

# **Filter Bubble Effects on Deliberative Democracy?**

## **– A Realist Synthesis of Empirical Research**

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by  
Jonas Wisbrant (spr15jwi)  
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*Supervisor and examiner:  
Howard Nothhaft*

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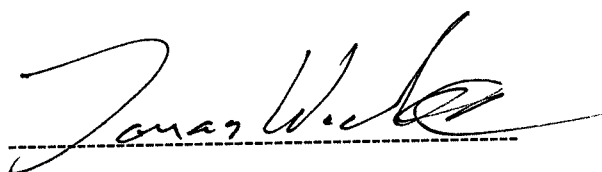
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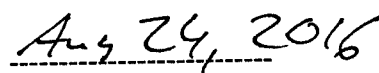
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## Abstract

In 2011 Eli Pariser coined the term ‘filter bubble’ and warned that online algorithm driven filters based on users’ click behaviour, would risk to reduce the diversity of public discourses and thereby deliberative democracy. Through the multidisciplinary and iterative Realist Synthesis method, the aim of the study has been to synthesise empirically based understanding of how online algorithm driven filter bubbles affect public discourses and deliberative democracies.

On *micro level*, the result confirms selection bias and corresponding confirmation bias in the contexts of online feed oriented political messages that would constitute a necessary key condition for algorithm driven filter bubbles to emerge. However, none of the studies in the sample have explicitly investigated effects of these filters on political attitudes. Therefore, filter bubble effects on public discourses and democracy can neither be verified, measured nor refuted.

On the *meso level*, the presence of online clusters of biased online political content, that could serve as foundations for online echo chambers, are shown, and their inner workings partly explained. Also shown is that these environments have the potential to reduce the diversity of political discourses, but also to support polarisation and radicalisation.

On *macro level* the results indicate that national borders, power distribution of political websites, and personalisation through localisation, language and political topics, differentiate what Internet users see when surfing or searching the web in a way that could affect diversity of global or national political discourses.

The results also indicate stratification of discourses where some users with high topic involvement, curiosity or interest in politics are relatively immune to political selection bias, while other groups of less interested or knowledgeable followers, are likely to be reached by less diversified messages.

Limited to the sampled research, this meta study shows that contemporary Internet brings challenges to deliberative democracy, but until further not because of algorithm driven filter bubbles.

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# 1 Definition of the research problem

## 1.1 Background

The idea of a threat to democracy from algorithm driven filter bubbles is widely spread and extensively discussed, but only partially researched. In May 2016 five years had passed since Eli Pariser released ‘The filter bubble: What the Internet is hiding from you’ (2011) and thereby coined the term ‘Filter Bubble’ that he described as:

The basic code at the heart of the new Internet is pretty simple. The new generation of Internet filters looks at the things you seem to like—the actual things you’ve done, or the things people like you like—and tries to extrapolate. They are prediction engines, constantly creating and refining a theory of who you are and what you’ll do and want next. Together, these engines create a unique universe of information for each of us—what I’ve come to call a filter bubble—which fundamentally alters the way we encounter ideas and information. (Pariser 2011, p.14)

In practice this, among other things, suggests that filters and recommender systems on the Internet lead to users being more and more exposed to information, which reinforces their insights and attitudes, having negative effects for public discourses and thereby democracy. In January 2016 Google gave 191.000 hits for the search term ‘filter bubble’, Google scholar gave 2.490 hits and reported 1102 citations of Pariser’s book. At the time of the publishing of the book there were both positive and negative reactions. Some commenters tried the simple test of asking friends to google a given term and found only small differences, and thus refuted the concept as too pessimistic. Others took the threat more serious and assisted in sounding the warning bells. Pariser was not the first to notice the phenomena. Without referring to self-confirming algorithms, Sunstein (2002, 2009) warned that the extensive options for Internet users, to voluntarily personalise e.g. news, threatened deliberative democracy by enclosing people into online echo chambers, and thereby isolate opinion groups from each other. One of the most significant contributors to the Internet as we know it, Tim Berners-Lee, had for instance publicly warned against the lock in effect of some social media services (Bosker, 2010).

However, it has been difficult to find evidence contradicting that it was Pariser who coined the term ‘filter bubble’. And in doing so, the family of rich metaphors influencing

natural language and thereby the way we understand the world, like for instance ‘social construction’, ‘the butterfly effect’, ‘brand’, ‘black hole’, ‘framing’, ‘subconscious’, ‘the public sphere’, and ‘the seventh wave’ *etc.* got a new sibling.

Intuitively plausible as the existence of a filter bubble with disastrous consequences may seem, it has been very difficult to find empirical studies looking into the big question of societal consequences for discourses in the public sphere and thereby also for deliberative democracy. There is research that for instance show filter bubble effects in a very limited setting. In a longitudinal study of user behaviour at a movie recommendation platform Nguyen *et al.* (2014) showed that people using the recommender system got a narrower taste for movies than those who did not use the recommender systems. Apart from verifying a weak but traceable filter bubble effect in a limited context of popular culture, they also suggested a credible method for measuring the effect. However, in a real world setting their approach of analysing user log files, covering more than a year, would be very difficult to scale to a study covering all media consumption and all offline communication for a representative part of a population in order to analyse what impact algorithm driven filters have on the forming of opinions in more or less public spheres, and thereby on deliberative democracy. Even with full access to the data and computational power of the server parks of Google, Facebook, FRA<sup>1</sup> and NSA, such a study would (not to speak of ethical considerations) be difficult to implement. As far as might be guessed, these organisations probably have access to metadata covering where people are, who they meet and also why many of them meet. But they are not likely to have access to codified versions of our real life communications.<sup>2</sup> A comprehensive research project to prove the existence of filter bubbles would be a project of society-wide dimensions extending over decades. An available and a more limited alternative strategy is to perform an interdisciplinary meta study on various aspects of the topic and try to synthesise empirically

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<sup>1</sup> Swedish analogue to NSA

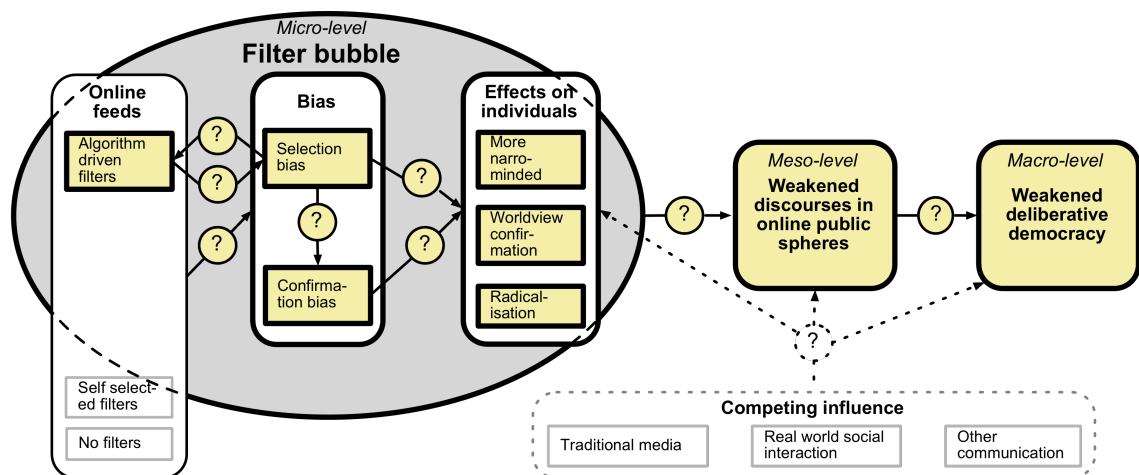
<sup>2</sup> Neither would these organisations likely give away the answers if they knew them.



based findings. This is what this study has tried to achieve. Believing that Internet as such has had tremendous, both positive and challenging consequences for the development of public discourse and democracies, the high-level results show that self-selected or algorithm based filters may impose various challenges to diversity of online political discourses. However, in the 28 purposely sampled reports from empirical research underpinning this study, there is no evidence showing that algorithm driven filters contribute to this development.

## 1.2 The filter bubble concept and problem

The aim of the study has been to analyse empirically based understanding of the effects of filtering algorithms on the workings of public spheres and thereby deliberative democracy. Before detailing the research purpose and questions, it is relevant sketch a high level model or theory of how algorithm driven filter bubbles are expected to challenge deliberative democracy. An illustration, based on the description by Pariser (2011), in combination with how the phenomena is construed by other authors, is outlined in Figure 1.



**Figure 1:** Model of how algorithm driven filter bubbles might affect online public discourses and thereby deliberative democracy – overview. Fields marked with yellow is at the centre of this analysis.

Driven by an ambition to make users continue or increase their usage of Internet services, providers of these services optimize their systems for user satisfaction. In order to optimize revenue, some providers also optimize for exposure to ads from customers or own products. Since concepts as selective exposure (Sears & Freedman, 1967; Hart *et al.*, 2009) and

the related confirmation bias<sup>3</sup> (Hart *et al.*, 2009; Yeo *et al.*, 2015) in many situations are effective, the service providers utilise knowledge of the users' previous behaviours to engineer a *framing* (Hallahan, 2011; Johansson, 2009) of messages or offers that the user, or similar users, are expected to like. Filters based on the user's own behaviour are often termed *content-based filters* while filters based on the behaviour of other users are termed *collaborative filters* (Adomavicius & Tuzhilin, 2005; Fleder & Hosanagar, 2009).

Other mechanisms expected to affect the success of the system are concepts like social proof as explicitly revealed aspect of collaborative filtering, and spiral of silence<sup>4</sup> leading to that the service provider, when it is possible and plausible, utilize knowledge about preferences of the user's friends in the same way. The more skilled the service provider is in this area, the more satisfied become the users, making the service provider more successful. The more a user uses the system the larger share of messages will confirm and thus reinforce her or his knowledge, beliefs and attitudes. If the content of the service is politically uncontroversial, e.g. knitting, sport fishing or HiFi, this would only be a problem for deliberative democracy if the user spent all time awake in that kind of online communities and thus avoiding information on topics more relevant from a political perspective. However, realising that many users increasingly also get the major part of their political information through algorithm driven feeds, where generally accepted concepts like selective exposure, framing, confirmation bias, social proof, and spiral of silence are at play, this could introduce serious threats to deliberative democracy by obfuscating public discourse on political matters.

In the course of this project, the author assumes a wide definition of deliberative democracy in the tradition of Kant (1784), Dewey (1927) and Rawls (1997), accompanied by

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<sup>3</sup> A concept explaining how people, in order to avoid discomfoting cognitive dissonance, tend favour information confirming their current beliefs and attitudes. It is generally acknowledged that the concept was introduced by Peter Wason in 1960 (Wason, 1960). The phenomena is expected to affect searching and interpretation of information, but also e.g. what people remember. The term 'selection bias' is later used in order to focus on the *selection* aspects that are a central parts of online behaviour.

<sup>4</sup> A theory suggested by Elisabeth Noelle-Neumann that suggest that people, in fear of being isolated from a social group, avoid expressing opinions opposing or being outside what is perceived as the main stream opinion of that particular group. The theory also suggests that people in these contexts may adopt the main stream perspective. (Noelle-Neuman, 1984)

the critical perspective of Habermas (1964), that in short would mean an organisation of national states based on representative open elections to public offices that rule by law. But also that these states recognise, defend and adjust regulations and resources for both freedom of speech in publicly accessible spheres and human rights in line with UN declarations. Furthermore, deliberative democracy in that tradition also requires that people and organisations acting in the in the political areas outside the public offices align to and recognize the same basic principles. This mean being fair and honest in discourses and, when in office, not try to alter the constitution or the openness of the discourse in order to gain advantages that facilitate staying in office.

In such political system auto confirming feeds on politically relevant topics, could in worst case lead to the formation of groups and subcultures in virtual echo chambers (Garrett, 2009; Sunstein, 2007; Williams *et al.*, 2015), sometimes termed Internet balkanization (Alstynne & Brynjolfsson, 1997), where partisan groups, protected from exposure to opposing views, attitudes and knowledge, were lead to successively more extreme and/or narrow attitudes. Such developments could infer two interconnected challenges to deliberative democracy. First, the public discourse would be fragmented into several more or less isolated discourses seldom exposed to each other and thereby to counter arguments. Secondly, protected by relative isolation, anti-democratic political movements could gain strength and in the long run even challenge the organisation of deliberative democracy as such.

Examples of recent legislative or other alterations of discourses are the Italian media concentration during Berlusconi, governments interfering with public service media in Hungary and Poland, and the public discourse backlashes in Egypt when the Muslim Brotherhood had won the first public election after the Arab Spring. Other examples of challenges to public discourses are the Russian and Turkish governmental interference with the traditional media also outside governmental control. These are all examples of when public discourses have been undermined by people and organisations that before gaining office hardly campaigned on restricting freedom of speech, but on safeguarding the nation against more or less realistic threats to “our way of living” from immigrants, theorists, or enemy states *etc.*

Assuming that people actively participating in a reasonably functioning public sphere, if asked directly, would strongly oppose a weakening of the discourses; how come that people or organisations restricting public discourses gain offices? Few would probably blame filter bubbles for the negative developments mentioned above, but rather explain it as unfortunate backlashes in young democracies where the non-constitutional deliberative aspects still have had a weak anchorage in the political culture. However, the contemporary ideological polarisation and strong extremist movements, some of them with an outspoken anti-democratic agenda, in rather stable western democracies, could perhaps to some degree be explained by filter bubbles driven echo chambers, where participants in partly isolated environments get a weak schooling in the for deliberative democracy so important acknowledgement of the non-constitutional aspects of open and honest deliberation.

There remains, of course, the question of causation in order to investigate a relation between filtering algorithms and threats to democracies, and if so, how strong the relation is. As a starting point one would need to clarify causality on several conceptual levels. On the micro level of online media, a key question is whether it is true that people consuming a lot of media inside filter bubbles become more narrow-minded, but also if it is possible to differentiate online from offline effects in social networks. Other questions on the micro level would be if awareness and understanding of the filter bubbles affects the media consumer behaviour. For example, are educated media consumers aware of the algorithm effects on their world view? And, do bubble-aware people use the filter bubbles to frame their environment or do they apply a more critical perspective toward the content delivered through these systems?

On the meso level, an investigation would focus on how online groups and subcultures emerge and develop and, if there are any interacting effects between different systems. One would also need to investigate if it is possible to differentiate density and isolation between networks hosted by different platforms, or between online and offline communication, or depending on what topics that are discussed.

Assuming that many media consumers spend time out of reach from algorithmically filtered communication by e.g. consuming traditional media or talk to people,

the questions on a societal macro level is if and how, algorithm driven filter bubbles scale to opinion building in the public sphere and thereby alter a key foundation for deliberative democracies. To make an empirically based effort to address this question would be an enormous quest over at least a decade covering a multitude of quantitative and qualitative coordinated studies, and in that by far be larger than the PR excellence research program (Grunig *et al.* 1992). To the knowledge of the author such a study is not published nor started. Furthermore, such study would be way out of scope for this project, but what could be done is to with an open mind and a creative research process start to investigate and synthesise findings of empirical research on parts of the presumed causal chain as illustrated in Figure 1.

### **1.3 Research problem, high-level research design and expected outcome**

With 2.500 google scholar hits, the term ‘filter bubble’ clearly is widely used and it ought by now (2016), to be possible to explore what aspects of the phenomena that have been researched and explained, proven or refuted. It should, in other words, be possible to dig into reported research and aggregate, compile and synthesise what knowledge has been gained so far.

Therefore, the high level research question was formulated as: What aspects of the filter bubble phenomena are empirically researched and proven? Despite the intriguing challenges and wide attention, to the knowledge of the author, this question has not been addressed in a systematic way.

The objective of this study was to, through an analysis of empirical studies try to synthesise empirical based knowledge in the domain. The analysed studies were identified in a sample of about 150 studies addressing various aspects of the causal chain: *filter algorithms in online communication platforms* → *narrow-mindedness* → *weakened discourse* → *problems for democracy* as outlined in Figure 1. Within that objective the aim was to identify what aspects of the filter bubble phenomenon that have been researched and proven, debated or refuted. Intermediate objectives were also to further detail and develop the model *per se* and to suggest a research process for continuously enriching the empirically based knowledge base.

Expected outcomes of the study were empirically based indications of the answer to the big question: to what extent and under what circumstances filtering algorithms are obfuscating public discourses on political matters. Answers to that question ought to be highly relevant to SC/PR scholars and practitioners as discussed in Sections 3.1 and 5, but also to other stakeholders as legislators and Internet service providers. However, on a second level, an expected outcome was to arrive at a better developed model of the filter bubble phenomena and to suggest a research process for continuously updating and extending the understanding of forces at play. The motives for choice of meta study method are discussed in Section 2 and further presented in Section 3.3.

## 2 Literature review of meta study methodologies<sup>5</sup>

The most difficult choice the author faced in this project was to choose the right method for conducting a meta study, i.e. a framework that could cover scientific domains as Communication Studies, Journalism, Computer Science, Informatics, Political Science, Public Relations, Management, and more. Even if the study is limited to primary empirical studies the method also had to address and support analysis of quantitative, qualitative as well as mixed method studies, but also a variety of epistemological traditions like positivist, post positivists, constructivists, Marxist, cultural studies *etc.* Given the unlikelihood of finding studies covering the full causality chain from the filter algorithms over effects on worldviews and obscured public discourses to weakened democracies, the method to be chosen also needed to be open for investigations of sub-aspects of larger phenomenon that might be outside the primary focus of the analysed studies.

The domain of aggregating knowledge from previous research is vast, growing and builds on many, and sometimes partly contradicting, scientific traditions, epistemologies, terminologies and concepts. Literature on how to perform meta studies within PR has been difficult to find. But since this study, by design, is multidisciplinary, advice and recommendation from other related disciplines like social science (Bryman, 2012; Pawson, 2006), anthropology (Riese *et al.*, 2014) education research (Suri & Clarke, 2009), and management studies (Tranfield *et al.*, 2003), proved useful when outlining a strategy. But also meta study experiences from less related disciplines like Health Care (Sandelowski *et al.*, 1997; Finfgeld-Connett, 2016) and Software Engineering (Cruzes & Dybå, 2011; Kitchenham *et al.*, 2002) were consulted.

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<sup>5</sup> **Disclaimer:** The motivation for putting this section here instead of in the methodology section, where it more naturally would belong, is to minimise violations to the master thesis policy guideline that expects a literature review at this position in the document. The guideline is not designed for meta analyses.

By design no meta study method can avoid to violate the studies to be aggregated. But aiming to learn from a rich variety of research performed within different disciplines it is difficult to find an alternative. Many meta study theorists use the perhaps oldest and most known method Statistical Research Syntheses (Suri & Clarke, 2009) also referred to as Meta-analysis (Bryman, 2012) as a reference point for further discussion on the topic. A typical domain for this method is in medical research, aggregating statistical findings from multiple and in best case almost identical, strictly quantitative, studies of effects of a specific drug in a specific context. The critique against synthesising research from multiple quantitative studies addressing the same research question are limited and mainly based on that those studies often are too optimistic regarding the context and conditions that need to be controlled in order to trust the validity of the aggregated findings (Pawson 2006). The consequence of this is that it would be inappropriate to add the result from one study to the result of another (sf. Pawson 2006).

The critique against synthesising qualitative studies is more comprehensive. Many of the challenges here are explained by Sandelowski *et al.* (1997) as (i) it could be epistemologically and ethically inappropriate to summarize studies about human experiences and that (ii) summarizing qualitative findings threatens the integrity of the individual studies. The latter is analogue to the main critique synthesising quantitative studies. But they also argue that that (iii) there is no proper method to deal with differences in “disciplinary, philosophical, theoretical, social, political, and ethical commitments” [when the disciplines] “often have very different views of how to execute ostensibly the same kind of qualitative research” (p.366). Further they argue that (iv) different disciplines uphold different norms regarding methodological rigour, results and discussions as well as (v) what research is to be considered as relevant. Their final critique is that the (vi) different disciplines uphold different norms with respect to relevance of findings (Sandelowski *et al.*, 1997). However, this critique against aggregating results from research studies can only be addressed in two ways. Either meta studies are performed based on strictly qualitative or on strictly quantitative findings within a specific discipline addressing a specific research question, or the six challenges are considered



during the meta studies based on a richer variety of contributing studies, which is the aim for this study.

