not only does this approach provide the ground and the 'language' to develop the series of logical steps undertaken to build the model, but it also facilitates the dialogue between diverse social theories (Bass, 1969; Candia et al., 2019) and empirical data. From a technical perspective, the aforementioned SD process of theory building could be meaningful in terms of the adopted procedure, which can be utilised as a practical example for future studies on policy awareness.

Finally, concerning the model boundaries, the model does not consider the way in which the information about CP is communicated. The main scope of this study is to explore how societies become aware and then eventually forget, and not how the citizens become informed. Hence, the assumption of a constant information inflow, though it is limited for now, is considered as appropriate with respect to the model purpose. However, a future extension including the dynamic pattern of the "*total number of citizens*

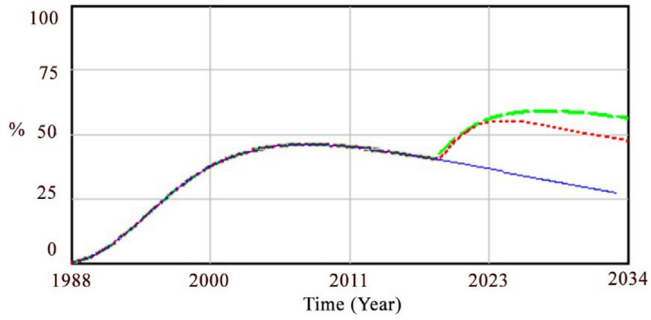

Fig. 20. Percentage of citizens aware of EU role in CP (solid blue line – reference; dotted red line – exogenous attention shock; dashed green line – communication increase). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

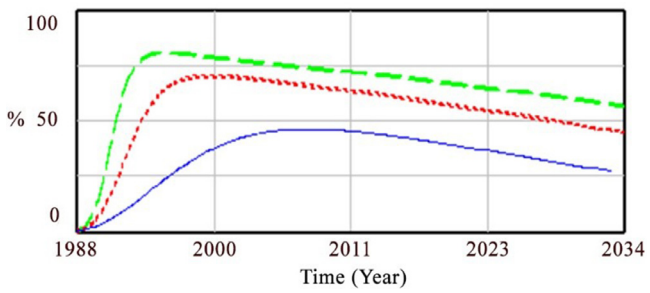

Fig. 21. Percentage of citizens aware of EU role in CP (solid blue line – reference; dotted red line – 50% initial communication increase; dashed green line – 100% initial communication increase). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

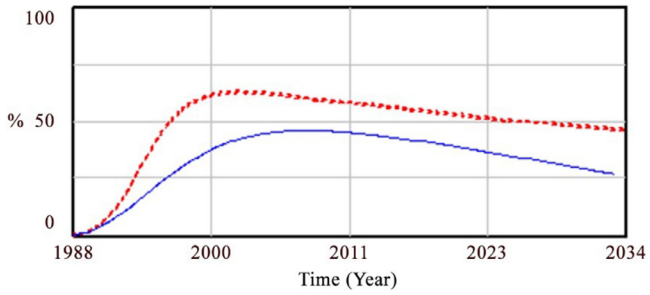

Fig. 22. Percentage of citizens aware of EU role in CP (solid blue line – reference; dotted red line – 50% attention decay rates reduction). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

informed on EU role in cohesion policy", which will be feasible in case data about the impact of CP communication will be available, could potentially provide additional meaningful insights about the CP awareness system.

5.2. Investigation of future awareness behaviour

The impact of the diverse scenarios on the future behaviour of awareness has been further explored to assess if the undesired behaviour continues and, in this case, if there are effective policy interventions. In the base scenario, all optimised parameters for the Italian case remain constant as presented in Table 1, while for simulations beyond 2018 the forecasted birth and death values were retrieved from the United Nations Department of Economic and Social Affairs (2017). In Fig. 20, the base case (solid blue line) indicates that awareness continues to decrease after 2018 till 2034 (when the policy cycle after next will be concluded); given the constant flow of information, the decay of attention, which constitutes the main driver of the system, will reduce the level of awareness. At the same time, the model can provide an indication of what could be the future awareness behaviour in reaction to systemic peculiarities, such as the increase in awareness in the UK. The dotted red line presents the case in which the collective attention mechanism has been reactivated temporarily due to an increased salience of the EU topic in the public debate in 2018. As a result, awareness increases, but, once the boost provided by the stimulus is over, it tends to decrease again. In the last case (dashed green line), the situation in which policy-makers increase the CP communication activities and improve their effectiveness is explored. A sudden increase in the communication effort by public authorities (e.g. number campaigns, investments in communication, improvements in communication quality, communication staff skills) or beneficiaries (i.e. communication due to the projects implemented and subsequent word of mouth) has been simulated to occur in 2018. This simulation generates a 100% growth in the number of citizens informed compared to the base scenario. Although there is an improvement in awareness, the decay of attention tends to reduce it in the future term. Thus, this effort could be a temporary solution, yet not sufficient in the long term.

5.3. Findings and policy recommendations

This study highlights that the decay of attention seems to be the main driver of the system. To limit or at least postpone its impact on awareness, policy-makers could consider to maximise the benefits of the initial high attention, which renders information inputs more effective, by spending more effort in communicating the new policy interventions at the beginning (i.e. increase *"total number of citizens informed on EU role in cohesion policy"*) to make aware as many people as possible. Indicatively, Fig. 21 below shows the behaviour of awareness when communication efforts are increased by 50% (dotted red line) and 100% (dashed green line) since the beginning of CP implementation. The peak of aware citizens is much higher than it is with the baseline number of information inputs. Although this intervention is expected to generate a high initial level of awareness, the number of aware people will decline anyway. Therefore, policy-makers and researchers should investigate if a proportional increasing effort in disseminating communication inputs could counterbalance the decreasing attention to keep up with the inflow of people getting aware. Alternatively, stimulating the public debate about CP could also benefit the citizens' awareness in order to reactivate the attention mechanism (as it probably happened during the Brexit debate).

Moreover, policy-makers may adopt a long-term and holistic approach and consider to act on social attitudes. More specifically, policy-makers could try to influence how citizens pay attention to an object through influencing collective attention. Specifically, improving the related decay rates: "*communicative attention decay rate (p)*", "*communicative attention decay rate-cultural attention growth rate (r)*", "*cultural attention decay rate (q)*" could be a possible solution. According to Candia et al. (2019), these parameters represent the manner in which society process its attention to a topic. Notably, recent evidence emphasises that the abundance of and the competition for up-to-date information (enabled by the technological advancements and the social media use) may increase decay rates and lead to the rapid exhaustion of collective attention (Lorenz-Spreen, Mønsted, Hövel & Lehmann, 2019). Hence, policy-makers are encouraged to guarantee a steady flow of credible, targeted, and balanced CP communication. This strategy could avoid the irregular distribution of information, which may lead into a whirlpool of attention competition, and counterbalance the rapid social attention decrease. Assuming that this policy could be effective, Fig. 22 showcases the awareness behaviour if all three

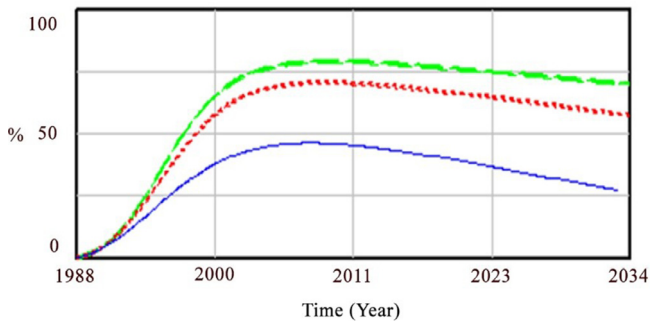

Fig. 23. Percentage of citizens aware of EU role in CP (solid blue line – reference; dotted red line – 100% memory increase; dashed green line – 200% memory increase). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

decay rates of collective attention are reduced to half (dotted red line) compared to the baseline scenario (solid blue line). As in the case of an increase in communication, the level of awareness rises significantly. In general, given the strong effect of attention decay, awareness' behaviour is decreasing, but at a lower rate.

In addition, the proposed study suggests that people might tend to forget the benefits that the EU brought to them. Although the EU offers a wide positive effect to member states in terms of a condition of peace, integration, and cooperation, the number of Eurosceptic citizens is increasing, maybe due to the fact that citizens have taken for granted the importance of the EU in their daily life. In general, the mechanism of memory loss expresses the idea that in society there is a potential 'take-for-granted effect': after an initial period of attention and appreciation for an object (e.g. CP), people start to forget the benefits that this object is providing them, taking it for granted. Thus, policy-makers may act towards increasing social education with respect to the manner in which citizens retain the attention and/or forget, in order to work on the roots of the system. In this direction, the impact of a change in the "*citizens average forgetting time of EU role in cohesion policy*" has been explored in the long term. In Fig. 23, the solid blue line reports the base scenario (slightly more than 6 years on average before people memory on CP benefits fades away), while the dotted red and dashed green lines portray an increase of 100% and 200% in memory, respectively. In fact, the higher the time to forget is (i.e. citizens have a strong memory), the higher the awareness is. Projecting the future behaviour, the general trend of awareness continues to decrease due to the inherent decay of attention but at a lower rate.