Performing a meta study of the multidisciplinary filter bubble phenomena excludes most of available candidate methods. Since this study aimed to aggregate and synthesise knowledge from both quantitative and qualitative studies, Statistical Research Syntheses (Suri and Clarke, 2009) and Meta-analysis (Suri and Clarke, 2009; Bryman, 2012) could be excluded from the candidate list since those methods focus on recalculate statistical findings from studies addressing the same questions in similar settings and contexts. Meta synthesis, as described by Sandelowski *et al.* (1997), could be discarded since it focuses on qualitative studies only. Since repeatability and future extendibility were among the aims, but also in order to identify what aspects of the filter bubble model that have not been researched, the ad-hoc oriented Narrative Review (Bryman, 2012) also was out of scope. For the same reason the traditional Systematic Literature Review (Bryman, 2012) was excluded. And, since research methodology as such was not a key topic for this study, Critical Impetus in Reviewing Research and Exemplary Syntheses as presented by Suri and Clarke (2009) also would be irrelevant.

The remaining list of meta study methods suitable for covering findings from both quantitative and qualitative studies could be divided into two categories; methods focusing on aggregating knowledge on rather specific research questions on one side e.g. Meta Synthesis as described by Sandelowski *et al.* (1997). On the other side is the positivistic majority of Systematic reviewers described by Suri and Clarke (2009) together with some exploratory and critical methods working with open questions, and thereby also coming closer to the qualitative research tradition. An advantage of the latter methods is their openness to research problems that are not necessarily strictly connected to the research questions for the studies under analysis, but rather to other aspects and findings, like how a phenomenon could be understood or how the context, conditions and other interfering circumstances that both quantitative and qualitative often tries to control for, actually may result in other new knowledge and learnings. Explicit examples of this school is Realist Synthesis (Pawson, 2006) and Meta Ethnography (Noblit & Hare, 1988). Both these methods are open to a variety of research paradigms,

domains and epistemologies. But while Meta ethnography put a strong focus on developing the understanding of a topic by identifying common denominators and translate metaphors among rather few thoroughly analysed studies, Realist Synthesis has, as the label suggest, the advantage of being more pragmatically oriented, but also of embracing variance in epistemologies, methods, contexts and conditions in order to answer questions like “what works for whom, in what circumstances” (Pawson 2006, p.25). Therefore, Realist Synthesis was chosen as method for this study and will be further presented and discussed in Section 3.3.

## 3 Research design and methods

### 3.1 Positioning the topic within PR/SC research

From a Strategic Communication (SC) and Public Relations (PR) perspective the filter bubble phenomena revolves around concepts, models and theories like framing, cognition, spiral of silence, social proof, cognitive bias, forming of attitudes *etc.* But the phenomena may of course also have a profound impact on both academic and professional PR/CS through the emerging robotization of both production and evaluation of PR/CS. This study draws on findings from many scholarly disciplines such as Sociology, Management, Computer Science, Anthropology, Health Care, Interaction Design, and Politics. But since the study foremost is an investigation of multiple levels of the contemporary conditions and environments for human communication the findings ought to be most welcome within Social Sciences as Politics, Sociology, Anthropology and SC/PR. Before detailing research problems and questions, it is relevant to situate the topic within PR scholarly traditions. But, there is also reason to positioning research on algorithm driven communication within the subdomain of PR research.

#### 3.1.1 *Filter bubbles in the PR scholarly tradition*

The main question of this project, whether algorithms narrow and damage public discourse and with it democracy, places this study in the critical paradigm of PR (L'Etang, 2008; Pieczka 2012). However, by revealing empirically based practical aspects of online communication, the report also could contribute to research within the excellence paradigm (Grunig *et al.*, 1992). Within the excellence paradigm there is an urge to understand how to be both proactive or reactive in communicating core corporate values in order to support long term legitimacy for a business. But the excellence paradigm also researches the role and effects of a business on its environment, and on its societal legitimacy, in order to uphold a long term license to operate (Cutlip, Center and Broom, 2006; Grunig *et al.*, 1992; L'Etang, 2008). To serve the holders of this perspective, the aim of the study would be to inform scholars and practitioners on how to respond to an environment where stakeholders might best be reached as algorithmically

computed micro audiences potentially locked into filter bubbles or framed in echo chambers, but also on how to achieve transparency based trust when lacking control of mediated feeds or being held accountable for exploiting filtering algorithms and unsymmetrical access to data.

The critical scholarly paradigm dissociates from the positivist and operative agenda of the excellence paradigm by embracing that social reality, including PR profession and scholarship as such, are social constructions. With the aim of bringing change to the profession, central aspects are also the analysis of how intrusive PR as power player shapes society. Related to this are ethical aspects of interaction, transparency and symmetry between private and governmental organisations and resourceful networks on one hand, and their audiences on the other hand (L'Etang, 2008; Ihlen & Verhoeven, 2009). From this critical perspective the study aims to inform anyone who is interested in e.g. the editorial power of the big internet service providers or the potentially eroding public spheres, but also in how to analyse emerging online echo chambers both as victims of, and sources for power in society.

Form both a normative and strictly managerial PR perspective, an understanding of how and to what extent filter bubbles work, the study may inform anyone who is interested in safeguarding or develop the public spheres that, at least until hitherto, has been a central arena for PR to operate in.

### *3.1.2 Algorithms in PR research and filter bubbles in PR-algorithm research*

Regardless of research paradigm, it is relevant to position the issues of big data algorithms within the PR domain. Unfortunately, contemporary PR research is only in the beginning of this quest. One of the few authors to engage is Simon Collister (Collister, 2015). Anchored in the critical paradigm and employing a neo-materialist perspective, Collister elaborates on the concept of Algorithmic Public Relations (Collister, 2016) as a lens for analysing how non-human actors, such as algorithms, and the increase in computational power, may affect public relations. And in doing that, he compiles the following, highly relevant questions:

... given the non-human agency in a neo-materialist world how do we conceptualize power and where does it lie? What are the ethical and moral implications

communication and acting from a quasi-subjective position? How can critical PR scholars study and understand such issues? (ibid, p.362)

Collister highlights, furthermore, the fundamental challenges to the power of PR brought about by the emerging communication landscape. It is necessary for both the PR profession and research, he argues, to recognise that computerised collections of information (in databases) presented as ubiquitous, non-interrupted feeds, or data streams, successively replaces narrative stories as the centre for communication, and that the editorship of these streams are driven by mediating algorithms.

Referring to Constine (2011), Collister (2015) exemplifies this with a case of a company that by overlooking Facebook's algorithm-based censorship, failed to be transparent towards a critical audience during a reputational crisis. A more critically oriented example he gives is how the access and means to utilise big-data are asymmetrically distributed in society in favour of PR. Based on these and other developments, Collister urges critically oriented scholars interested in the power of PR to "go beyond socio-culturally constructed hegemonic representations" (p.366) and start to recognise the relevance of how non-human algorithmic (post-hegemonic) power interfere with traditional PR power by in some cases amplify it, while in other cases reduce it.

Another conceptual work on the how Algorithms and Big Data relate to professional and scholarly SC from a critical perspective is given by Holzhausen (2016). In her report, she analyses research in the area and urges both researchers and practitioners to recognise that current developments means that the power over SC is transferred to software developers. She also argues that algorithms never are neutral, and in many situations are misused in order to discriminate target groups. Furthermore, she highlights the importance of understanding the algorithms effects for communication outcome in the short run, but also the need to defend public spheres against segmentation. The segmentation issue, as one aspect of the filter bubble phenomena, is further detailed and discussed by Bentele and Nothhaft (2010) who describe public spheres as "communication spheres characterized by a high communication density and being defined by the density within the sphere being higher than towards the outside

of the sphere” (p.112). In their report, they also outline a development where interest groups, organised in real life or as algorithm served networks, push and pull messages that increasingly consists of references to other sources.

Both Collister and Holzhausen, together with many other constructivist analytics contribute with theory based understanding, sometimes referring to or anchored in empirical studies. But in order to fully understand what threats and possibilities the filter bubble phenomena bring to PR/SC professionals and scholars, and also to inform public policy makers who want to make evidence-based decisions, the starting point should be in what actually is known. This study aims to build a starting point for this by revealing aspects of algorithmic power, and indirectly indicate ethical aspects of utilizing it, but also by suggesting a method for monitoring the development in the area.

### **3.2 Research questions and limitations**

The issues presented in the previous sections represents only a fraction of relevant questions to be asked regarding filter bubbles and democracy. But instead of picking out and dig in to one of these questions, the objective chosen for this study has been to identify and synthesise empirical research in the domain that have been reported and that could be relevant from SC/PR perspective. The key questions guiding the sampling and analysis of research studies has been: What is the state of empirically based knowledge on algorithm driven filter bubbles effecting discourse and democracy, as illustrated in Figure 1? This high level question is broken down into three open research questions as follows.

**RQ1 (micro):** Based in empirical research, what is known about how online algorithm driven filters affect confirmation of political worldviews?

Examples of studies expected to contribute here was analysis’ of generic or politically oriented effects on attitudes of individuals, and what mechanisms and moderators that may contribute or reduce these effects.

**RQ2 (meso):** Based in empirical research, what is known about the effects of online algorithm driven filters on political discourses?

Examples of studies expected to contribute to this question was those addressing how the filtering algorithms affect specific political discourses in online platforms, when and how different online platform might interact, or whether e.g. different topics are differently served by specific platform.

**RQ3 (macro):** Based in empirical research, what is known about the effects of filter algorithms on political discourses and political outcomes on national and global levels?

Examples of studies expected to contribute could have been e.g. algorithm driven macro level forces such as personalisation of search engines, but also studies showing correlations between massive social media consumption and voting behaviour or evaluations of political elections with strong references to decisive effects of their filtering algorithms.

### *3.2.1 Limitations and restrictions by design*

Although filter and recommender algorithms are at the centre, they are in principle considered as back boxes where only input and output is considered. Therefore, no attempts have been made to actually explain or analyse these algorithms beyond a layman's level. Related to this, studies focusing on improving recommender systems were excluded since the result of these, if any, would be a worsening of a filter bubble effect.

Reports evaluating personalised online e-commerce platforms were excluded since their outcome by design ends with buy or no-buy decisions with only a limited expected effect on political attitudes, except from effects of marketed products.

The underpinning studies were systematically and purposely sampled by following upstream references from three defined starting points. An alternative search strategy, as discussed in Section 3.3.3, could have given other results.

## **3.3 Research method and implementation**

Based on the research problem and research questions, the method selected for this study was screening and analysis of previous research in the area, i.e. a meta study, see Section 2.

### 3.3.1 *Realist Synthesis and filter bubble algorithms as a social program*

The Realist Synthesis method proposed by Pawson *et al.* (2001; 2005) and further developed by Pawson (2006) has its origin in Social Science. The method aims to support policy makers in making evidence based decisions through meta-analysis of scientific evaluation results from various kinds of social programs. Regarding practical applications, the method is indifferent to quantitative and qualitative research. Epistemologically the Realist Synthesis method positions itself as post-positivist “where it steers a path between empiricist and constructivist accounts of scientific explanation” (Pawson 2006, p.17).

### 3.3.2 *Filter bubbles as interventions in a social program*

The Realist Synthesis method was developed to synthesise evaluations of social programs that are expected to have an intended effect on a specific social phenomenon. In this study the filter bubble algorithms are considered to be the ‘social programs’ or *interventions*, with the expected outcome of *unintended* challenges to deliberative democracy. The method was initially designed for social programs such as the relation between street lighting and crime, the effects of youths mentoring programs on performance in schools (*ibid.*) etc. The question of whether these kinds of programs have any effect is relevant and important, and can be synthesised with care, given the six constraints to Meta Synthesis presented in Section 2. However, there are often significant differences between the implementations of the programs regarding the recognition of conditions and environmental settings and how the evaluations of these programs have been performed. This has encouraged the realist synthesists to focus on extracting knowledge based on these differences between variants of an intervention, i.e. under what circumstances, contexts, and for what groups *etc.* the variants have been studied. Or to quote Pawson, to find out: “what works for whom, in what circumstances” (2006, p.25). At the centre of the strategy for answering these kinds of questions is the analysis of research reports where the analysis is enlightened by theories or models of how the investigated social program was intended to work. Typically, these theories are described as a causality model built on the components initial



*Condition, Intervention, Mechanisms and Outcome*. These components are flanked by the circumstances in form of *Contexts, Mediators and Moderators*.

The central assumption of the Realist Synthesis method is that many of these components vary between unique implementations of a social program. This assumption leads to the demand that the research problems are stated as open questions regarding the relation between the outcome of an *intervention* and its circumstances, which in statistical synthesis is a problematic. Therefore, the *circumstances* are put in focus for the exploration, and the *variation of circumstances* turned into an advantage. This is a central argument for the very openly formulated research problem; “what is known about” on the micro, meso and macro levels of the full filter bubble casual chain. Another motivation is the aim to design and test a research process for continuous updates of the knowledge base on the topic. Given this, it is no hurry to identify and analyse all research in the area, but to find enough research to develop and prove the relevance of the model. Thus, this study could be viewed as an initial iteration exploring *some* relevant *Initial conditions, Mechanisms, Contexts, Mediators, Moderators* and build a foundation to a mosaic of what-works-in-what-circumstances. Some known knowns would be identified and mapped into the model. And if findings in some regions of the model contradict each other this could indicate *known unknowns*. However, *unknowns* that depend on that issues in the model not yet have been researched, or research that have been performed but was missed due to decisions in the sampling process, would continue to be unknown unknowns. Examples of both of these types of unknowns are illustrated as question marks in Figure 4 and Figure 7.

### 3.3.3 *Realist Synthesis – the process*

When Pawson (2006, chapter 4) describes how to perform a Realist Synthesis, he contrasts the process with what he refers to as the “‘standard’ sequence of systematic review” (p.79) leading to an iterative research process model with steps as described in Table 1. The process is rather straightforward and will not be further commented here; the reader is referred to Pawson (2006) for details. In order to explain decisions regarding the implementation of the study that could affect results, validity and repeatability, but also some deviations from the model, key elements

of the process are described below. Where it is applicable, cell numbers in Table 1 are referred to. When directly referring to explicit reports underpinning the analysis and synthesis the publication numbers (#) in Appendix A are used.

	Time →				
High level tasks	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
a. Identifying the review question	1a. Map the territory / Map key program theory	2a Prioritizing the review questions	3a Formalize the model to be tested		
b. Searching for primary studies	1b. Background familiarization search	2b Search for sources of program theory	3b Search for empirical studies to test model		5b Search for further empirical studies consequent on revisions to model
c. Quality appraisal			3c Assessment of relevance of primary inquiry to inform the model	4c Assessment of rigor of primary data to test theory	5c Further assessment of rigor as each study enters the synthesis
d. Extracting the data		2d Annotation note-taking on candidate theories	3d Collation of materials from selected primary studies	4d Detailed reportage of evidence from each case study	5d Differential reportage of evidence from each case study
e. Synthesizing the data		2e Prime focus of synthesis selected and formalized		4e Absorbing primary materials into developing synthesis	5e Juxtaposing, adjudicating, reconciling and situating further evidence
f. Disseminating the findings		2f Negotiation with decision makers on analytic and policy focus		4f Consultation on which emerging lines of inquiry should be followed	5f Summary theory to initiate process of 'thinking through' future implementation decisions

**Table 1:** A task - and time matrix for realist synthesis. Based on Pawson 2006, p.103 but rotated and numbered in order to facilitate the understanding of the report, where the latter represents the position in the standard sequence of systematic review.

The objective of the first iteration was to formulate the mission, describe primary theories and to identify studies and reports in order to verify that there are enough studies performed in the field to motivate the coming efforts. The map of the territory and key theory regarding contexts, moderators and outcomes (Table 1:1a) on the micro-meso-macro levels are reported in Section 1.2; here as a reminder repeated as: filter bubbles make people isolated and narrow minded, which is bad for public discourse and thereby for democracy.

With 2.500 reports in Google Scholar somehow related to filter bubbles it was for practical reasons necessary to reduce their numbers for thorough analysis. The strategy recommended by Pawson (2006) in this situation is to use purposive and iterative sampling. In order to reduce search bias, and to form a starting point for the sampling, the search started out of from three different batches of publications;

- 28 first publications identified by searching the term “filter bubble” in google scholar filtered by the publish year 2016.
- 30 publications identified as relevant among 108 annotated bibliographies performed by university students in 2013 (Annotated Bibliographies, 2013).

- 17 publications on the topic known to the author before 2016.

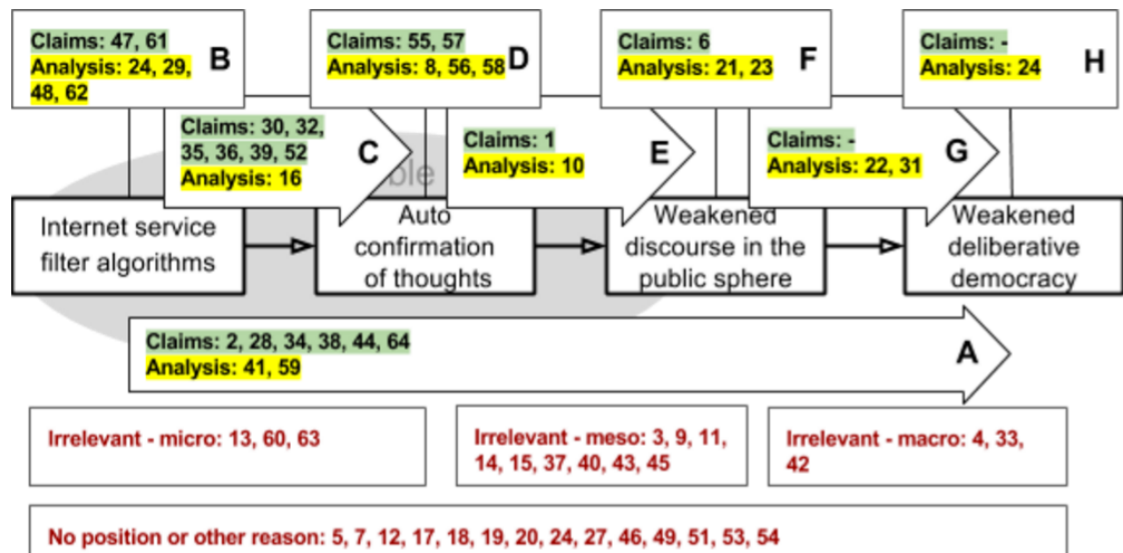
Ten of the 75 reports where overlaps. Of the 65 remaining reports, five were excluded as they were written in languages not understood by the author (German and Spanish). The remaining reports were downloaded and their bibliometric data, abstracts, and keywords were recorded. They were also briefly analysed with respect to in what context they used or referred to key terms as *filter bubbles* or *echo chambers*. Upstream references for these concepts were also recorded as input to the second search iteration.

Mainly based on *titles*, *abstract* and *keywords*, but also on the usage of key concepts in the model, the publications were categorised according to Table 2.

Category	Description	Number retrieved for analysis
Claim candidate	Probably based on primary empirical research making claims in or near the model	18
Analysis support candidate	Secondary research that might contribute to explanations and theory within the model	18
No claim or analysis	Probably no claims, e.g. just referring to filter bubble as a related phenomenon or difficult to access.	29

**Table 2:** Categorisation of publication found in the initial search round.

Thereafter, a first attempt to map the publications (based on abstracts) to an initial four-step high level model was performed. It resulted in a distribution as illustrated in Figure 2.



**Figure 2:** Initial mapping publications of the first search round to an initial four-step filter bubble model. The numbers refer to publication number in Appendix A. initial Claim Candidates are marked in green. Analysis Candidates are marked in yellow. Reports excluded for different reasons are marked in red.

Preliminary search for theories (Table 1:2b) and further empirical research (input to Table 1:3b) to test the model on was conducted simultaneously through thorough analysis of the 18 claim candidates. The result was documented according to the themes in Table 3.

The result of this analysis was that four (#6, #28, #44, and #47) of the 18 claim candidates could be discarded as false positives since shown to be oriented to e-commerce or not empirical. These were therefore re-categorized as “no longer claim candidates”. A reanalysis of the Analysis Candidates revealed three false negatives [#8, 10 and 41] as potential claim candidates to be analysed together with claim candidates later identified in the second search round.

The research process started out from an assumption that it would be possible to find studies clearly connected to each of the four steps of the initial model as illustrated in Figure 2. However, due to difficulties to differentiate studies addressing the first two steps *filtering algorithms* and *attitude development*, but also due to the fact that hardly any of the studies evaluated effects on attitudes, the decision was taken to combine the first two steps into the micro level of a micro-meso-macro model as outlined in Section 1.2.

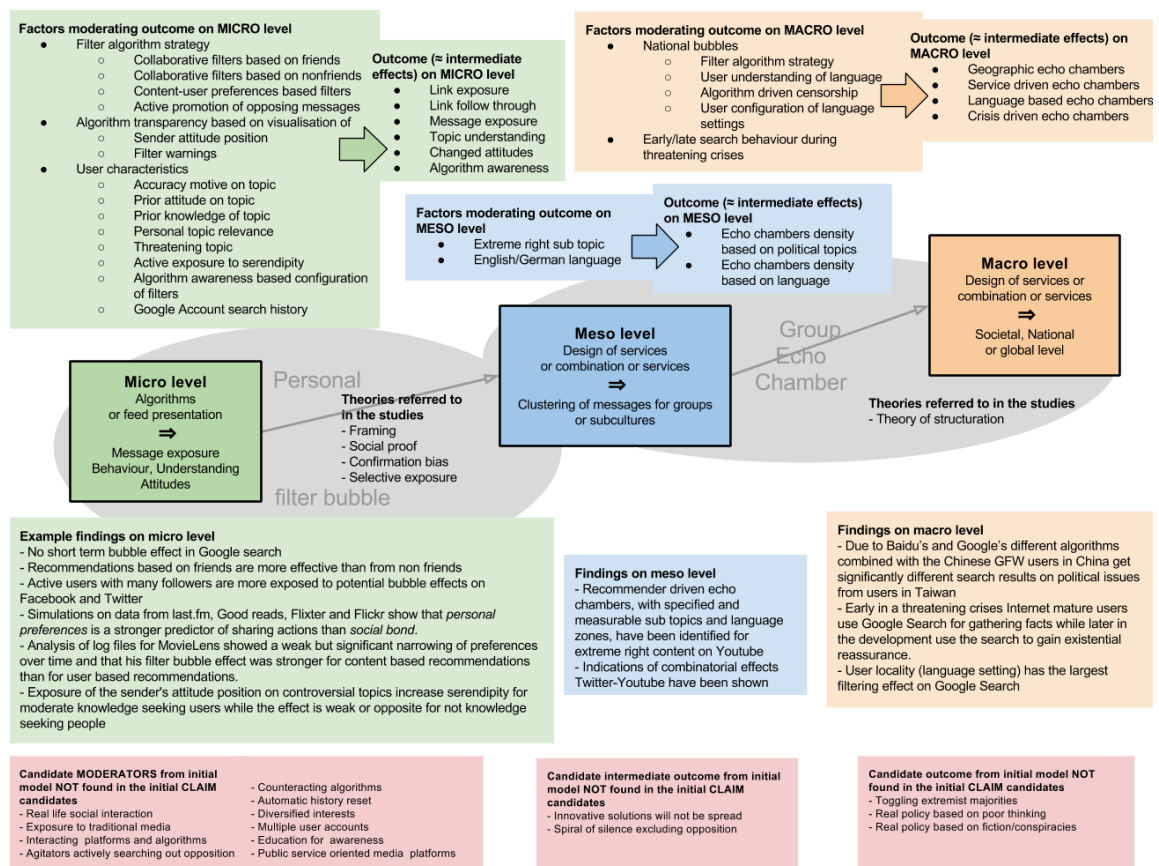
Before the second search round, the thirteen claim candidates quite easily were analysed and annotated according to the annotation scheme in Table 3. The reports were also re-categorised into the three-step-model.

Figure 3 illustrates a graphical summary of empirically based findings in the claim candidate reports identified in the first search round. Unfortunately, not so many studies referred to theories (Table 1:2d); none on meso-level. Some of the expected moderators and intermediate or final outcomes in the model as discussed in Section 1.2, were identified in the reports, while many of these (red fields of Figure 3) were not identified in the samples of the first iteration.

<b>Themes for annotation</b>	
Contexts/domain, conditions, definitions, constructs etc.	On methodology and explicit epistemological stance and reasoning (for step 2d).
Research question / Problem	Referred to SC/PR related theories (for step 2d).
How the filter bubbles are argued as contributing to explanations of conclusion deduced from key findings?	Upstream references for referred to SC/PR theories (for step 2b)
What claims with respect to the filter bubble that is made by or derived from the study	Upstream references for empirical research on the topic (for step 3b)
Model position - in the new micro-meso-macro model	

**Table 3:** Themes for annotation of claim candidates in the first and second search rounds.

Some steps of the first and second iterations focus on limiting the scope of the synthesis into a manageable task (Table 1:2a, 2e, 3e). The prioritisation of the review questions is reported as scope limitations in Section 3.2.1. Since one of the scopes for the study was to identify theories, it was already in the first iteration relevant to identify what theories or concepts that had informed the models used in the claim candidate reports. Unfortunately, and Pawson (2006) warns against this, many of the reports did not anchor their studies in established theories but rather indirectly implied the existence of them. However, the following theories, models or concepts were explicitly referred to in the studies: Framing, Social proof, Confirmation bias and Selective exposure and theory of structuration as reported in Figure 3. At this stage, the high level theory (Section 1.2; Figure 1) prevailed and no alternative candidate theories were revealed among the empirical studies found in the familiarisation search.



**Figure 3:** High level summary of findings from 13 (of 18) empirical claim candidates identified in initial search round (Table 1:1b) Micro level in green fields, Meso-level in blue fields, Macro-level (in orange fields). Red fields represent aspects and moderators hoped for but not identified in the reports.

The strategy for assessing relevance (Table 1:3c) through analysis of abstract and keywords was, with exception for the initially ignored search for false negatives among the

analysis candidates, shown successful regarding studies on the micro level. However, since disappointingly few studies were found on meso and macro level, special attention were put on these levels during the second search round. When preparing for the second search round, two competing strategies for the purposive sampling had emerged. One alternative was to go downstream from the most promising studies in the familiarisation research, and thus investigate studies referring to them. A second alternative was to continue analysing upstream research given by the familiarisation search. Based on the mission of setting a baseline for future research on the topic, the decision to continue with the upstream references was taken. In the second and final search round, 75 reports found relevant were localised. Those accessible were recorded and briefly analysed in the same way as familiarisation search, but now directly categorised into micro-meso-macro levels. The new claim candidates were then thoroughly analysed and annotated according to the themes in Table 3. Five reports that on abstract analysis level was considered as empirical analysis of effects of search engine personalisation or algorithm awareness, was due to time constraints, late in the process excluded from the analysis.

Some activities in Table 1:[2f, 4f and 5f] were excluded from the process due to lack of access to real stakeholders, but indirectly addressed in Section 5.

Strategies for dealing with the validity of the underpinning reports (Table 1:4c and 5c) are presented in Section 4.1. The presentation and analysis of the underpinning reports (Table 1:4d) are documented in sections 4.2-4. The synthesis, including discussion about the validity of the final results are presented in Section 4.5.

## 4 Analysis and synthesis

### 4.1 Description of underpinning studies and synthesis strategy

Sidestepping the discourse within Social Science of whether micro-level behaviour form macro-level structures or if the macro-level structures sets the parameters for micro level behaviour, the reports were categorised into micro, meso and macro level. The criteria for studies to be categorised to the micro level was that their evaluated outcomes were analysed on an individual level. Most of the studies here address variants of selection or confirmation bias in feed oriented communication, and thereby contribute to the understanding of the key necessary component of filter bubbles phenomena to occur. However, none of these studies actually address to what extent filtering algorithms, in the Pariser (2011) sense, contribute to the exposure of political content in ways that are likely to affect political discourses. The criteria for categorising studies into meso level was that they address online structures on group or community level. Most of these studies describe clusters of interconnected content as a necessary foundation of online echo chambers supporting public discourses. However, it is important to emphasize that, for the filter bubble model to be valid on the meso level, it should be shown likely that these content clusters are visited by the same users over long periods, preferably without competing influences from other echo chambers, or from offline communication. The common denominator for studies categorised to the macro level was that they address structural algorithm related online phenomena which might affect the exposure to political content, and thereby directly or indirectly public discourses on global, national, meso or micro level. Some methodological characteristics of the 28 analysed reports, and high level distribution of over academic disciplines, are summarised in Table 4.

Each of the three following subsection presents the studies on macro, meso respective macro level in relation to the filter bubble model, and thereby also address the research question (Section 3.2) for each level. Each subsection is also complemented with a figure summarising most relevant conditions, inputs, moderators and outcomes and a table (Appendix B-D) giving more details.

Analysis level	Number of studies
Analysed on Micro Level	13
Analysed on Meso Level	8
Analysed on Macro Level	7
<b>Methodology</b>	
Quantitative	24
Qualitative	4
Case study	1
<b>Based on</b>	
Interviews	2
Survey	8
Real world data	18
Experimental platform	7
Experiment on real-world platform	6

High level academic discipline	Number of Studies
Social sciences and computing	9
Web technologies	6
Communication, Media studies and Journalism	5
Political science	3
Generic science	2
Defence and Security	1
Management	1
Science	1

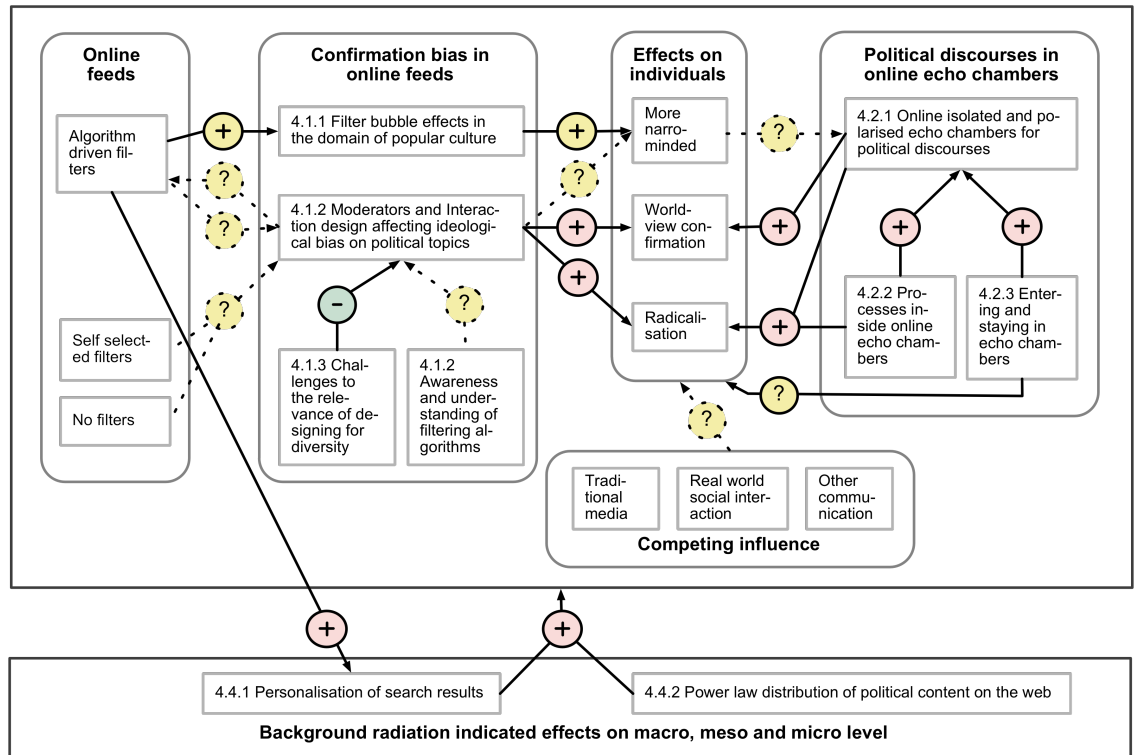
**Table 4:** Methodological characteristics and high level distribution of over academic disciplines of the purposely samples studies underpinning the analysis.

The issue of validity of results from the underpinning reports (Table 1:4c) is handled in two partly complementing ways. First, all reports underpinning the analysis and synthesis are peer reviewed and published within respective scientific community. Since this is a multi-disciplinary study and since the author only partly is competent to validate or translate criterions for scientific rigour within or between these disciplines, the results of each underpinning study are considered valid. This strategy is problematized but recommended by Pawson (2006). Secondly, a side effect of this is that policies regarding significance of statistical findings follow the policy of each report. If the analysis and synthesis refer to statistically non-significant results this is explicitly mentioned.

The concluding synthesis (Section 4.5) was based on triangulation of finding from the underpinning studies. In order to strengthen the validity, a conservative strategy was applied, where a key criterion for inclusion was support from more than one study, preferably on different levels or based on different methodologies, or if the result referred to was based on a very strong stand alone result. All identified conflicts among the underpinning studies are reported in the analysis. Results based on real world users, or based on real user data, have been considered stronger than results from experiments.



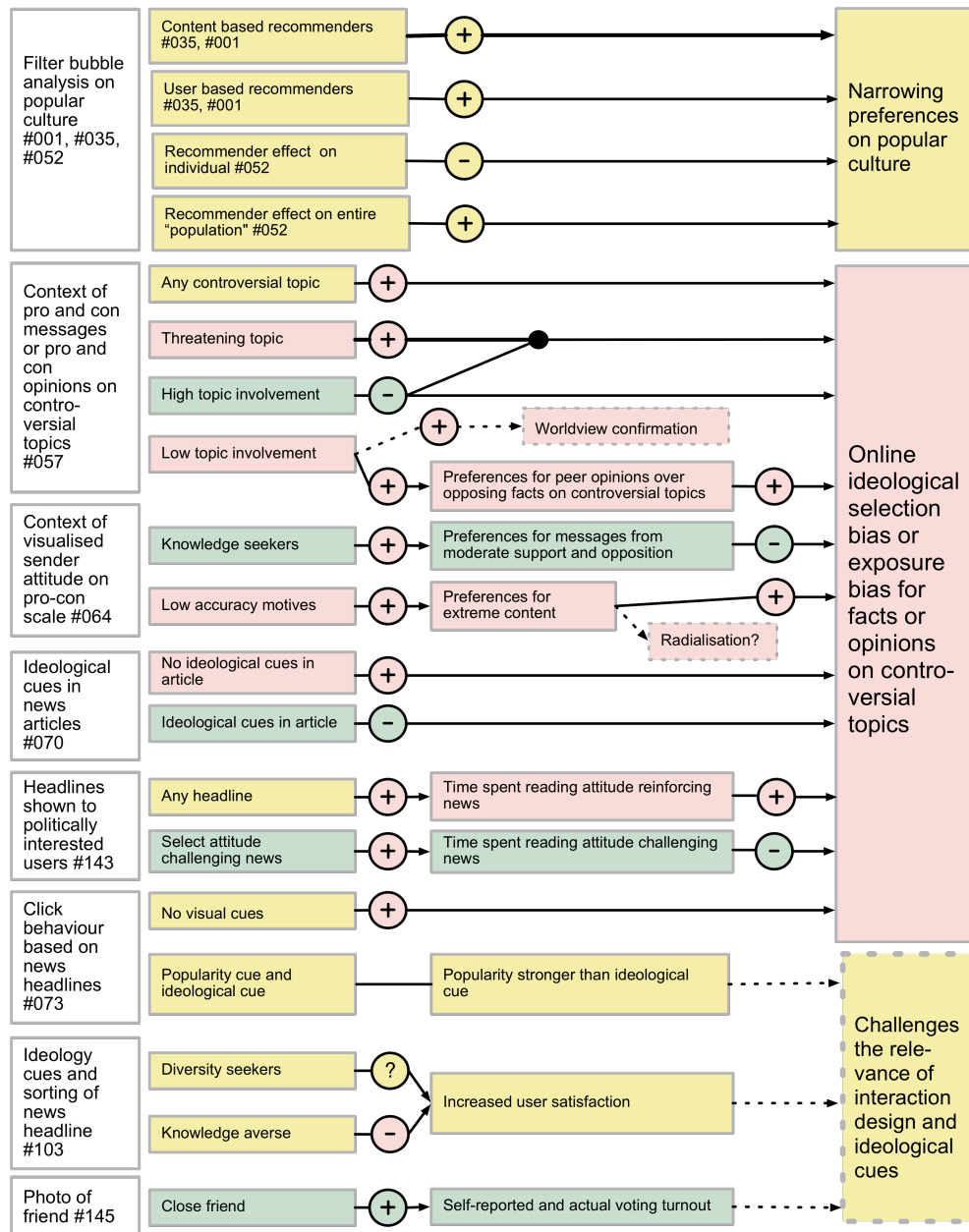
A high level description of how the following subsections are interlinked with a variant of the filter bubble model is illustrated in Figure 4. This could serve as a reading guideline or the following presentation.



**Figure 4:** Mapping of subsections into an expanded version of the filter bubble model where the tokens +/- represent direction of impact and question marks stands for not known or unclear direction of impact. The colour code red stands for “expected negative impact on diversified public discourses” and green stands for the opposite. Yellow stands for neutral impact or unclear direction. Dotted lines stands for that no results on the issue is provided by the underpinning studies.

## 4.2 Micro level analysis

When brought together, the reports underpinning the micro level analysis, and thereby addressing RQ1, do not show evidence of filter bubble effects on an individual level on political topics. However, they do reveal some common denominators highly relevant for the understanding of how and when filter bubbles could occur. Figure 5 summarises the most relevant contexts, moderators and outcomes on individual levels in the domain of online and mostly feed oriented communication. Since the contexts, moderators and outcomes of these studies are so varied it would be inappropriate to report the numerical impact of each moderator. In general, they are significant but weak.



**Figure 5:** Summary of contexts, conditions moderators and outcome on micro level where the tokens +/- represent direction of impact and the colour code green stands for “expected positive impact on diversified public discourses” and red stands for the opposite. Yellow stands for neutral impact or unclear direction. Dotted lines are used when the relation is not explicitly reported in the underpinning reports. Further details are described in Appendix B.

Unfortunately, the only studies in the sample that actually tried to measure, but also showed significant but weak filter bubble effects over time, did this in the context of popular culture (Section 4.2.1). A context that only to a limited degree could be expected to affect political discourses. However, to the extent that personalised filtering algorithms are fed by user click behaviour, as expected by the filter bubble model, the group of studies that investigated

online behaviour in a context of political communication (Section 4.2.2), do contribute to the understanding of potential ideological filter bubble effects on an individual level; this by confirming that ideological selection bias<sup>6</sup> and confirmation bias are highly relevant factors in online feed oriented environments.

Many of these studies were performed on experimental online platforms combined with surveys. Some of these platforms were designed to evaluate what potential various visual or text based ideological cues have to reduce selection or confirmation bias, as strategies to mitigate filter bubble effects. Some of them succeeded in this, but when brought together, one of the most interesting results here was that different personalities or personas show different behaviour. Curious or knowledgeable users seem to be more immune to selection bias than users less interested in, or less informed about, a given topic. It was also shown that threatening topics in most settings increase selection bias.

The relevance of reducing ideological biases by introducing ideological cues in online feeds could however be questioned by the results from a group of studies (section 4.2.3), showing that other than ideological cues, as e.g. the popularity of a message, probably have a stronger impact on user click behaviour. Therefore ideological cues are less likely to be implemented in real world online platforms. Section 4.2.4 presents studies addressing how users perceive and understand filtering algorithms, but none of these evaluate the consequences of this awareness.

#### *4.2.1 Filter bubble effects in the domain of popular culture*

Two of the selected studies were directly designed to address the filter bubble phenomena on a micro level, both of them based on real user data. Unfortunately, for the purpose of this study, the studies were performed in the context of popular culture. Through statistical analysis of system log files for a movie recommender platform, Nguyen *et al.* (2014) showed that users

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<sup>6</sup> The term selection bias is from here used to emphasise the decision to follow (select) a link to expected attitude reinforcing information.

over a period of 1.5 years got a slightly narrower preference for movies, and thereby confirm a weak filter bubble effect in this isolated setting. Contrary to their expectations, the authors could also show that *content based recommendations* had a stronger moderating effect than recommendations based on active recommendations from *other users*. With a different angle, Hosanagar *et al.* (2013) partly confirmed and partly refuted the result in a nonrandomized test of users versus non-users of recommenders in a plugin to an early version of iTunes. The Hosanagar report showed that, except from significantly increasing their music consumption, the *total population of recommender users* became closer to each other in consumption pattern, while the *non-users* did not change their consumption volume or consumption pattern at all. This result indicates a filter bubble effect for the group of all *recommender users*. However, in contrast to Nguyen *et al.* (2014), Hosanagar *et al.* (2013) also showed that on an individual level the recommender users actually broadened their consumption mix, and in that refuted an individual filter bubble effect found in the Nguyen study. However, since Nguyen *et al.* (2014) based their similarity measures on generic movie genres while Hosanagar *et al.* (2013) based their similarity measures on artists, which very well could represent the same music genre, one should be cautious to compare their results on this.