These findings highlight the extent to which social and cultural characteristics are crucial in determining the level and the decreasing rate of awareness. Therefore, policy-makers should invest in creating an appropriate cultural terrain. Indicatively, the investment in education could increase the resilience of the communication investments in the long term. However, these socio-cultural processes appear to be rather challenging to be influenced and might be considered as ethically questionable, as they require interaction with intrinsic personal and social characteristics. Thus, working on these aspects entails a long-term perspective on the development of innovative interventions respecting both social cohesion and human individuality. Overall, the integration of all abovementioned efforts could be the most effective approach to limit the awareness decay.

6. Conclusions

Based on real-world evidence, the citizens' awareness of CP shows a declining trend over the last years, despite the accumulation of regional EU interventions for more than thirty years. Although researchers have recently started to focus on the relationships between the CP implementation and the citizens' awareness, the existing efforts are limited to static approaches. Thus, a lack of a systemic, dynamic and operational explanation of the related social phenomena is evident. To fill this gap, this study aims to provide a sounded modelling framework using the SD methodology as an exploratory method for theory building (De Gooyert, 2016; De Gooyert & Größler, 2018; Forrester, 1994; Schwaninger & Grosser, 2008). In terms of simplicity, by using four mechanisms occurring together, yet on different levels, the empirically collected awareness behaviours were explained and replicated to a sufficient extent. The basic diffusion dynamics (Bass, 1969) is the first mechanism employed to understand awareness dynamics. The second mechanism is associated with the process of citizens becoming aware by being actually informed ("*total number of citizens informed on EU role in cohesion policy*") and by paying attention to the topic of the EU funding in order to internalise these information inputs ("*collective attention on cohesion policy*" theory-mechanism, as adapted by Candia et al. (2019)). The third mechanism refers to the preferential attachment ("*preferential attachment effect on cohesion policy attention*") in which attention begets attention. Finally, the individual characteristic through which people tend to forget ("*citizens 'forgetting' of EU role in cohesion policy*") is the fourth mechanism.

The contribution of this work is multi-fold. Firstly, it offers an important empirical validation of the theory developed by Candia et al. (2019) regarding collective attention to a cultural object. Secondly, this model could be a relevant SD contribution to theory building in the field of social sciences. In fact, given that studies of the awareness fluctuations over time are scarce, this effort could be a step forward towards improving the comprehension of the underlying mechanisms driving this phenomenon. More specifically, the fact that people might forget, along with the dynamics of collective attention towards social topics, seems to be overlooked by academics, policy-makers, and practitioners. This might explain the reason why, during the last years, increasing efforts on CP communication resulted ineffective in reaching citizens. Hence, the presented cause-effect operational analysis further constitutes a first attempt to integrate diverse research domains (e.g. social science, statistics, operational research) to explain CP awareness dynamics. Overall, this research effort can be also considered as a step forward in computational social sciences, confirming the utility of SD in this field as an operational research tool (Lane, 1999). Thirdly, the modelling findings could be generalised for other EU policies and the EU organisations in general. As citizens' support towards EU institutions is decreasing over time, the EU seems unable to stimulate attention and support continuous awareness of its actions and contribution. Thus, the European citizens might not get aware or forget about the benefits provided by the EU, ending up taking them for granted. Finally, the model could be further implemented to institutions and organisations other than the EU, especially to those that encounter difficulties in gathering citizens' attention towards their policy interventions. Thus, this conceptualisation could support policy-makers in developing an effective communication strategy.

As regards future research directions, empirical research could be used to test the causal connections amongst variables thereby enhancing the robustness of the model structure. This is a common step of exploratory SD (De Gooyert, 2016). The structure should be further refined and improved. In addition, the calibration of the parameters with real-world data is a priority. In particular, the value of the forgetting time ("*citizens average forgetting time of EU role in cohesion policy*") should be explored to assess whether this time is actually constant or it depends on dynamic cultural determinants. This investigation could offer additional information regard-

ing the take-for-granted effect that potentially exists. Similarly, emphasis should be placed on the number of people informed ("*informed citizens on EU role in Cohesion Policy*") which has been considered as a constant outside the system boundaries. Additionally, research should be driven towards holistic cause-effect dynamic approaches and not be limited to static analyses. Moreover, operational research practitioners should further assist in tackling complex problems that affect societies, such as the CP system; scientists are anticipated to start *"walking the line"* (Sterman, 2000, p.449) and interact with practitioners in the field of behavioural and social sciences to improve the tangible outcomes of their models (Brocklesby, 2016). In this context, it is crucial that many forms of knowledge on CP awareness should be integrated to map and analyse its complexity in a comprehensive manner. Therefore, participatory approaches could be valuable (Franco & Montibeller, 2010; Scott et al., 2016; Vennix, 1996). Finally, the adoption of a similar cause-effect operational analysis to study the personal behaviour towards public policies from an individual perspective, to complement the proposed societal level of analysis, could further unveil meaningful insights for behavioural scientists.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.ejor.2020.07.017.

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