Nether of the two studies analysed potential effects of real social relations between the users. But a third study in the context of popular culture was reported by Sharma and Cosley (2016). This study, too, was based on real world user data from personalized media services (last.fm, Good reads, Flixter and Flickr). The study evaluated the performance of different types of recommendation algorithms and showed that *homophily* (operationalised as similarity in historical preferences) was a stronger predictor for content sharing behaviour than social bond with online friends was. This result suggests that *content based* algorithms for those services would be stronger than *social based recommendations*, a finding closely related to the findings of Nguyen *et al.* (2014) that *content based recommenders* for cultural content are more effective than recommenders based on other users' active recommendations.

#### 4.2.2 Moderators and Interaction design affecting ideological bias on political topics

Anchored in theories of cognitive dissonance and selective exposure, Liao and Fu (2013) developed an experimental platform that simultaneously exposed a pro and con factual message, or a pro and con opinion, on controversial topics to a panel of test subjects. The test subjects were then urged to inform themselves on the topics. Through analysis of message selection based on user logs, combined with pre and post surveys, they showed short term (two weeks) effects on user attitudes towards the topics in various directions. The experiment also confirmed a selection bias toward attitude consistent facts and opinions, especially towards topics related to *anxiety or threat*, but that this effect was weakened by *high involvement in the topic*. The study also indicates that *high involvement in a topic* drives a behaviour to seek out *opposing facts* as well as *opposing opinions*, while people with *low topic involvement* prefer *peer opinions* over *opposing facts*. The experiment operationalized the users' attitudes on a topic on a seven step scale from strong pro to strong con but did not try to measure the *strength* of an attitude position (that would mean worldview confirmation). Moreover, it is difficult to tell from the report any outwards shifts in attitudes (that would mean radicalisation). But the attitude changes, that in other words would be the opposite to worldview confirmation, were stronger for users exposed to both attitude consistent and inconsistent messages, but less so on *high involvement topics*. The latter could suggest that a *worldview conservation* effect could be strongest for users with *low involvement* on *threatening topics*.

With a similar setup, Liao and Fu (2014) developed an experimental online discussion forum where message headlines were complemented with a scaled graphical visualisation of the senders' attitude position on the topic. Through analysis of survey results on prior attitudes and knowledge on the topics, combined with analysis of logged user behaviour, they showed that visualizing the senders' position on the topics inspired *knowledge seeking users* with *moderate position* to read arguments and learn from *moderate opposition*, but ignore messages from both *extreme supporting* and *opposing positions*. In some of the settings users with low *accuracy motives* choose to be exposed to more extreme arguments.

In a survey based experiment on selection bias by Yeo *et al.* (2015), U.S. respondents were shown the same news on nanotechnology but with modified text based and visual ideological cues in the article. Thereafter the respondents were urged to choose further reading from a feed oriented list consisting of nine different headlines accompanied with abstracts. These articles were also reinforced with combinations of visual and text based ideological cues. The result showed that when the news article had no ideological cues the respondents held a strong preference for ideological consistent further reading on the topic, and thus confirming ideological selection bias under *uncertain conditions*. The preferences for ideologically inconsistent further reading increased with both consistent and inconsistent cues in the news article. Both these results are in line with Liao and Fu (2013).

Yet another study in this category was performed by Garrett (2009) focusing on political news preferences among *partisan subscribers* to two U.S. online newsletters. This study, too, was a survey based experiment where the participants, after revealing their political positions on a left-right scale were exposed to news headlines (the wording of the headline as only cue) and offered to read some of the articles. Afterwards they were asked questions on how they perceived the delivered articles *etc.*, but also about their perception of the platform as such. Extending Yeo *et al.* (2015), this study also measured time spent actually reading the articles. As expected, the study showed significant high ideological selection bias leading to reading of attitude reinforcing news, here also controlled for socioeconomic factors. The study also showed that selection of attitude challenging messages was very common among the users. And in this group of users, there was also a high degree of actual reading of the opposing texts.

#### 4.2.3 *Challenges to the relevance of designing for diversity*

With an experimental setup similar to Garrett (2009), but addressing the step from online news headlines to news stories, as well as using a more representative sample of respondents, Messing and Westwood (2012) performed two survey based experiments comparing effects of

*popularity cues*<sup>7</sup> (number of Facebook likes) to *ideological cues* (news media logotypes) on the selection of ideological consistent respective inconsistent news articles. The first experiment simulated an online news media environment, while the second simulated a social media oriented environment. Both experiments showed that without neither popularity nor ideological cues there was a clear selection bias towards ideological consistent articles as shown by many of the studies presented in section 4.2.2. However, when introducing both popularity cues and ideological cues, the popularity cues strongly outperformed the ideological cues as predictor of click behaviour.

Another survey based experiment trying to test cues for online news aggregators with diverse ideological content, that could be satisfying for individuals with different preferences was performed by Munson and Resnick (2010). The study tried to group the respondents into the categories *diversity seekers*, *challenge averse* and *support seekers* but could only confirm the two first among the participants. This result acknowledges the relevance of categorising users into the groups diversity seekers and challenge averse. However, the main result showed that highlighting or sorting ideological consistent news headlines could not improve the *challenge averse* individual's satisfaction with the news aggregator.

Bond *et al.* (2012) reported from a full scale randomized controlled trial experiment on 120 million Facebook users older than 18 years during the American 2010 U.S. Congressional midterm elections day. At the top of the users Facebook news feed, they showed a for the purpose designed post that (i) reminded about the election, (ii) offered a link to the closest polling stations and (iii) offered a clickable button for stating that 'I voted'. Half of the participants were also shown photos of Facebook friends that already had pushed the 'I voted'-button, thereby introducing a social proof oriented angle to the messages, while the control group was not shown any corresponding photos. The experiment also cross-referenced the self-

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<sup>7</sup> In the report the *number of Facebook likes* is used to represent *social endorsement*, but in order to not confuse the concept with situations where the endorser actual is known to the respondent (as in Bond 2012 *et al.*) the term *popularity* is used here.

reported voting with real voting behaviour from public records. The overall result indicated a significant positive impact on real world voting turnout on U.S. national level. Thereby they also showed a significant impact of online feed oriented messages on real world politics. However, the study also showed that the social proof oriented visual cue of *photos of close friends*, strongly outperformed corresponding cues to *distant friends* as predictor of the outcome. Since the message post was put as number one for all 120 million users it is unfortunately impossible to draw any conclusion about how Facebook's filtering algorithm could have affected the outcome. However, in the study social closeness was operationalised as frequent Facebook interaction, and since this is assumed to be given very high priority in Facebook's news feed algorithm, it is likely to believe that any filter bubbles on Facebook would have propagated to the voting turnout.

All-in-all, the three reports presented in this section indicate that the relevance of ideological cues as instrument for reducing selection bias in feed oriented environments, as instrument for stimulating diversified public discourses could be questioned.

#### 4.2.4 Awareness and understanding of filtering algorithms

In a mixed method analysis of responses to an Internet survey answered by 464 experienced Facebook users, Rader and Gray (2015) showed a broad variance in how users understand the workings and effects of Facebook's filtering and prioritising of their personal news feed. A central result of the study was the identification of six partly overlapping high level positions with respect to attitude and understanding. In summary, they found at one end of a spectrum a group of the respondents that were highly aware of the algorithm, and also had a rather realistic perceptions of how the algorithm worked; that their news feed was affected by both how they used the system and how they configured their personal settings. On the other end was a group that was not at all aware of the filtering and perceived no problems. In the middle was a group that sometimes experienced the frustrating perception of missing posts, but had only had limited ideas of why.



In order to test how to increase algorithm awareness, Nagulendra and Vassileva (2014) developed a prototype social media platform where each message on both controversial and less controversial topics was complemented with graphic illustrations of *attitudinal distance* on the topic to network friends, represented by a clickable photo and name. They also developed a similar solution illustrating *distance to related topics*. A survey with test persons showed increased awareness and understanding of both socially and content based filters, but also an increased perception of ability to control the filtering.

Brought together, these two studies show a broad span of algorithm awareness that could affect the attitudinal effects of both algorithms generated and self-selected filters. They also show that the awareness could be increased by revealing the workings of the algorithms to the users. However, based on Munson & Resnick (2010), there are reasons to believe some users groups would likely reject this kind of interference.

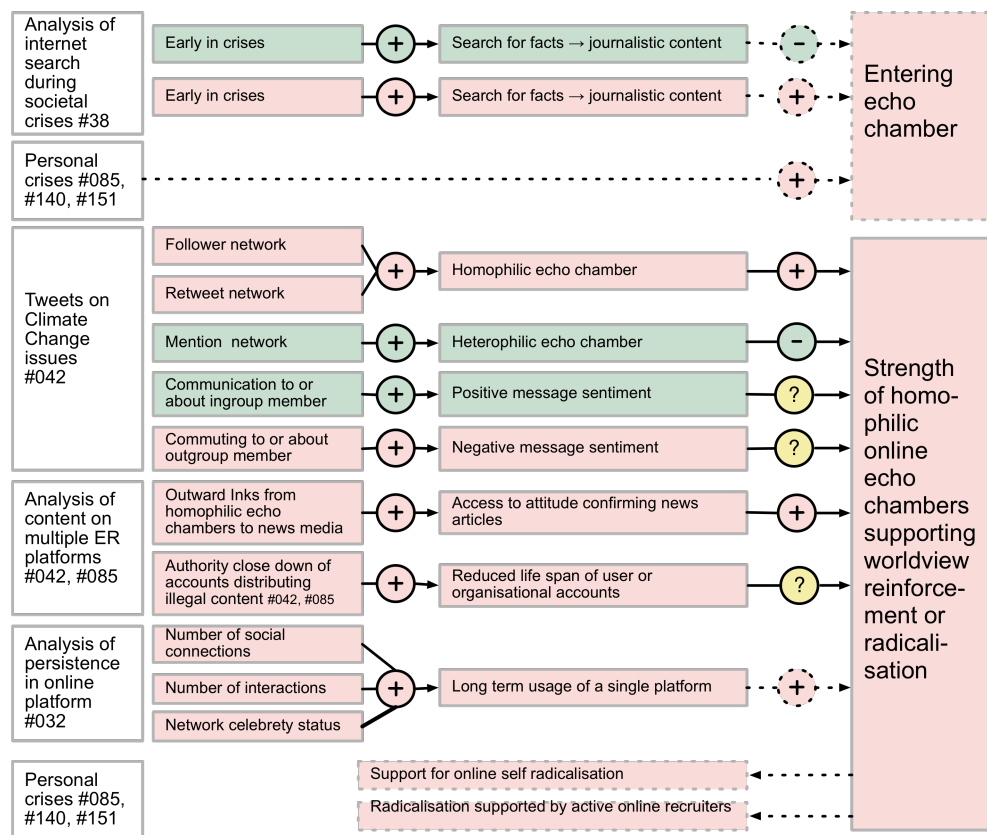
### 4.3 Meso-level analysis

Most of the studies categorised as empirical on meso level, and thereby address RQ2, identify and investigate virtual online communities on controversial topics like Extreme Right (ER) politics, Climate Change, Radical Islamism and alternative treatment of Lyme Syndrome. Also discussed in three qualitative studies are experiences from within such echo chambers that give plausible explanations to how online echo chambers may facilitate not only worldview confirmation, but also radicalisation. Together, the studies verify the existence of, and to some extent also shed light on the inner mechanisms of single echo chambers for political discourses that are relatively isolated from each other; an isolation of discourses that ought to be a necessary cornerstone for the filter bubble model to be plausible on the meso level. However, none of the reports addresses to what degree these echo chambers are reached through, and sustained by, algorithm driven filters<sup>8</sup>, self-selected filters, or by other means. On the contrary,

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<sup>8</sup> An exception to this is O'Callaghan et.al (2010) that based online ER echo chambers on the results from YouTube's video recommender algorithms

the studies addressing this entrance problem suggest e.g. off-line contacts, self-selected twitter feeds, or search engines as gateways. Only to a limited degree do the reports shed light on whether a visitor of one echo chamber on specific ideological positions consume consistent content from other online or offline environments. However, one study does analyse the temporal sustainability of echo chambers, and another present factors affecting users to stay over time in an online platform. These studies could have underpinned the filter bubble model, but they point in different and partly disparate directions. A summary of moderators affecting online echo chambers are presented in Figure 6.



**Figure 6:** Summary of conditions moderators and outcome in online echo chambers. The tokens +/- represent direction of impact and the colour code green stands for “expected positive impact on public discourses” and red stands for the opposite. Yellow stands for neutral impact or unclear direction. Dotted lines are used when the moderating effect is not measured through quantitative methods or explicitly reported in the underpinning reports. Further details are described in Appendix C.

#### 4.3.1 Online isolated and polarised echo chambers for political discourses

O’Callaghan (2010) followed ER-related tweets to algorithmically generated English or German language YouTube-channels. These channels were then analysed with respect to ER sub topics

with the result that users exposed to one ER oriented video are likely to be recommended another and similar video. Through content analysis of e.g. meta text and user comments, the study also measured, on a more detailed level, how different ER sub ideologies, e.g. Anti-Islam, Populist or White Nationalist, were clustered with content-wise different densities, overlaps and distance/isolation. Differences in this respect were also shown between English and German language content. However, the report did not show how and by whom these content bubbles were visited; by the same individuals over time with expected worldview reinforcement as outcome, or if the visitor turnover was high and thereby with less expected impact on worldview reinforcement.

The study design decision by O’Callaghan *et al.* (2010), which was to start off from Twitter references to the YouTube content clusters, raises the question of who is reached by the referring tweets and to what extent echo chambers on Twitter could be expected to propagate to YouTube content clusters. This question was partly addressed by Williams *et al.* (2015) analysing clusters of Twitter discourses on the topic of Climate Change. By grouping users of five relevant #tags into groups that (i) included references to other tweeters (mentions), (ii) retweeted messages or just being (iii) followers, they identified three categories of networks of users with mutually different characteristics with respect to attitude towards the topic and sentiment in messages. A central result was evidence of strongly polarized and relatively isolated discourses among users supporting respective refuting the dominant science based view on Climate Change and through this isolation seldom being reached by arguments from the opposition. The study also revealed that this polarisation, or homophily, was strongest for the *follower networks* and *retweet networks*, and that a vast majority of the total number of tweets were shared within these two groups. However, some of the *mention networks*, revealed a more balanced discourse containing both pro and con arguments. In general, the sentiment analysis showed significantly more negativity towards the opposition (outgroup) and opposing arguments and corresponding positivity towards the ingroup. A result that indicate that visitors to these echo chambers, at least are reached by information of the mere existence of opposing

arguments. Negative sentiment towards the outgroup was also shown for participants in heterophilic networks holding polarised views.

Assuming that ER discourses on Twitter would show the same characteristics as the Climate Change discourses, this would indicate that an echo chamber effect on twitter for ER content would directly propagate into the ER echo chambers on YouTube shown by O'Callaghan *et al.* (2010). However, since the filtering of Twitter messages, as understood by the author, is relatively self-selected, it is once again hard to claim an effect of filtering algorithms. Instead the question propagates to how users select whom to follow on twitter. Verifying the existence of online ER echo chambers, but also extending them to include some other major platforms, O'Callaghan *et al.* (2013) analysed networks of ER content and to some extent also users. This study did not measure distances between or density of the networks, but did analyse for how long the networks sustained and how persistent different users' (accounts) were. Again, this study started from English and German language tweets and identified and tracked the development of online ER networks of both *users* and *content* over five months by following links in retweets and mentions (the same strategy as in Williams *et al.* (2015)) not only to YouTube clusters, but also to public websites, blogs and openly available content on Facebook. A central finding was the revealing of thematical connections between the online footprint of electoral and non-electoral ER organisations or ad-hoc groups related to them. But the study also showed that links to mainstream media content was highly present and mostly referred to content supporting the ER agenda, thus enforcing the image of a strong homophily over multi-platform echo chambers. Regarding the question of long term exposure, the study showed that only few network members were persistently active in each network over the entire five-month period, while the majority was not. This would indicate that the majority of the participants were exposed to the content for only a limited time period with a corresponding limited expected impact on worldviews.

Another result related to this was that some of the networks were rather short lived. This was explained by that the ER scene as such is very agile or dynamic with corresponding short duration of active accounts and websites, but also that some ER organisations and

members, through legal banning, get their accounts closed by Internet service providers. In both cases they would disappear from the radar of this kind of study. A similar situation would likely not emerge in the Climate Change discourse or Lyme syndrome discourse (below).

#### 4.3.2 *Processes inside online echo chambers*

The three studies above show clear evidence of the existence of empirically measurable online thematic echo chambers, and also how these may relate to each other within and between different platforms. Mankoff *et al.* (2011) investigated the dynamics inside a mixed<sup>9</sup> platform echo chamber environment. Based on survey responses from a small sample of Americans suffering from prolonged Lyme symptoms they analysed the respondents' online behaviour. The result showed that the patients, when trying to understand their disease, over time developed a search behaviour that led them into online communities that advocated a, by the majority of medical expertise considered, ineffective and dangerous understanding of how to treat the disease. The report shows examples of how individuals embarked on a career from limited understanding of science based treatments through ad-hoc searches on the topic ended at websites and online communities arguing for and reinforcing alternative and unproven methods. The results were quantitatively verified by survey results showing a positive correlation between period of symptoms and visits to web-sites advocating the non-science based perspective. The respondents also revealed how these online environments helped them to socially construct a new identity with respect to the disease, but also how they had been encouraged to actively support other Lyme Syndrome sufferers. Some of the respondents also adopted an activist approach towards the outside world, and some respondents described how they became more alienated towards their real world social networks. Among the respondents' quotations, obvious examples of confirmation bias, social proof, and spiral of silence, were represented.

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<sup>9</sup> The platform mix as such was neither described nor analysed.

All in all, Mankoff *et al.* (2011) illustrates plausible ways for both radicalisation and polarisation. The radicalisation aspect was more or less confirmed by a qualitative study reported in two publications by Edwards and Gribbon (2013) and von Behr *et al.* (2013). The study was based on evidence presented in court, online footprints from computer caches, but foremost interviews with ten convicted terrorists and five other respondents being revealed by authorities during a radicalisation process. The respondents represented e.g. Islamism, ER and animal right issues. The high level result of the study was a clear confirmation that online echo chambers facilitate self-radicalisation as well as radicalisation supported by active online recruiters. On a detailed level, the report adds additional examples to Mankoff *et al.* (2011) descriptions of the abilities of these echo chambers to (i) offer role positions for careers within an online community, to (ii) facilitate and strengthen identity construction as community members, and to support alienation towards (iii) personal real life networks and (iv) to facilitate alternative worldviews. The study did not analyse the relative isolation of echo chambers. But the analysis of respondents' Internet history, retrieved from computer registers, showed for some of them a background with a dual online social world including internet activities outside politics. In contrast to this, other respondents had an online life limited to a spectrum of e.g. religious content to guidelines for constructing suicide bombs. The latter as an example of user with an active online behaviour strongly focused inside an online mixed platform echo chamber.

#### 4.3.3 *Entering and staying in echo chambers*

One out of many possible clues to how people find and enter online echo chambers may be given by Sanz and Stančík (2014). Through statistical and narrative analysis of Google search words combined with a socio economic survey their study analysed how users shifted their Internet search behaviour during four major threatening events<sup>10</sup>. The study showed how search patterns change between phases of a crisis. In the initial phase, users look for factual answers on

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<sup>10</sup> WikiLeaks publication of US diplomatic cables 2010; Japan tsunami 2011; the killing of Bin Laden 2011; and the advent of Irene hurricane on the US East Coast 2011. (Sanz & Stančík, 2014)

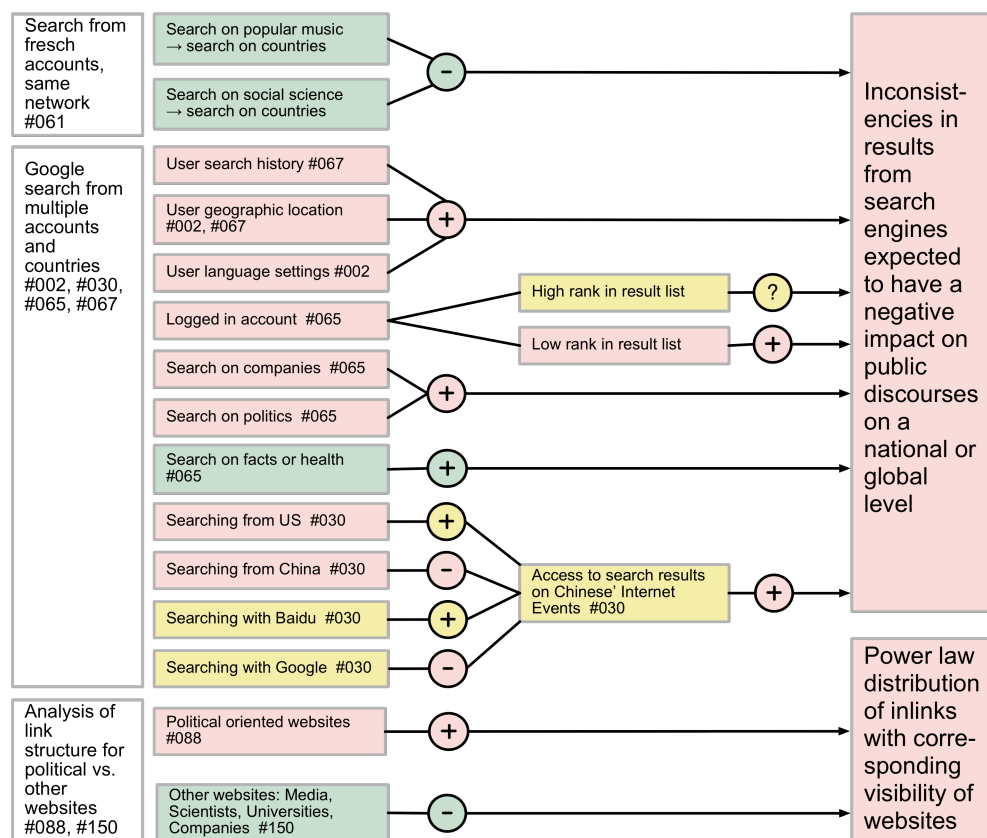
the development of events and thus target big and trustworthy traditional media. After a while they get more interested in either religious or philosophical aspects answered by more sacred or conspiracy oriented media platforms. The authors argue that this shift from facts to belief is motivated by a personal need to reduce existential anxiety and (re)gain trust and thus that, except from pure instrumental functions, the search behaviour in Internet mature societies also serves significant sacred needs. The relevance of threats for selection bias was confirmed by Liao and Fu (2013) on the micro level. But more important here is the understanding of the importance of how societal crises, or personal crises as in Mankoff *et al.* (2011), may inspire people to go beyond the top lists of search engines and find what initially was perceived as more odd information.

A factor that might shed some light on who stays in a platform over time was investigated by Lang and Wu (2013). Through statistical analysis of large quantities of crawled data from Twitter and Buzznet, they showed that the more active a user of the platforms is, measured as *getting posts* and *sending posts*, the longer they stay as users of the platforms. The study also shows that users with *central positions in the social graph*, operationalised as having far more followers than they follow, are the ones that stay longest. The latter inferring that intense senders in a specific platform also are the ones that over time are likely to be exposed to the circulating messages on the particular platform.

#### **4.4 Macro level analysis**

The reports presented and discussed in this sections address RQ3 and relate to algorithm curated messages or outcome on national or global level. Combined, they reveal two tendencies that permeate, and have the potential to further moderate, most of the outcomes presented on micro and meso level. In relation to the filter bubble model this means that added to the potential effects of algorithmically reinforced confirmation bias on micro level, the Internet, by design on national or global level, may introduce macro level algorithmically generated background radiation that may constrain the diversity of political discourses. The first tendency is significant but weak inconsistencies in results from search engines that, mostly based in language settings

or physical localisation, ought to restrict global political discourses on global issues. This phenomenon ought to be further reinforced by results indicating that Internet search on political topics are more personalised than e.g. search on facts or health issues. The studies underpinning these results are represented in section 4.4.1. Secondly, a clearly demonstrated power law distribution<sup>11</sup>, of especially politically oriented web content, would act in the same direction (section 4.4.2). A summary of moderators and outcomes on macro level underpinning the analysis are illustrated in Figure 7.



**Figure 7:** Summary of conditions moderators and outcome on macro level where the tokens +/- represent direction of impact and the colour code green stands for an expected positive impact on diversified public discourses and red stands for the opposite. Yellow stands for neutral impact or unclear direction. Further details are described in Appendix D.

<sup>11</sup> The relation between two values (function) is power law distributed if the maximum value is considerably larger than the second largest, that in turn is much larger than the third largest value, and so on. Typically, few top values represents a considerable part of the whole sample.



#### 4.4.1 *Personalisation of search results*

By seeding two initially unused google accounts on computers with identical configuration on the same network, with mutually different search words picked from different domains (entertainment vs. social science), Von Schoultz & Van Niekerk (2012) tried to provoke the search engine to develop personalised search results on a different third domain (countries). No difference in search results was observed after seven rounds of searching on five unique terms per round.

In a Case Study of the Red Bull Stratos Event in 2012, Ørmen (2016) investigated what aspects of personalisation had the greatest impact on the outcome of Google search. The result showed that among the factors that could be configured by users, the language settings was most influential.

Results from a real world experiment reported by Xing *et al.* (2014) showed that Google search results for 76.000 queries from real world users over a nine-month period, showed that both *users' search history* and *geographic localisation* contributed to significant inconsistencies in search results, where *localisation* was the strongest moderator.

In a more advanced experiment Hannak *et al.* (2014) compared search results delivered to 200 real world users with authentic search history, to search results delivered to a control group of identical but geographically (IP-address) distributed fake Google accounts. The Experiment showed an on average 11.7 differentiation between the top 10 search results. The personalisation effects increased with lower rank on the result page. The dominant moderator was the *localisation* of the real world users Google account. Least personalised were topics related to search on *factual issues* and *health* while, in contrast, most affected topics were related to *companies* and *politics*.

After Google in 2010 moved its mainland China servers to Hong Kong, Jiang (2014) performed a comparative analysis of the differentiation between search results from Google respective Baidu, and also of what search results were accessible from mainland China compared to from U.S. Starting from search words addressing 316 identified Chinese Internet events, analysis of a sample of 3160 links showed that 299 (9.5%) of the Google links and 24

(0.8%) of the Baidu links were accessible from US, but not from mainland China. Most of the blocked content was evaluated as politically sensitive, thereby giving figures to the impact of the Chinese governmental blocking by the so called Great Firewall. Analysis of the ranking and overlap of links to non-blocked content from the two search engines showed an overlap rate of 6.8%. This is much lower than a 11.4% benchmark reported by Spink et al. (2006, referred to by Jiang (2014) p.223). A qualitative analysis showed that much of these differences could be contributed to their finding that Baidu distribute links evenly over their own add-on services (e.g. Q&As, analogues to Wikipedia or Google Docs) while Google strongly favours Baidu's blog service over the other Baidu add-on services.

#### 4.4.2 *Power law distribution of political content on the web*

To most Internet users, the Internet is constituted of web-pages and posts that link to other web-pages or posts. The decision to create a link is decentralised to the billions of people publishing information on the Internet. Embedded in this decentralised link structure on the Internet<sup>12</sup>, Hindman *et al.* (2003) showed that Internet by design seems to downplay the visibility of minority and nuanced arguments on political content. Based on convincing arguments that there is a strong positive correlation between the number of links to a website<sup>13</sup>, and the size of the actual traffic to, and corresponding impact of, the same website, they analysed links to and from politically oriented U.S. webpages. These web-pages were localised by searching on six U.S. political topics<sup>14</sup> on Yahoo and Google. When the websites were identified, 3 million web-pages in four levels were crawled down, and inbound and outbound links on domain name level (e.g. sites like bbc.uk) were counted. The result showed a close to power law distribution of visibility, meaning that the most popular sites get a disproportionate large share of in-links, with

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<sup>12</sup> Whether the human behaviour underpinning the power law distribution of websites should be considered as a "filtering algorithm" or not could be debated. But Hindman (2003) is included here since it shows differences for political *versus* much other content.

<sup>13</sup> The number of links to a web page is considered to be the main contributing factor in Google's and other engines search result prioritisation algorithms, a feature that probably reinforces the effect.

<sup>14</sup> Abortion, Death Penalty, Gun Control, President, U.S. Congress, General Politics

a corresponding large share of the public attention. This stands in contrast to websites run by e.g. newspapers, universities and company sites where the visibility of the websites are much more evenly distributed as shown by Pennock *et al.* (2002)<sup>15</sup>.

#### **4.5 Concluding synthesis**

Algorithm driven filter bubbles threatening public discourses and thereby deliberative democracy, as outlined by Pariser (2011) and further developed, detailed and problematized in this text, are still very plausible. Put together and synthesised, the analysis of the empirical studies presented above show several moderators and outcomes on micro, meso, and macro level that are likely to have negative effects on the diversity of public political discourses. However, the same reports show very little evidence that filtering or recommender algorithms contribute to this in a significant way. On a high level, there is support for the notion that selection and thereby confirmation bias are forces that significantly affects what online feed oriented political communication people are exposed to (section 4.5.3). If it could be shown that the feeds carrying these messages were generated by selection biased click behaviour to an extent that outcompeted self-selected online filters or other means of communication, the filter bubble model would gain empirically based support. However, this is still a missing link, neither tested nor shown in any of the analysed reports. This stated, there are other forces at play that make the Internet problematic for deliberative democracies. Selection bias in online feeds, algorithm generated or not, is likely more negative for diversified public discourses than traditional media or real world communication. The polarised online echo chambers (section 4.5.2) exemplify this, even though the underpinning studies primarily focus on content and messages, but hardly at all address their effects on attitudes. Adding to this is the finding that algorithm driven personalisation of search engines, to some extent are likely to differentiate search results between locations, nations and language zones. So, combined, the power

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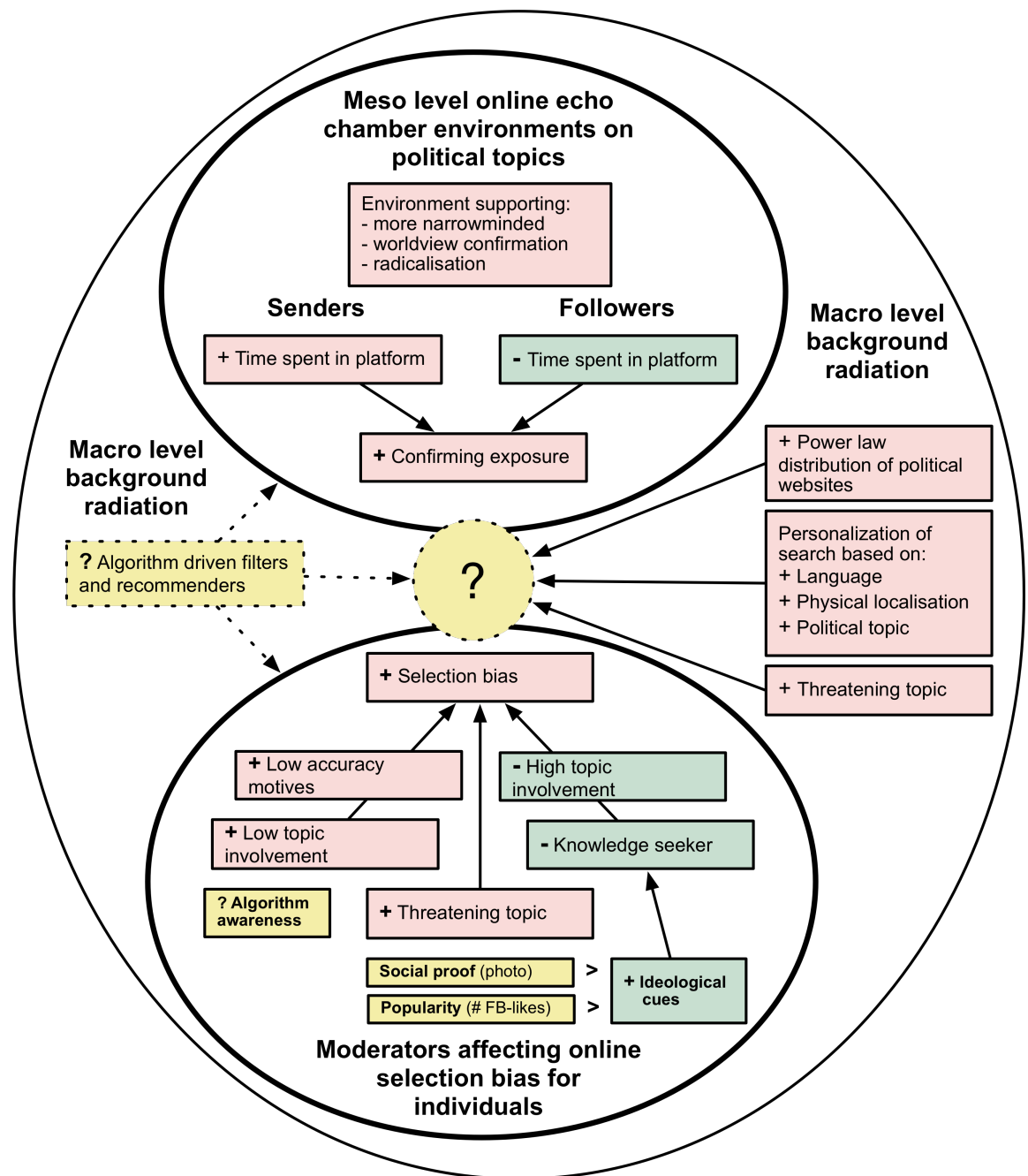
<sup>15</sup> This report was localised during analysis of reports in search round 2 and should therefore not be included, but was included in here for ensuring the validity of the claims of Hindman *et al.* (2003) regarding other categories of websites.

distribution of political websites and the personalisation of search on political content<sup>16</sup>, might affect worldviews and thereby global discourses *per se*. The content of online feeds in the echo chambers might also be affected. Not to forget; the content of traditional media, as well as the content in lunch conversations at home, at work or the streets might also be affected by these phenomena.

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<sup>16</sup> This is only shown for Google (Hannak *et al.*, 2013), while e.g. Baidu on the other hand seems to downplay political topics in favour non-political topics (Jiang, 2014).

The synthesising analysis underpinning this reasoning is summarised in the following sections and briefly illustrated in Figure 8.



**Figure 8:** Summary of moderators and outcome on ideological reinforcement on micro, macro and meso level where the tokens +/- represent direction of impact and the colour code green stands for “expected positive impact on diversified public discourses” and red stands for the opposite. Yellow stands for neutral impact or unclear direction. Dotted lines stands for unclear impact.

#### 4.5.1 *National and language based echo chambers and two unique conditions for political content*

The analysed report suggests that user language and localisation in combination with national borders and the unique characteristics for online political content creates a background radiation that ought to permeate and reinforce most effects on micro and meso level.

According to the analysed reports, the general personalisation of search results is limited but significant. A common denominator for Ørmen (2016), Xing *et al.* (2014) and Hannak *et al.* (2014) is that localisation and language deliver significantly different results from Google search to different users. To this could be added the results from O'Callaghan *et al.* (2010, 2013), investigating differences between German and English language ER material on YouTube and the analysis of differentiation between U.S. and Chinese search results based on national borders, as well as market shares for search engines (Jiang, 2014). Combined, it is clear that language and national borders both are factors that determine what information users meet when they search the Internet.

The power law distribution of specifically political websites shown by Hindman *et al.* (2003) is another factor that seems to influence who sees what on the Internet. If combined with the finding of Hannak *et al.* (2013) showing that, at least for Google search, that politics has a relatively high degree of personalisation this would support for understanding of that even if search *per se* is not very personalised, search combined with Internet by design support, not necessary polarisation, but domination of a few strong voices. And this in several ways. First, regardless of personalisation effects the most visible political web sites are likely to be highly ranked by search engines. Secondly, there are reasons to believe that the most prominent political web sites represent political parties, think tanks or interest organisations that either are very close to a political middle point or running a more polarizing agenda as voices of balkanised echo chambers. Anyhow are the polarised echo chambers revealed by O'Callaghan *et al.* (2010, 2013), Williams *et al.* (2015) and Mankoff *et al.* (2011) likely to be reinforced by the same phenomena. A claim that is supported by Williams *et al.* (2015), whom showed that, besides from what was reported on meso level, how a small number of tweeters in the Climate

Change discourse had a huge number of followers. Remembering that the *twitter followers* are expected to primarily be exposed to confirming arguments, this power law distribution would propagate to them, inferring that alternative or nuanced arguments are likely to get relatively lesser attention also in that context. Another issue related to the power law distribution on meso level was reported by Mankoff *et al.* (2011). Outside the survey analysis of Lyme Syndrome sufferers, their web content analysis showed that 40% of the 45 top results of a Google search referred to the minority perspective, while an analogue share of references to minority material at the bookmarking site delicious.com represented 80%. This result further emphasises that the material that was highly accessed by the minority group was not easily accessible through traditional search engines. And in that the study revealed a strategy for holders of minority perspectives to circumvent the power law distribution of web content by simply sharing privately edited lists of bookmarks.

All in all, the personalisation of Google search, shown to be limited but relatively strong on politics, languages and localisation would, in combination with the power law distribution of politically oriented web sites, tend to work against varied national and global discourses. It is important to recognize, however, that these tendencies are mitigated by the online presence of minority voices, continued exposure to offline media and real life social interaction, phenomena not investigated in the analysed reports.

#### 4.5.2 *Online isolated potential echo chambers for political content are real but their effect unclear*

The existence of online environments promoting political content with narrow perspectives and arguments are shown for both the Extreme Right (O'Callaghan, 2010) and Climate Change (Williams *et al.*, 2015) topics on single platforms. O'Callaghan *et. al* (2013) expanded from the single platform perspective by extending the Twitter networks also to include content on other social media platforms, as well as to traditional websites. However, none of the reports addressed communicative competition from the offline environment.

Some aspects of the inner structure of these content environments were shown and explained. In addition, it was shown that these echo chamber environments, besides from providing support for users becoming more narrow-minded, also may support radicalisation (Mankoff *et al.*, 2011; Edwards & Gribbon, 2013; Von Behr *et al.*, 2013) and polarisation (Mankoff *et al.*, 2011). Worth mentioning in relation to the inner workings of the echo chambers is the finding by Williams *et al.* (2015), that the sentiment, when users communicated to the outgroup, or about the outgroup, in the Climate Change discourses were generally negative. This finding could suggest that ‘spirals of silence’ could contribute the homophily of the content clusters.

There is no reason to believe that these findings would be unique to the domains of ER, Climate Change or alternative treatments of Lyme Syndrome. So, all in all, the results indicate that online echo chambers should be considered as rather problematic from a deliberative democracy perspective. However, for the filter bubble model to be valid, it has to be shown that algorithm driven filters and recommenders persuade users to first enter, and then stay in the echo chambers long enough to be affected. None of the reports do this. However, the O’Callaghan *et al.* (2013) study addressed the time factor; and thereby indirectly if a user entering the environment is likely to stay there long enough to be significantly affected. The answer to this was that the most active (accounts), and presumably sending, users stays the longest, while the followers are relatively short lived. These results were confirmed by Lang and Wu (2013). Given that followers on e.g. Twitter are relatively highly exposed to one-sided content (Williams *et al.*, 2015), but for a limited period of time (O’Callaghan *et al.*, 2013; Lang & Wu, 2013), while the most active senders, who stay longest (Lang & Wu, 2013), also are the ones that are exposed to more diverse content (Williams *et al.*, 2015), it is difficult to determine a high level outcome of this equation.



#### 4.5.3 *Confirmation bias on online feed oriented political content makes personal filter bubbles plausible but not proven*

Unfortunately, the two studies that tried to measure, and actually showed significant but weak filter bubble effects in terms of users becoming more narrow-minded over time (Hosanagar *et al.*, 2013; Nguyen *et al.*, 2014), did this on topics of popular culture, that only to a limited degree can be expected to affect political discourses<sup>17</sup>. Both studies showed that, given access to data, it would be plausible to actually measure effects also in other domains. But since the focus here is politics, the group of studies that analysed aspects of confirmation bias in online environments focusing on politics have more to say. When brought together as illustrated in Figure 5 they show several common denominators revealing the workings of selection bias and confirmation bias as preconditions for a filter bubble phenomena.

In line with the filter bubble model, many of the studies (Yeo *et al.*, 2015; Liao & Fu, 2013, 2014; Garrett, 2009) in experimental settings confirm, and none of them contest, the existence of selection bias and confirmation bias for online political content. However, that result is complicated by the apparent existence of a category of curious knowledge seekers which is more immune to these effects when compared to a group of challenge or knowledge averse users. Users highly involved with a topic are, when exposed to both pro and con arguments, keen to read opposing messages (Liao & Fu, 2013). This result was supported by real user data in Williams *et al.* (2015) analysis of heterogeneous Twitter networks. Moreover, the follow-up study (Liao & Fu, 2014) showed that a group of knowledge seekers, when exposed to a sender's attitude, also selected both pro and con messages. The fourth study in this domain (Garrett, 2009) also showed that, when encouraged by ideological cues, politically interested users select both sides of a topic. Whether the rationale behind this behaviour is to learn, or to get an excuse to use negative sentiment as in Williams *et al.* (2015), is an open

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<sup>17</sup> One important sub echo chamber in O'Callaghan *et al.* (2010) was ER music videos. There were no corresponding discussions related to Climate Change or Lyme Syndrome in corresponding analysis.

question here. But anyhow is this group likely to be exposed to a variety of messages, as least to the extent the power law distribution and understanding of used language allows. In contrast to this group, users with e.g. low topic involvement (Liao & Fu, 2013) show signs of a stronger confirmation bias when exposed to both pro and con arguments. This group seems to prefer *peer opinions* over *opposing facts*, that in the settings of the filter bubble model would support getting a narrower worldview. And, if these results are combined with the results of Liao and Fu (2014), that users with low *accuracy motives*, when exposed to the sender's attitude prefer *extreme content*, a potential hotbed for radicalisation is identified.

Explicitly or implicitly aiming at preventing the effect of filter bubbles, several of the studies (Liao & Fu, 2013, 2014; Yeo *et al.*, 2015; Garrett, 2009; Messing & Westwood, 2012) developed and tested different visual or text based cues directed towards mitigating ideological selection bias. Munson & Resnick (2010) directly addressed challenge averse users. However, the probability for these kind of solutions to be implemented in real systems ought to be rather low since, especially the challenge averse users, according to Munson and Resnick (*ibid.*) show a limited interest in using such a system. And, given the focus on developing ideological cues, the findings by Messing and Westwood (2012), namely that the exposure of number of Facebook likes outperform ideological cues, the expected real world usage of ideological cues are reduced even further. And recognising the result from the Facebook elections study (Bond *et al.*, 2012), that showed that photo based social proof was the dominant predictor of actual voting behaviour, it would make it yet more difficult to motivate e.g. the social media industry to dilute their feeds with ideological cues, at the risk of losing the large user groups that do not like these cues.

Liao & Fu (2013) also investigated effects of personal feelings towards the controversial topic that built the foundation for their study. Their results showed that topics perceived as threatening increased the confirmation bias for all groups. This theme of threat is also present in other reports on the meso level echo chambers, where the Climate mainstreams are likely to feel threatened by global warming and the sceptics are threatened by the Climate mainstreams. And how the sufferers from Lyme Syndrome perceive their health situation is

easy to guess. Also a common denominator among the proven and candidate extremists in Edwards & Gribbon (2013) and Von Behr *et al.* (2013) give evidence of a history with personal crisis. All in all, the analysed reports strongly indicate that threatening topic as predictor for increased confirmation bias deserve to be added to the background radiation affecting the entire online environment on a macro level.

## 5 Implications for PR practice and research

The results of the synthesis presented in the previous section suggest several relevant implications or recommendations for PR professionals as well as for scholars.

First, the most hands on recommendation to any professional or amateur strategic communicator utilising the Internet is to take a look at Figure 5-7, and consider whether their current communication practices might bring until now unknown or undesirable side effects.

Secondly, since algorithm driven filter bubble effects on political issues are shown to be probably existent but not empirically proven beyond doubt, the practical implication for PR professionals depends on preferred strategy regarding ethics and transparency. Those arguing for ethical and transparent relations to audiences should, in line with the discussion by Holzhausen (2016), take precautions and investigate how their market and IT departments use filtering and recommender algorithms when utilising access to big data for public communication. Then, regardless of the outcome of future research on the topic, they ought to discuss how to avoid strongly persuasive, or unsymmetrical communication technologies, in order to avoid accusations of excessive manipulation through algorithmic power. Ethical communicators could, based on the synthesised findings in this report, point out the need to safeguard public spheres for PR to operate in. If the mechanisms strengthening online echo chambers are allowed to grow, it may become very costly to reach audiences that are not yet supporters.

A third recommendation for professional PR practitioners, especially if supporting active political discourses from positions in e.g. think tanks, interest organisations or political parties, is to consider potential consequences of the stratification of political discourses combined with isolation of online echo chambers. In a complex and diversified discourse among a group of knowable and skilled debaters an incisive tweet or Facebook comment may get attention and respect as a clever counter argument to a, by the community known opponent. However, for many followers in isolated echo chamber the same incisive message might be the

only truth available, with corresponding potential effects on understanding of the topic, polarisation or radicalisation.

A recommendation to scholars in the excellence tradition performing research in support of operative PR, would be to research how PR professionals can respond to reputational risks emanating from excessive usage of unsymmetrical recommender systems. For them it would also be relevant to analyse the stratification issue by researching if online sharing of politically oriented critique towards e.g. companies, follows the echo chambering patterns indicated in Section 4.3; this since if pro and con audiences to a controversial company were shown to be isolated from each other on e.g. Twitter, it could be possible to test and analyse effects of applying different communication strategies towards the two groups.

Since algorithm driven filter bubble effects on political issues cannot be said to be conclusively empirically proven, the recommendation to critical oriented PR scholars involved in the topic is to pause the warnings bells and use their intellectual energy to perform, or at least support, empirical research on the issue; but also to further study other algorithmic phenomena in the domain of Big Data. Despite its limitations with respect to details and precision of the results, the Realist Synthesis method have shown to be plausible as research process for synthesising research from various scientific domains and methodologies. And in that the method could complement Collister's (2015) list of suggested methods for researching Algorithmic PR.

Key Internet service providers such as Facebook or Google seem to possess great editorial and algorithmic powers. Partly they also have access to data making it possible for them to address some of the filter bubble questions not answered by the studies underpinning this report. The recommendation to them is to do their scientific homework, and to act on the conclusions. The assumption here is, of course, that those businesses are far more prosperous on markets supporting freedom of speech. If their research showed that the public spheres and deliberative democracy were threatened by their operations, they would likely tune down these effects in order to ensure sustainable profit.

## 6 Contributions and conclusions

On a methodological level this study exemplifies how Realist Synthesis, given its limitations, can be used to synthesise research findings from several scientific disciplines and research methodologies. Another contribution is the expanded model describing filter bubble effects on diversified online public discourses and deliberative democracies (Figure 1).

On micro level (RQ1), the result confirms selection bias and corresponding confirmation bias in the contexts of political messages in online feeds that could constitute a necessary key condition for algorithm driven filter bubbles to emerge. However, none of the studies in the sample have explicitly investigated long term effects of algorithm driven filters on political attitudes. Therefore, filter bubbles confirming individual worldviews with effects on public discourses or democracy, as introduced by Pariser (2011), can neither be verified or refuted.

On meso level (RQ2) the existences and inner workings of biased and isolated online clusters of political content that could serve as foundations for online echo chambers have been shown and to some extent explained. It has also been shown that these environments have the potential to counteract the diversity of political discourses, but also to support both polarisation and radicalisation. However, the underpinning studies do not show long term participation in these echo chambers, nor do they show how algorithm driven filters support people entering them.

The underpinning studies on micro and meso level also indicate a stratification of discourses where a group of users with high degree of topic involvement, curiosity or interest in politics are relatively immune to selection and confirmation bias, while on the other hand groups of less interested or knowledgeable followers are likely to be reached by more one-sided arguments.

On *macro level* (RQ3) the results indicate that national borders, power distribution of political websites, and personalisation through localisation, language and political topics, differentiate what messages Internet users meet when surfing or searching the web. This could

affect diversity of global or national political discourses. The only study actually addressing political outcome (Bond *et al.*, 2012), showed a strong relative effect of social proof on voting turnout, but without interference of algorithm driven filters.

All in all, while recognising that the Internet brings people together and makes a tremendous amount of political information and arguments accessible to billions of users, the results also suggest that the contemporary Web brings some inherent challenges to public discourses. The empirical studies underpinning this analysis do not prove conclusively, however, that algorithm driven filter bubbles can be blamed for the development. This negative result does not mean that algorithm driven filter bubbles cannot restrict diversity of public discourses and thereby deliberative democracy. On the contrary, the result should rather be seen as call for further research addressing the issue in well-defined empirical studies, where the dotted question marks in Figure 4 could be a starting point. Hopefully this report may inspire that.

## Appendix A: List of sampled publications with motivation for inclusion and exclusion

Search round	Publication ID	APA Reference	Inclusion or exclusion argument	Micro Level	Meso Level	Macro Level
1	001	Sharma, A., & Cosley, D. (2016). Distinguishing between personal preferences and social influence in online activity feeds. In Proceedings of the 19th ACM Conference on Computer-Supported Cooperative Work & Social Computing (pp. 1091-1103). ACM. DOI: <a href="http://dx.doi.org/10.1145/2818048.2819982">http://dx.doi.org/10.1145/2818048.2819982</a>	Empirical and INCLUDED	x		
1	002	Ørmen, J. (2016). Googling the news: Opportunities and challenges in studying news events through Google Search. <i>Digital Journalism</i> , 4(1), 107-124. DOI:10.1080/21670811.2015.1093272	Empirical and INCLUDED			x
1	003	Dainow, B. (2016). Digital alienation as the foundation of online privacy concerns. <i>ACM SIGCAS Computers and Society</i> , 45(3), 109-117. DOI:10.1080/21670811.2015.1093272	Not relevant			
1	004	Dainow, B. (2016). Key dialectics in cloud services. <i>ACM SIGCAS Computers and Society</i> , 45(3), 52-59. DOI: 10.1145/2874239.2874247	Not relevant			
1	005	Atzenbeck, C. (2016). Interview with Eelco Herder. <i>ACM SIGWEB Newsletter</i> , (Winter), 2. DOI: 10.1145/2857659.2857661	Not relevant			
1	006	Cacciatore, M. A., Scheufele, D. A., & Iyengar, S. (2016). The End of Framing as we Know it... and the Future of Media Effects. <i>Mass Communication and Society</i> , 19(1), 7-23. DOI:10.1080/15205436.2015.1068811	no longer claim candidate			
1	007	Fernández, J. G., Almeida, C. A., Fernández-Baldo, M. A., Felici, E., Raba, J., & Sanz, M. I. (2016). Development of nitrocellulose membrane filters impregnated with different biosynthesized silver nanoparticles applied to water purification. <i>Talanta</i> , 146, 237-243. DOI:10.1016/j.talanta.2015.08.060	Not relevant			
1	008	Graells-Garrido, E., Lalmas, M., & Baeza-Yates, R. (2016, March). Data Portraits and Intermediary Topics: Encouraging Exploration of Politically Diverse Profiles. In Proceedings of the 21st International Conference on Intelligent User Interfaces (pp. 228-240). ACM. DOI:10.1145/2856767.2856776	Analysis			
1	009	Head, S. L. (2016). Teaching grounded audiences: Burke's identification in Facebook and composition. <i>Computers and Composition</i> , 39, 27-40. doi:10.1016/j.compcom.2015.11.006	Not relevant			
1	010	Liao, Q. V., Fu, W. T., & Strohmaier, M. (2016, May). # Snowden: Understanding Biases Introduced by Behavioral Differences of Opinion Groups on Social Media. In Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems (pp. 3352-3363). ACM. DOI: 10.1145/2858036.2858422	Analysis			
1	011	Veletsianos, G. (2016). <i>Social Media in Academia: Networked Scholars</i> . Routledge.	Not relevant			
1	012	Nardi, B. (2016). APPROPRIATING THEORY. <i>Theory Development in the Information Sciences</i> , 204.	Not relevant			
1	013	Hsieh, G., & Kocielnik, R. (2016, February). You Get Who You Pay for: The Impact of Incentives on Participation Bias. In Proceedings of the 19th ACM Conference on Computer-Supported Cooperative Work & Social Computing (pp. 823-835). ACM. DOI: <a href="http://dx.doi.org/10.1145/2818048.2819936">http://dx.doi.org/10.1145/2818048.2819936</a>	Not relevant			
1	014	Roth, Y. (2016). Zero Feet Away: The Digital Geography of Gay Social Media. <i>Journal of homosexuality</i> , 63(3), 437-442. DOI:10.1080/00918369.2016.112470	Not relevant			
1	015	Wu, K., Vassileva, J., Zhao, Y., Noorian, Z., Waldner, W., & Adaji, I. (2016). Complexity or simplicity? Designing product pictures for advertising in online marketplaces. <i>Journal of Retailing and Consumer Services</i> , 28, 17-27. DOI:10.1016/j.jretconser.2015.08.009	Not relevant			
1	016	Webberley, W. M., Allen, S. M., & Whitaker, R. M. (2016). Retweeting beyond expectation: Inferring interestingness in Twitter. <i>Computer Communications</i> , 73, 229-235. DOI:10.1016/j.comcom.2015.07.016	Analysis			
1	017	Keen, Andrew. <i>Vertigine digitale</i> . EGEA spa, 2016.	Language			
1	018	Hartmann, M. (2016). Coworking oder auch die (De-) Mediatisierung von Arbei. In <i>Medien-Arbeit im Wandel</i> (pp. 177-204). Springer Fachmedien Wiesbaden. DOI: 10.1007/978-3-658-10912-7_9	Language			
1	019	Keim, N., & Rosenthal, A. (2016). Memes, Big Data und Storytelling. Rückblick auf den digitalen US-Wahlkampf 2012. In <i>Die US-Präsidentenwahl 2012</i> (pp. 307-330). Springer Fachmedien Wiesbaden. DOI: 10.1007/978-3-531-19767-8_14	Language			
1	020	Zurstiege, G. (2016). Werbung–Gesellschaft–Kultur. In <i>Handbuch Werbeforschung</i> (pp. 77-97). Springer Fachmedien Wiesbaden. DOI: 10.1007/978-3-531-18916-1_4	Language			
1	021	Pearson, G. D., & Kosicki, G. M. (2016). How Way-Finding is Challenging Gatekeeping in the Digital Age. <i>Journalism Studies</i> , 1-19. DOI:10.1080/1461670X.2015.1123112	Analysis			
1	022	Kreide, R. (2016). Digital spaces, public places and communicative power In defense of deliberative democracy. <i>Philosophy and Social Criticism</i> 2016, Vol. 42 (4-5) 476–486. DOI: 10.1177/0191453715623831	Analysis			
1	023	Bruns, A., & Highfield, T. (2016). Is Habermas on Twitter? Social Media and the Public Sphere. <i>The Routledge Companion to Social Media and Politics</i> , 56-73. <a href="http://eprints.qut.edu.au/91810/">http://eprints.qut.edu.au/91810/</a>	Analysis			



Search round	Publication ID	APA Reference	Inclusion or exclusion argument	Micro Level	Meso Level	Macro Level
1	024	Karlsson, M., & Sjøvaag, H. (2016). Content Analysis and Online News: Epistemologies of analysing the ephemeral Web. <i>Digital Journalism</i> , 4(1), 177-192. DOI:10.1080/21670811.2015.1096619	Analysis			
1	025	Romero-Rodríguez, L. M., & Aguaded, I. (2016). Consumo informativo y competencias digitales de estudiantes de periodismo de Colombia, Perú y Venezuela. <i>Convergencia Revista de Ciencias Sociales</i> , 23(70). <a href="http://hdl.handle.net/10272/11618">http://hdl.handle.net/10272/11618</a>	Language			
1	026	Cohen, J. E. (2016). The Regulatory State in the Information Age. <i>Theoretical Inquiries in Law</i> , 17(2). <a href="http://papers.ssrn.com/sol3/Papers.cfm?abstract_id=2714072">http://papers.ssrn.com/sol3/Papers.cfm?abstract_id=2714072</a>	Not relevant			
1	027	Skjelbo, J. F. Musik blandt unge med muslimsk baggrund: En etnografisk undersøgelse af praksis (Doctoral dissertation, Københavns Universitet, Faculty of Humanities, Department of Arts and Cultural Studies).	Analysis			
1	028	Gillespie, T. (2014). The Relevance of Algorithms. Media technologies - Essays on communication, materiality, and society, 167. <a href="http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.692.3942&amp;rep=rep1&amp;type=pdf">http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.692.3942&amp;rep=rep1&amp;type=pdf</a>	no longer claim candidate			
1	029	Hallinan, B., & Striphas, T. (2016). Recommended for you- The Netflix Prize and the production of algorithmic culture. <i>New media &amp; society</i> , 18(1), 117-137. DOI: 10.1177/1461444814538646	Not relevant			
1	030	Jiang, M. (2014). The business and politics of search engines - A comparative study of Baidu and Google's search results of Internet events in China. <i>New Media &amp; Society</i> , 16(2), 212-233. DOI:10.1177/1461444813481196	Empirical and INCLUDED			x
1	031	Kennedy, H., & Moss, G. (2015). Known or knowing publics? Social media data mining and the question of public agency. <i>Big Data &amp; Society</i> , 2(2). DOI:10.1177/2053951715611145	Analysis			
1	032	Lang, J., & Wu, S. F. (2013). Social network user lifetime. <i>Social Network Analysis and Mining</i> , 3(3), 285-297. DOI 10.1007/s13278-012-0066-8	Empirical and INCLUDED		x	
1	033	Uldam, J. (2016). Corporate management of visibility and the fantasy of the post-political: Social media and surveillance. <i>New media &amp; society</i> , 18(2), 201-219. DOI:10.1177/1461444814541526	Not relevant			
1	034	O'Callaghan, D., Greene, D., Conway, M., Carthy, J., & Cunningham, P. (2015). Down the (White) Rabbit Hole The Extreme Right and Online Recommender Systems. <i>Social Science Computer Review</i> , 33(4), 459-478. DOI: 10.1177/0894439314555329	Empirical and INCLUDED		x	
1	035	Nguyen, T. T., Hui, P. M., Harper, F. M., Terveen, L., & Konstan, J. A. (2014) Exploring the filter bubble: the effect of using recommender systems on content diversity. In Proceedings of the 23rd international conference on World wide web (pp. 677-686). ACM. <a href="http://dx.doi.org/10.1145/2566486.2568012">http://dx.doi.org/10.1145/2566486.2568012</a> .	Empirical and INCLUDED	x		
1	036	Rader, E., & Gray, R. (2015, April). Understanding user beliefs about algorithmic curation in the Facebook news feed. In Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems (pp. 173-182). ACM. <a href="http://dx.doi.org/10.1145/2702123.2702174">http://dx.doi.org/10.1145/2702123.2702174</a>	Empirical and INCLUDED	x		
1	037	Rieder, B., & Sire, G. (2013). Conflicts of interest and incentives to bias A microeconomic critique of Google's tangled position on the Web. <i>New Media &amp; Society</i> , DOI:1461444813481195.	Not relevant			
1	038	Sanz, E., & Stančík, J. (2014). Your search-'Ontological Security'-matched 111,000 documents - An empirical substantiation of the cultural dimension of online search. <i>New Media &amp; Society</i> , 16(2), 252-270. DOI: 0.1177/1461444813481198	Empirical and INCLUDED		x	
1	039	Sharma, A., Gemici, M., & Cosley, D. (2013). Friends, Strangers, and the Value of Ego Networks for Recommendation. <i>International Conference on Weblogs and Social Media</i> , 13, 721-724. <a href="http://www.aaai.org/ocs/index.php/ICWSM/ICWSM13/paper/download/6115/6333">http://www.aaai.org/ocs/index.php/ICWSM/ICWSM13/paper/download/6115/6333</a>	Empirical and INCLUDED	x		
1	040	Stroud, N. J., & Muddiman, A. (2012). Exposure to news and diverse views in the internet age. <i>IS Journal of Law and Policy</i> , 8, 605. <a href="http://heinonline.org/HOL/Page?handle=hein.journals/isjlpoc8&amp;div=31&amp;g_sent=1&amp;collection=journals">http://heinonline.org/HOL/Page?handle=hein.journals/isjlpoc8&amp;div=31&amp;g_sent=1&amp;collection=journals</a>	Not relevant			
1	041	Wang, K., Peng, H. K., & Wu, S. F. (2014). <i>Framing Strategies in Facebook Discussion Groups</i> . <a href="http://www.ase360.org/handle/123456789/51">http://www.ase360.org/handle/123456789/51</a>	Analysis			
1	042	Williams, H. T., McMurray, J. R., Kurz, T., & Lambert, F. H. (2015). Network analysis reveals open forums and echo chambers in social media discussions of climate change. <i>Global Environmental Change</i> , 32, 126-138.0 <a href="http://dx.doi.org/10.1016/j.gloenvcha.2015.03.006">http://dx.doi.org/10.1016/j.gloenvcha.2015.03.006</a>	Empirical and INCLUDED		x	
1	043	Collister, S (2016) Algorithmic public relations Materiality, technology and power in a post-hegemonic world in L'Etang, J., McKie, D., Snow, N., & Xifra, J. (Eds.). <i>The Routledge handbook of critical public relations</i> . Routledge.	Theory			
1	044	Couldry, N., & Turow, J. (2014). Advertising, Big Data and the clearance of the public realm: Marketers' new approaches to the content subsidy. <i>International Journal of Communication</i> , 8, 1710-1726. <a href="http://eprints.lse.ac.uk/57944/">http://eprints.lse.ac.uk/57944/</a>	no longer claim candidates			
1	045	Kant, T. (2014). Giving the "Viewer" a Voice? Situating the Individual in Relation to Personalization, Narrowcasting, and Public Service Broadcasting. <i>Journal of Broadcasting &amp; Electronic Media</i> , 58(3), 381-399. DOI:10.1080/08838151.2014.935851	Not relevant			
1	046	Sunstein, C. R. (2009). <i>Republic.com 2.0</i> . Princeton University Press.	Analysis			

Search round	Publication ID	APA Reference	Inclusion or exclusion argument	Micro Level	Meso Level	Macro Level
1	047	Fleder, D., and Hosanagar, K. Blockbuster Culture's Next Rise or Fall: The Impact of Recommender Systems on Sales Diversity. <i>Management science</i> 55, 5 (2009), 697–712. <a href="http://dx.doi.org/10.1287/mnsc.1080.0974">http://dx.doi.org/10.1287/mnsc.1080.0974</a>	no longer claim candidate			
1	048	Jannach, D., Lerche, L., Gedikli, F., and Bonnin, G. What recommenders recommend—an analysis of accuracy, popularity, and sales diversity effects. <i>User Modeling, Adaptation and Personalization</i> (2013), 25–37. DOI:10.1007/978-3-642-38844-6_3	Analysis			
1	049	N. Negroponte. 000 000 111 - double agents. <a href="http://www.wired.com/wired/archive/3.03/negroponte_pr.html">http://www.wired.com/wired/archive/3.03/negroponte_pr.html</a> , visited on 2016-03-09.	Not relevant			
1	050	Kamba, T., Bharat, K. A., & Albers, M. C. (1995). <i>The Krakatoa Chronicle-an interactive, personalized newspaper on the Web</i> . DOI:10.1007/978-3-642-38844-6_3	Not relevant			
1	051	Linden, G. (2011) <i>Eli pariser is wrong</i> . <a href="http://glinden.blogspot.com/2011/05/eli-pariser-is-wrong.html">http://glinden.blogspot.com/2011/05/eli-pariser-is-wrong.html</a> , visited on 2016-08-03.	Analysis			
1	052	Hosanagar, K., Fleder, D., Lee, D., & Buja, A. (2013). Will the global village fracture into tribes? Recommender systems and their effects on consumer fragmentation. <i>Management Science</i> , 60(4), 805-823. <a href="http://dx.doi.org/10.1287/">http://dx.doi.org/10.1287/</a>	Empirical and INCLUDED	x		
1	053	Howard, Philip N., (2006) <i>New Media Campaigns and the Managed Citizen</i> . New York: Cambridge University Press.	Analysis			
1	054	Hillygus, D. S., & Shields, T. G. (2014). <i>The persuadable voter: Wedge issues in presidential campaigns</i> . Princeton University Press.	Analysis			
1	055	Sayooran Nagulendra and Julita Vassileva. 2014. Understanding and Controlling the Filter Bubble through Interactive Visualization: a User Study. Proceedings of the 25th ACM Conference on Hypertext and Social Media, ACM Press, 107–115. <a href="http://doi.org/10.1145/2631775.2631811">http://doi.org/10.1145/2631775.2631811</a>	Empirical and INCLUDED	x		
1	056	Paul Resnick, R. Kelly Garrett, Travis Kriplean, Sean A. Munson, and Natalie Jomini Stroud. 2013. Bursting Your (Filter) Bubble: Strategies for Promoting Diverse Exposure. Proceedings of the 2013 Conference on Computer Supported Cooperative Work Companion, ACM Press. DOI:10.1145/2441955.2441981	Analysis			
1	057	Q Vera Liao and Wai-Tat Fu. 2013. Beyond the filter bubble: interactive effects of perceived threat and topic involvement on selective exposure to information. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems. ACM, 2359–2368. DOI: 10.1145/2470654.2481326	Empirical and INCLUDED	x		
1	058	Beinsteiner, A. Filter Bubble and Enframing: On the Self-Affirming Dynamics of Technologies. <a href="http://ceur-ws.org/Vol-859/paper3.pdf">http://ceur-ws.org/Vol-859/paper3.pdf</a>	Analysis			
1	059	Memon, N., & Larsen, H. L. (2006). Practical algorithms for destabilizing terrorist networks. In <i>Intelligence and Security Informatics</i> (pp. 389-400). Springer Berlin Heidelberg. DOI: 10.1007/11760146_34	Analysis			
1	060	Cheek, G., Shehab, M., Ung, T., & Williams, E. (2011, June). iLayer: Toward an Application Access Control Framework for Content Management Systems. In <i>Policies for Distributed Systems and Networks (POLICY)</i> , 2011 IEEE International Symposium on (pp. 65-72). IEEE. DOI:10.1109/POLICY.2011.28	Not relevant			
1	061	Von Schoultz, D., & Van Niekerk, J. (2012, September). You, according to Google—the effects of filter bubbling. In 2012 ANNUAL CONFERENCE ON WORLD WIDE WEB APPLICATIONS. <a href="http://www.zaw3.co.za/index.php/ZA-WWW/2012/paper/view/574/170">http://www.zaw3.co.za/index.php/ZA-WWW/2012/paper/view/574/170</a>	Empirical and INCLUDED			x
1	062	Malik, Z. K., & Fyfe, C. (2012). Review of Web Personalization. <i>Journal of Emerging Technologies in Web Intelligence</i> , 4(3), 285-296. doi:10.4304/jetwi.4.3.285-296	Analysis			
1	063	Choudhury, A. (2002). <i>Fast machine learning algorithms for large data</i> (Doctoral dissertation, University of Southampton).	Not relevant			
1	064	Liao, Q. V., & Fu, W. T. (2014, February). Can you hear me now?: mitigating the echo chamber effect by source position indicators. In Proceedings of the 17th ACM conference on Computer supported cooperative work & social computing (pp. 184-196). ACM. DOI:dx.doi.org/10.1145/2531602.2531711	Empirical and INCLUDED	x		
2	065	Hannak, A., Sapiezynski, P., Molavi Kakhki, A., Krishnamurthy, B., Lazer, D., Mislove, A., & Wilson, C. (2013, May). Measuring personalization of web search. In Proceedings of the 22nd international conference on World Wide Web (pp. 527-538). <i>International World Wide Web Conferences Steering Committee</i> . <a href="http://www-dev.ccs.neu.edu/home/amislove/publications/FilterBubbles-WWW.pdf">http://www-dev.ccs.neu.edu/home/amislove/publications/FilterBubbles-WWW.pdf</a>	Empirical and INCLUDED			x
2	066	Feuz, M., Fuller, M., & Stalder, F. <i>Personal Web Search in the Age of Semantic Capitalism</i> . <a href="http://bureausituatif.ch/uploads/files/personal_web_search_in_the_age_of_semantic_capitalism_feuz-fuller-stalder.pdf">http://bureausituatif.ch/uploads/files/personal_web_search_in_the_age_of_semantic_capitalism_feuz-fuller-stalder.pdf</a> Accessed 2016-08-03	E: Google search excluded due to time constraints			
2	067	Xing, X., Meng, W., Doozan, D., Feamster, N., Lee, W., & Snoeren, A. C. (2014, March). Exposing inconsistent web search results with bobble. In <i>International Conference on Passive and Active Network Measurement</i> (pp. 131-140). Springer International Publishing. DOI:10.1007/978-3-319-	Empirical and INCLUDED			x

Search round	Publication ID	APA Reference	Inclusion or exclusion argument	Micro Level	Meso Level	Macro Level
		04918-2_13				
2	068	Scheufele, D. A., & Iyengar, S. (2012). The state of framing research: A call for new directions. <i>The Oxford Handbook of Political Communication Theories</i> . Nueva York: Oxford University Press. Pág. 1-26.	Analysis			
2	068b	Duplicate to 044 - solved	Duplicate			
2	069	Bennett, W. L., & Iyengar, S. (2008). A new era of minimal effects? The changing foundations of political communication. <i>Journal of Communication</i> , 58(4), 707-731. DOI:10.1111=j.1460-2466.2008.00410.x	Analysis			
2	070	Yeo, S. K., Xenos, M. A., Brossard, D., & Scheufele, D. A. (2015). Selecting Our Own Science How Communication Contexts and Individual Traits Shape Information Seeking. <i>The ANNALS of the American Academy of Political and Social Science</i> , 658(1), 172-191. DOI:10.1177=0002716214557782	Empirical but Irrelevant	x		
2	071	Kunda, Z. (1990). The case for motivated reasoning. <i>Psychological bulletin</i> , 108(3), 480. DOI:10.1037=0033-2909.108.3.480	Theory			
2	072	Ladwig, P., Anderson, A. A., Brossard, D., Scheufele, D. A., & Shaw, B. (2010). Narrowing the nano discourse?. <i>Materials Today</i> , 13(5), 52-54. <a href="http://www.sciencedirect.com/science/article/pii/S1369702110700845">http://www.sciencedirect.com/science/article/pii/S1369702110700845</a>	E: Google search excluded due to time constraints			
2	073	Messing, S., & Westwood, S. J. (2012). Selective exposure in the age of social media: Endorsements trump partisan source affiliation when selecting news online. <i>Communication Research</i> , DOI: 10.1177/0093650212466406	Empirical and INCLUDED	x		
2	074	Bailenson, J. N., Iyengar, S., Yee, N., & Collins, N. A. (2008). Facial similarity between voters and candidates causes influence. <i>Public Opinion Quarterly</i> , 72(5), 935-961. DOI:10.1093/poq/nfn064	Empirical but Irrelevant			
2	075	Finkelstein 2008	Bad reference, never located			
2	076	Pan B, Hembrooke H, Joachims T et al. (2007) In Google we trust. <i>Journal of Computer-Mediated Communication</i> 12(3). DOI: 10.1111/j.1083-6101.2007.00351.x	Empirical on Awareness Excluded due to time constraints			
2	077	Deibert, R., Palfrey, J., Rohozinski, R., Zittrain, J., & Stein, J. G. (2008). <i>Access denied: The practice and policy of global internet filtering</i> . Mit Press.	No access			
2	078	Davidson, J., Liebald, B., Liu, J., Nandy, P., Van Vleet, T., Gargi, U., Sampath, D. (2010). The YouTube video recommendation system. In Proceedings of the 4th ACM conference on Recommender Systems (pp. 293–296). RecSys '10. New York, NY: ACM. DOI: 10.1145/1864708.1864770	Empirical but on Algorithm improvement			
2	079	Bucher, T. (2012). Want to be on the top? Algorithmic power and the threat of invisibility on Facebook. <i>New media &amp; society</i> , 14(7), 1164-1180. DOI: 10.1177/1461444812440159	Theory			
2	080	Zhou, R., Khemmarat, S., & Gao, L. (2010). The impact of YouTube recommendation system on video views. In Proceedings of the 10th ACM SIGCOMM conference on Internet measurement (pp. 404-410). ACM. DOI: 10.1145/1879141.1879193	Empirical but on Algorithm improvement			
2	081	Figueiredo, F., Benevenuto, F., & Almeida, J. M. (2011, February). The tube over time: characterizing popularity growth of youtube videos. In Proceedings of the fourth ACM international conference on Web search and data mining (pp. 745-754). ACM. DOI:10.1145/1935826.1935925	Empirical but Irrelevant			
2	082	Filippova, K., & Hall, K. B. (2011, July). Improved video categorization from text metadata and user comments. In Proceedings of the 34th international ACM SIGIR conference on Research and development in Information Retrieval (pp. 835-842). ACM. DOI: 10.1145/2009916.2010028	Empirical but Irrelevant			
2	083	O'Callaghan, D., Greene, D., Conway, M., Carthy, J., & Cunningham, P. (2013). Uncovering the wider structure of extreme right communities spanning popular online networks. In Proceedings of the 5th Annual ACM Web Science Conference (pp. 276-285). ACM. DOI: 10.1145/2464464.2464495	Empirical and INCLUDED		x	
2	084	Roy, S. D., Mei, T., Zeng, W., & Li, S. (2012, October). Socialtransfer: cross-domain transfer learning from social streams for media applications. In Proceedings of the 20th ACM international conference on Multimedia (pp. 649-658). ACM. DOI:10.1145/2393347.2393437	Empirical but Irrelevant			
2	085	Edwards, C., & Gribbon, L. (2013). Pathways to violent extremism in the digital era. <i>The RUSI Journal</i> , 158(5), 40-47. DOI: 10.1080/03071847.2013.847714	Empirical and INCLUDED		x	
2	086	Alstynne, M., & Brynjolfsson, E. (1997). Electronic communities: Global village or cyberbalkans. In Proceedings of the 17th International Conference on Information Systems.	Theory			

Search round	Publication ID	APA Reference	Inclusion or exclusion argument	Micro Level	Meso Level	Macro Level
2	087	Diaz A (2008) Through the Google Goggles: sociopolitical bias in search engine design. In: <i>Web Search: Multidisciplinary Perspectives</i> , vol. 14. pp. 11–34. Springer Series in Information, Science and Knowledge Management. DOI: 10.1007/978-3-540-75829-7_2	Theory			
2	088	Hindman, M., Tsioutsoulakis, K., & Johnson, J. A. (2003, April). Googlearchy: How a few heavily-linked sites dominate politics on the web. In annual meeting of the <i>Midwest Political Science Association</i> (Vol. 4, pp. 1-33). <a href="http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.160.8347&amp;rep=rep1&amp;type=pdf">http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.160.8347&amp;rep=rep1&amp;type=pdf</a>	Empirical and INCLUDED			x
2	089	Bar-Ilan, J. (2007). Manipulating search engine algorithms: the case of Google. <i>Journal of Information, Communication and Ethics in Society</i> , 5(2/3), 155-166. <a href="http://dx.doi.org/10.1108/14779960710837623">http://dx.doi.org/10.1108/14779960710837623</a>	Empirical but strictly on E-commerce			
2	090	Duplicate to 076 - solved	Duplicate			
2	091	Huang, H., Keser, C., Leland, J., & Shachat, J. (2003). Trust, the Internet, and the digital divide. <i>IBM systems journal</i> , 42(3), 507-518. <a href="http://www.digitale-chancen.de/transfer/downloads/MD362.pdf">http://www.digitale-chancen.de/transfer/downloads/MD362.pdf</a>	Theory			
2	092	Katz, E. (1996). And deliver us from segmentation. <i>The Annals of the American Academy of Political and Social Science</i> , 22-33. <a href="http://www.jstor.org/stable/1048167">http://www.jstor.org/stable/1048167</a>	Analysis			
2	093	Prior, M. (2007). Post-broadcast democracy: How media choice increases inequality in political involvement and polarizes elections. Cambridge University Press.	No access			
2	094	Jamieson, K. H., & Cappella, J. N. (2008). Echo chamber: Rush Limbaugh and the conservative media establishment. Oxford University Press.	No access			
2	095	Sunstein, C. R. (2002, 2006). <i>Republic.com</i> . Princeton, NJ: Princeton University Press.	Analysis			
2	096	Gitlin, T. (1998). Public sphere or public sphericules? In T. Liebes & J. Curran (Eds.), <i>Media ritual and identity</i> (pp. 168–174). London, UK: Routledge.	Analysis			
2	097	Duplicate to 069 - solved	Duplicate			
2	098	Nir, L. (2012). Public space: How shared news landscapes close gaps in political engagement. <i>Journal of Broadcasting &amp; Electronic Media</i> , 56(4), 578-596. DOI:10.1080/08838151.2012.732145	Theory			
2	099	Couldry, N. (2012). Media, society, world: Social theory and digital media practice. Polity.	Analysis			
2	100	Papacharissi, Z. (2010). A private sphere: Democracy in a digital age. Polity.	No access			
2	101	Hart, W., Albarracín, D., Eagly, A. H., Brechan, I., Lindberg, M. J., & Merrill, L. (2009). Feeling validated versus being correct: a meta-analysis of selective exposure to information. <i>Psychological bulletin</i> , 135(4), 555. <a href="http://dx.doi.org/10.1037/a0015701">http://dx.doi.org/10.1037/a0015701</a>	Theory			
2	102	Duplicate to 086 - solved	Duplicate			
2	103	Munson, S. A., & Resnick, P. (2010). Presenting diverse political opinions: how and how much. In Proceedings of the <i>SIGCHI conference on human factors in computing systems</i> (pp. 1457-1466). ACM. DOI: 10.1145/1753326.1753543	Empirical and INCLUDED	x		
2	104	Sears, D. O., & Freedman, J. L. (1967). Selective exposure to information: A critical review. <i>Public Opinion Quarterly</i> , 31(2), 194-213. DOI:10.1086/267513	Theory			
2	105	Holtzhausen, D. (2016). Datafication: threat or opportunity for communication in the public sphere?. <i>Journal of Communication Management</i> , 20(1). <a href="http://dx.doi.org/10.1108/JCOM-12-2014-0082">http://dx.doi.org/10.1108/JCOM-12-2014-0082</a>	Theory			
2	106	Zerfass, A., & Sherzada, M. (2015). Corporate communications from the CEO's perspective: How top executives conceptualize and value strategic communication. <i>Corporate Communications: An International Journal</i> , 20(3), 291-309. <a href="http://dx.doi.org/10.1108/CCIJ-04-2014-0020">http://dx.doi.org/10.1108/CCIJ-04-2014-0020</a>	Not relevant			
2	107	Bell E. (2014) Silicon Valley and Journalism: Make up or Break up? Reuters Memorial Lecture 2014. Available at: <a href="http://reutersinstitute.politics.ox.ac.uk/news/silicon-valley-and-journalism-make-or-break">http://reutersinstitute.politics.ox.ac.uk/news/silicon-valley-and-journalism-make-or-break</a> (accessed 3d August, 2016).	Analysis			
2	108	Duplicate to 065 - solved	Duplicate			
2	109	Eslami, M., Rickman, A., Vaccaro, K., Aleyasen, A., Vuong, A., Karahalios, K., ... & Sandvig, C. (2015, April). I always assumed that I wasn't really that close to [her]: Reasoning about Invisible Algorithms in News Feeds. In Proceedings of the 33rd Annual <i>ACM Conference on Human Factors in Computing Systems</i> (pp. 153-162). ACM. DOI: 10.1145/2702123.2702556	Empirical on Awareness Excluded due to time constraints			
2	110	Slee T. (2014) <i>In Praise of Fake Reviews</i> . Whimsley. Available at: <a href="http://thenewinquiry.com/essays/in-praise-of-fake-reviews/">http://thenewinquiry.com/essays/in-praise-of-fake-reviews/</a> (accessed 3d August, 2016).	Not relevant			
2	111	Vaccaro, K., Karahalios, K., Sandvig, C., et al. (2015) Agree or Cancel? Research and Terms of Service Compliance. Paper presented to the Ethics Workshop of the 18th Annual Association for Computing Machinery (ACM) <i>Conference on Computer-Supported Cooperative Work (CSCW)</i> Available at: <a href="http://www-personal.umich.edu/~csandvig/research/Vaccaro-CSCW-Ethics-2015.pdf">http://www-personal.umich.edu/~csandvig/research/Vaccaro-CSCW-Ethics-2015.pdf</a> (accessed 3d August, 2016)	Theory			

Search round	Publication ID	APA Reference	Inclusion or exclusion argument	Micro Level	Meso Level	Macro Level
2	112	Benkler, Y. (2006). <i>The wealth of networks: How social production transforms markets and freedom</i> . Yale University Press.	Not relevant			
2	113	Tran, T., & Yerbury, H. (2015). New Perspectives on Personalised Search Results: Expertise and Institutionalisation. <i>Australian Academic &amp; Research Libraries</i> , 1-14. DOI:10.1080/00048623.2015.1077302	Empirical on Awareness Excluded due to time constraints			
2	114	Haider, J., & Sundin, O. (2016). <i>Algoritmer i samhället</i> . Kansliet för strategi- och samtidsfrågor, Regeringskansliet. <a href="http://lup.lub.lu.se/record/8851321">http://lup.lub.lu.se/record/8851321</a>	Analysis			
2	115	Mager, A. (2012). Algorithmic ideology: How capitalist society shapes search engines. <i>Information, Communication &amp; Society</i> , 15(5), 769-787. DOI:10.1080/1369118X.2012.676056	Theory			
2	116	Duplicate to 100 - solved	Duplicate			
2	117	Sundin, O., & Haider, J. (2013). The networked life of professional encyclopaedias: Quantification, tradition, and trustworthiness. <i>First Monday</i> , 18(6). DOI:10.5210/fm.v18i6.4383	Not relevant			
2	118	Silverman, C. (2015). Lies, damn lies, and viral content: How news websites spread (and debunk) online rumors, unverified claims, and misinformation. <i>Tow Center for Digital Journalism</i> . <a href="http://towcenter.org/wp-content/uploads/2015/02/LiesDamnLies_Silverman_TowCenter.pdf">http://towcenter.org/wp-content/uploads/2015/02/LiesDamnLies_Silverman_TowCenter.pdf</a> [2016-01-12]	Empirical but Irrelevant			
2	119	Bäck, E., Bäck, H. & Gustafsson, N. (2014). <i>Ungas politiska deltagande: Nya former och aktivitet genom sociala medier?</i> Rapport för Demokratiutredningen.	Analysis			
2	120	Bolin, G. & Andersson Schwarz, J. (2015). Heuristics of the algorithm: Big Data, user interpretation and institutional translation, 2(2). DOI: 10.1177/2053951715608406	Analysis			
2	121	Gillespie, T. (in press 2016). #trendingistrending: When algorithms become culture. I R. Seyfert & J. Roberge, <i>Algorithmic Cultures: Essays on Meaning, Performance and New Technologies</i> . Routledge.	No access			
2	121	Hannak, A., Soeller, G., Lazer, D., Mislove, A., & Wilson, C. (2014) Measuring price discrimination and steering on e-commerce web sites. In Proceedings of the 2014 <i>conference on internet measurement conference</i> (pp. 305-318). ACM. DOI: 10.1145/2663716.2663744	Empirical but strictly on E-commerce			
2	122	Van Alstyne, M., & Brynjolfsson, E. (2005). Global village or cyber-balkans? Modeling and measuring the integration of electronic communities. <i>Management Science</i> , 51(6), 851-868. <a href="http://dx.doi.org/10.1287/mnsc.1050.0363">http://dx.doi.org/10.1287/mnsc.1050.0363</a>	Theory			
2	123	Senecal, S., & Nantel, J. (2004). The influence of online product recommendations on consumers' online choices. <i>Journal of retailing</i> , 80(2), 159-169. DOI: 10.1016/j.jretai.2004.04.001	Empirical but strictly on E-commerce			
2	124	Bozdog, E. Bias in algorithmic filtering and personalization. <i>Ethics and Information Technology</i> 15, 3 (2013), 209–227. DOI:10.1007/s10676-013-9321-6	Theory			
2	125	Duplicate to 034 - solved	Duplicate			
2	126	Singer, J. B. (2014). User-generated visibility: Secondary gatekeeping in a shared media space. <i>New Media &amp; Society</i> , 16(1), 55-73. DOI: 10.1177/1461444813477833	Analysis			
2	127	Chen, J., Nairn, R., & Chi, E. (2011, May). Speak little and well: recommending conversations in online social streams. In Proceedings of the SIGCHI <i>Conference on Human Factors in Computing Systems</i> (pp. 217-226). ACM. ISO 690 <a href="http://dx.doi.org/10.1145/1978942.1978974">http://dx.doi.org/10.1145/1978942.1978974</a>	Empirical but on Algorithm improvement			
2	128	Lavie, T., Sela, M., Oppenheim, I., Inbar, O., & Meyer, J. (2010). User attitudes towards news content personalization. <i>International Journal of Human-Computer Studies</i> , 68(8), 483-495. DOI:10.1016/j.ijhcs.2009.09.011	Empirical but on Algorithm improvement			
2	129	Steck, H. Item popularity and recommendation accuracy. In <i>RecSys '11</i> (2011), 125–132. DOI:10.1145/2043932.2043957	Empirical but on Algorithm improvement			
2	130	Hamilton, K., Karahalios, K., Sandvig, C., & Eslami, M. (2014). A path to understanding the effects of algorithm awareness. In CHI'14 <i>Extended Abstracts on Human Factors in Computing Systems</i> (pp. 631-642). ACM. DOI:10.1145/2559206.2578883	Analysis			
2	131	Ma, H., Zhou, D., Liu, C., Lyu, M. R., & King, I. (2011). Recommender systems with social regularization. In Proceedings of the fourth ACM <i>international conference on Web search and data mining</i> (pp. 287-296). ACM. DOI:10.1145/1935826.1935877	Empirical but on Algorithm improvement			
2	132	Adomavicius G, Tuzhilin A (2005) Toward the next generation of recommender systems: A survey of the state-of-the-art and possible extensions. <i>IEEE Trans. Knowledge Data Engrg.</i> 17(6):734–749. DOI:10.1109/TKDE.2005.99	Analysis			
2	133	Konstan, J. A., & Riedl, J. (2012). Recommender systems: from algorithms to user experience. <i>User Modeling and User-Adapted Interaction</i> , 22(1-2), 101-123. DOI: 10.1007/s11257-011-9112-x	Analysis			
2	134	Nagulendra, S., Vassileva, J.: Providing Awareness, Understanding and Control of Personalized Stream Filtering in a P2P Social Network. 19th <i>International Conference, CRIWG 2013</i> . pp. 61–76	Empirical but Partly			

Search round	Publication ID	APA Reference	Inclusion or exclusion argument	Micro Level	Meso Level	Macro Level
		Springer Berlin Heidelberg (2013). DOI: 10.1007/978-3-642-41347-6_6	Duplicate to #055			
2	135	Kriplean, T., Morgan, J., Freelon, D., Boring, A., Bennett, L. Supporting Reflective Public Thought with Considerit. In Proc. CSCW2012, 265-274. DOI: 10.1145/2145204.2145249	Empirical but on Algorithm improvement			
2	136	Oh, A. H., Lee, H. J., & Kim, Y. M. (2009) User Evaluation of a System for Classifying and Displaying Political Viewpoints of Weblogs. In ICWSM. <a href="https://www.semanticscholar.org/paper/User-Evaluation-of-a-System-for-Classifying-and-Oh-Lee/c1eea8364638605fb3ae4b1b731b8d4472176ae2/pdf">https://www.semanticscholar.org/paper/User-Evaluation-of-a-System-for-Classifying-and-Oh-Lee/c1eea8364638605fb3ae4b1b731b8d4472176ae2/pdf</a> [2016-08-03]	Empirical but on Algorithm improvement			
2	137	Park, S., Kang, S., Chung, S., & Song, J. (2009). NewsCube: delivering multiple aspects of news to mitigate media bias. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (pp. 443-452). ACM. DOI:10.1145/1518701.1518772	Empirical but on Algorithm improvement			
2	138	Jiang, Y., Liao, Q. V., Cheng, Q., Berlin, R. B., & Schatz, B. R. (2012). Designing and evaluating a clustering system for organizing and integrating patient drug outcomes in personal health messages. In AMIA Annual Symposium Proceedings (Vol. 2012, p. 417). American Medical Informatics Association. <a href="http://www.ncbi.nlm.nih.gov/pubmed/23304312">http://www.ncbi.nlm.nih.gov/pubmed/23304312</a>	Not relevant			
2	139	Faridani, S., Bitton, E., Ryokai, K., & Goldberg, K. (2010, April). Opinion space: a scalable tool for browsing online comments. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (pp. 1175-1184). ACM. DOI:10.1145/1753326.1753502	Empirical but on Algorithm improvement			
2	140	Mankoff, J., Kuksenok, K., Kiesler, S., Rode, J. A., & Waldman, K. (2011, May). Competing online viewpoints and models of chronic illness. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (pp. 589-598). ACM. DOI: 10.1145/1978942.1979027	Empirical and INCLUDED		x	
2	141	Garrett, R. K., & Resnick, P. (2011). Resisting political fragmentation on the Internet. <i>Daedalus</i> , 140(4), 108-120. DOI:10.1162/DAED_a_00118	Analysis			
2	142	Vydiswaran, V. G., Zhai, C., Roth, D., & Pirolli, P. (2012). Unbiased learning of controversial topics. Proceedings of the American Society for Information Science and Technology, 49(1), 1-4. DOI:10.1002/meet.14504901291	Empirical but on Algorithm improvement			
2	143	Garrett, R. K. (2009). Echo chambers online?: Politically motivated selective exposure among Internet news users. <i>Journal of Computer-Mediated Communication</i> , 14(2), 265-285. doi:10.1111/j.1083-6101.2009.01440.x	Empirical and INCLUDED	x		
2	144	Duplicate to 103 - solved	Duplicate			
2	145	Bond, R. M., Fariss, C. J., Jones, J. J., Kramer, A. D., Marlow, C., Settle, J. E., & Fowler, J. H. (2012). A 61-million-person experiment in social influence and political mobilization. <i>Nature</i> , 489(7415), 295-298. doi:10.1038/nature11421	Empirical and INCLUDED	x		
2	146	Duplicate to 093 - solved	Duplicate			
3	146	Lin, Y.-R., Keegan, B., Margolis, D. and Lazer, D. (2014), "Rising tides or eising starts? Dynamics of shared attention on Twitter during media events. <i>Plos One</i> , Vol. 9 No. 5, e94093.	Never evaluated due to time constraints			
3	147	Gentzkow, M. and Shapiro, J.M. (2011). Ideological segregation online and offline. <i>The Quarterly Journal of Economics</i> , Vol. 126, pp. 1799-1839.	Never evaluated due to time constraints			
3	148	Kreiss, D. (2012), Media, movements, and political change <i>Research in Social Movements, Conflicts and Change</i> , Vol. 33, pp. 195-223.	Never evaluated due to time constraints			
3	149	Marwick, A.E. (2014), How Your Data Are Being Deeply Mined, <i>The New York Review of Books</i> , New York, NY, available at: <a href="http://www.nybooks.com/articles/2014/01/09/how-your-data-are-being-deeply-mined/">http://www.nybooks.com/articles/2014/01/09/how-your-data-are-being-deeply-mined/</a> (accessed 2016-08-03).	Never evaluated due to time constraints			
3	150	Pennock, D. M., Flake, G. W., Lawrence, S., Glover, E. J., & Giles, C. L. (2002). Winners don't take all: Characterizing the competition for links on the web. <i>Proceedings of the national academy of sciences</i> , 99(8), 5207-5211. <a href="http://www.jstor.org/stable/3058470">http://www.jstor.org/stable/3058470</a>	Empirical and INCLUDED			x
3	151	Von Behr, I., Reding, A., Edwards, C., & Gribbon, L. (2013). <i>Radicalisation in the digital era</i> . <a href="http://www.rand.org/pubs/research_reports/RR453.html">http://www.rand.org/pubs/research_reports/RR453.html</a>	Empirical and INCLUDED		x	

## Appendix B: Micro level summary

Report	Input/context/intervention	Moderators	Outcome
#001 Sharma, A., & Cosley, D. (2016)	Experimental analysis of real world user data from last.fm, Good reads, Flixter and Flickr	Content homophile Social bond	Sharing behaviour
#035 Nguyen et.al (2014)	Statistical analysis of shift in Movie preference over time in system log files system log for MovieLens movie recommender system.	User generated recommendations Content generated recommendations	Slightly narrowed individual movie preferences
#036 Rader & Gray (2015)	Quantitative and Qualitative analysis of 464 responses to an Internet survey answered by mostly experienced Facebook users	Not applicable.	Partly overlapping high level positions: - Passive Consumption (103) - Producer Privacy (45) - Consumer Preferences (130) - Missed Posts (208) - Violating Expectation (216) - Speculating about the Algorithm (223)
#052 Hosanagar et al. (2013)	Statistical analysis of shift in music preferences based on analysis of user data from a plugin to iTunes.	Use of recommender  No use of recommender	Increased and broadened individual consumption pattern Narrowing global consumption pattern  No change
#055 Nagulendra & Vassileva. (2014)	Experimental prototype of a social media platform focusing on visualization of potential bubble driving filter mechanisms	Visualization of close topics Visualization of close senders	- Awareness - Understanding - Control of filtering algorithms
#057 Liao & Fu (2013)	Statistical analysis of message selection and (short) term effects on attitude performed on experimental platform simultaneously exposing different types of messages on controversial topics.	Threatening vs. nonthreatening topics.  High vs. low topic involvement  Factual vs. opinion message  Attitude consistent vs. attitude inconsistent message	Message selection and thereby exposure to controversial topics  Short time development attitudes
#064 Liao & Fu (2014)	Analysis of surveys on knowledge and attitudes performed before and after usage of a experimental discussion platform exposing sender attitude position on a pro-con scale connection to message headline.	User accuracy motive on topic.  User prior knowledge on topic.  User prior attitude on topic.	Exposure to moderate opposition  Exposure to extreme position
#070 Yeo et al. (2015)	Experiment on selection bias where American survey respondents were shown the same news on nanotechnology but with modified ideological cues and thereafter urged to choose from nine different links/abstracts (that also were reinforced with ideological cues) to further reading	No text or logotype based ideological cues in news article  Ideological clear or ambiguous text or logotype based ideological cues in news article	Increased preference to opt for ideologically consistent further reading  Relatively more interest in countervailing further reading
#073 Messing & Westwood (2012)	Two experiments survey based experiment comparing effects of popularity cues to ideological cues on click behaviour. The first in simulated online media environment, the second in simulated social media oriented online environment.	Visual popularity cue (number of Facebook likes) complementing news headline  Visual ideological cue complementing news headline (news source logotype)	Increased selection of news to read regardless of ideological consistency  Weak and in some cases negative correlation to corresponding click behaviour

Report	Input/context/intervention	Moderators	Outcome
#103 Munson & Resnick (2010)	A survey based experiment aiming at testing out cues for online news aggregators with diverse ideological content that would be satisfying for users with different personal characteristics	Diversity seeking individuals (10/40) Challenge averse individuals (30/40) Support seeking individuals (none)	No result Order or visual cues for links does not affect/improve user satisfaction No result
#143 Garrett (2009)	A survey based experiment with participants recruited among subscribers to either a left-wing or right-wing US online newsletter	Attitude reinforcing messages  Attitude challenging messages Selecting attitude challenging messages No significant influence from socio-economic variables	Limited but significant: Increased selection of attitude reinforcing news Increased time reading attitude reinforcing news Limited selection of reinforcing news Increased time reading attitude challenging news
#145 Bond et.al (2012)	Randomized controlled trial experiment on 120 million Facebook users older than 18 years during the American 2010 US Congressional midterm elections day.	Specially designed FB message - combined with photos of FB friend claimed to have voted (social message) - Without corresponding photos (informational message)  Secondary message endorsed by: - Close friend - Distant friend	Self-reported voting Real world voting  Limited effect  Increased voting turnout by up to 0.6%



## Appendix C: Meso level summary

Report	Input/context	Moderators	Outcome
#032 Lang & Wu (2013)	Statistical analysis of user activity and duration in crawled data from the social media sites Twitter and Buzznet	Number of social connection Number of interactions  Celebrity status ( $\approx$ many followers/responses)	Activity  Increased period in system
#034 O'Callaghan et.al (2010)	Youtube recommender algorithm	ER sub topic content	Density, overlap and distance for recommender based content clusters at YouTube
#038 Sanz & Stančik (2014)	Statistical and narrative analysis of search words combined with socio economic survey investigating search behaviour during threatening events.	Early during threatening event  Later during threatening events	Search for facts  Search for existential confirmation
#042 Williams et al. (2015)	Tweets on climate change containing:  #climateréalists #agw #globalwarming #climatechange #climate	Follower network Retweet network  Mention network  Communicating to or about ingroup members  Communicating to or about outgroup members	Homophilic twitter communities  Both homophilic or heterophilic twitter communities  Positive sentiment  Negative sentiment
#083 O'Callaghan (2013)	Web-site URL references from ER related tweets to: - Youtube - Facebook (open content) - Public websites	Not applicable	Relations between homophilic online footprints of ER-organisations and networks on multiple platforms over time  User persistence
#085 Edwards & Gribbon. (2013a)  #151 Von Behr et al.. (2013)	Qualitative analysis of online radicalisation based on evidence presented in court, online footprints from computer registers, but foremost interviews, with ten proven terrorists and five respondents under radicalisation in UK.	Not applicable	Conclusion in summary: - online echo chambers facilitating online radicalisation and self-radicalisation - no support of internet accelerating or being sufficient for radicalisation on this level.
#140 Mankof et.al (2011)	Online radical minority Lyme disease community	Not applicable	Radicalisation

## Appendix D: Macro level summary

Report	Input/context	Moderators	Outcome
#002 Ørmen, J. (2016)	Investigation of personalisation effects through a Case Study of the Red Bull Stratos case in 2012	Language setting IP-address	Differentiation of results in Google Search
#030 Jiang (2014)	A comparative analysis of search results from Google Search and Baidu in mainland China and Taiwan on political events in china in a setting of constraining national legislation/policy and different algorithmic strategies by Baidu respective Google.	National censorship firewall  Baidu and Google search engine design priority:	Link overlap Accessibility  Ranking Bias patterns: - Baidu blogs (Google) - Baidu Online dictionaries, Q&A etc
#061 Von Schoultz & Van Niekerk (2012)	Evaluation of personalisation in Google search from unused accounts on the same computer network	Search terms on popular music Search terms on social science	No personalisation effects when searching on countries
#065 Hannak et.al (2013)	Experiment on search results delivered to 200 real world users compared to search results delivered to a control group of identical but geographically (IP-address) distributed fake Google accounts.	Logged in to a Google Account Search from different geographic areas (IP-address): - Higher rank position - Lower effect  Search on companies  Search on politics  Search on facts and health	On average 11.7% personalisation of top 10 search results - weaker effect - stronger effect  Relatively high degree of personalisation, mostly contributed to by localisation  Relatively high degree of personalisation  Relatively low degree of personalisation
#067 Xing at.al. (2014)	Real world experiment comparing Google search results for 76.000 queries from real world users over nine month.	User search history  User geographic localisation	Significant inconsistency in Google search results  Stronger inconsistency in Google search results
#88 Hindman et.al (2003)	Internet linking structure for political oriented web sites.	Websites on the American political themes: Abortion Death Penalty Gun Control President U.S. Congress General Politics	Variations of close to power law distribution of inbound and outbound links inferring corresponding visibility and impact.
#150 Pennock et.al (2002)	Internet linking structure for some categories of web sites compared to the random websites	Media web sites University Websites Company web sites sites Scientist's websites	Even distribution of inbound and outbound links (and thereby expected visibility)

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