Using Wikipedia Article Traffic Volume to Measure Public Issue Attention

Simon Munzert
University of Konstanz, Germany
Department of Politics and Public Administration
simon.munzert@uni-konstanz.de

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Abstract **The contemporary attention towards issues in the public is an important concept in the study of politics and public opinion. Existing measures like the 'most important problem' question or media coverage data have well-known drawbacks, such as high costs, sparseness of time series, or problematic bridging assumptions. In this paper, I propose an alternative behavioral measure that builds upon *Wikipedia* page view statistics. I argue that nonreactive measurement of issue attention provides several advantages over previously employed approaches, including low costs, high frequency, and issue specificity. To corroborate the suggested measure, I present several validation efforts in which I compare time series based on *Wikipedia* page view statistics with salience measures from political polls and external criteria of events and political activities. Preliminary results indicate that *Wikipedia* meta data provide unique potential to measure public issue attention.**

1. Introduction

Representative democracy, the by far most common style of democratic government, rests upon the idea that delegates are able to capture the will of the represented and govern in their place. While it is at the core of representative systems that voters rarely have the chance to state their policy preferences on single issues or communicate demands regarding a vast set of problems, such priorities are likely to matter. Research on issue voting has demonstrated that the salience of specific issues can be an important determinant of party choice (e.g., RePass, 1971; Niemi and Bartels, 1985; Bélanger and Meguid, 2008; Clarke et al., 2012) and that congruence (or the lack thereof) between voters and parties in policy priorities affects satisfaction with democracy and electoral participation (Reher, 2014, Forthcoming).

But how to identify issues of public interest in the first place? The most common approach to measure public issue attentiveness is to use "most important problem" (MIP) surveys. However, despite its popularity, this approach is far from being a gold standard. General population surveys are costly to conduct and often not geared for testing theories about public attentiveness. While public belief systems are often found to be comparatively stable, the prominence of issues in the public can change very quickly in face of external shocks like, for example, a nuclear disaster or terror attack, or changed political realities (Downs, 1972; McCombs and Zhu, 1995; Newig, 2004). It is questionable if survey data, which often provide infrequent snapshots of public opinion, are suited to capture the true volatility. In addition, the instrument itself has been fundamentally questioned for its use to measure the importance of issues (Wlezien, 2005). Another popular approach is to approximate public attention with media coverage data. This strategy may compensate for some

of the drawbacks of the survey-based approach, but has its own limitations. Most importantly, it prohibits the researcher to test for the influence of mass media on issue attention in the public.

Bearing the limitations of existing measures in mind, I tie in with recent work that exploits online behavioral data, in particular Internet search trends, to measure public issue attention (Ripberger, 2011; Mellon, 2014). Specifically, I suggest the use of *Wikipedia* page view data to identify short-term attention of selected topics. I argue that measures based on these data can provide a contribution to our understanding of public opinion on suddenly emerging issues and their effects on political activities.

In the remainder of this paper, I start with a conceptual framework of public issue awareness. Following this, I review existing measures of public attention in more detail. Next, I present the suggested alternative approach. Thereby, I discuss potential problems such as the difficulty of selecting adequate *Wikipedia* entries and the representativeness of *Wikipedia* users. Afterwards, this approach is validated using time series data from an MIP survey. The last section concludes.

2. Concepts of Public Issue Awareness

What characterizes public issue attention in contrast to related concepts such as public opinion, issue salience, or policy mood? And how does this matter theoretically and with regards to possible measurement strategies? In what follows, I provide a more detailed conceptualization and review previous theoretical assessments to arrive at a list of desirable properties for a new measure of public issue attention.

2.1. *Attention, opinion, and salience*

Public issue attention has been described as "the scarce resources that people are willing to devote toward thinking about a political issue" (Ripberger, 2011, 239). 'Thinking' can be understood more generally as the search for and consumption of issue-related news but also—literally—as the investment of cognitive resources to think about an issue.

It has been noted earlier that public opinion towards an issue on the one hand and public attention on the other are two distinct concepts (Newig, 2004; Ripberger, 2011). Roughly speaking, the former encompasses "what people think", whereas the latter stands for "what people think about" (Newig, 2004). Attentiveness perceived this way is largely agnostic about any sentiment related to an issue, whereas public opinion reflects (aggregate) attitudes. This distinction is important because a very popular measure of issue attention—MIP survey items—have been criticized for capturing problem status rather than importance, which clearly implies a negative connotation (Wlezien, 2005).

Another important characteristic is volatility. While public opinion is based on internalized belief systems and therefore often found to be rather stable over time (e.g., Page and Shapiro, 1992; Herron and Jenkins-Smith, 2006; Druckman, Fein and Leeper, 2012),[1], attention is not only more likely to be affected by sudden events, it is substantively driven by issue-related news transported by the media and other channels of information. Consequently, Ripberger (2011, 240) notes that "conflating the two necessarily restricts our ability to test the dynamic propositions projected by our theoretical understanding of how public attentiveness to political problems effects, shapes, and/or constrains governmental behavior." Put differently, the concept of issue attention can be useful to analyze change of public opinion as well—major events can be a game changer regarding issue-specific politics, but rapidly changing attention in response to an external shock could be a necessary (but not sufficient) precondition for gradual change in public opinion.

A concept more closely related to public attention is issue salience, which has been described as the importance of political issues (Wlezien, 2005). It "designates a weight individuals attach to po-

[1] See, however, Converse (1964) and Zaller (1992) for opposing views.

litical information" (Wlezien, 2005, 557). Relatedly, salience has been used to describe "top of the head" phenomena (Taylor and Fiske, 1978), that is issues which are currently paid attention to, but which are not necessarily of importance in the long term. Some scholars use both terms equivalently (e.g., Peters and Hogwood, 1985). It is less important to create an artificial dichotomy between both concepts, however, there are certain characteristics of public issue awareness that cannot be captured very well with existing measures of issue salience. Survey-based measures of salience capture problems that people consider as most important. These problems are often defined broadly, such as 'the environment' or 'the economy'. In contrast, public attention feeds on particular events and can be thus identified for narrowly defined issues—such as 'nuclear disaster' or 'refugee crisis'—but also for broader topics. A useful synonym for public attention could be 'short-term salience', emphasizing that it describes sudden interest which can ebb away as quickly as it occurred. That said, the specific characteristics of public attention—in contrast to other, related concepts—have important implications for theory building and measurement, as will be set forth in the following.

2.2. *The 'public' in public attention*

The 'public' in public attention emphasizes that it is a social phenomenon that can affect (and be affected) by the political sphere, i.e., governmental or party actors. I agree with Newig (2004) that, for this very reason, it is not adequate to use indicators of political activity like parliamentary debating time (Baumgartner and Mahoney, 2005) or organizational change Peters and Hogwood (1985) as proxies for public attention. Rather, they can be used to examine causes and consequences of public attention or, when a sufficiently strong theoretical relationship can be justified, as criteria to assess external validity of a public attention measure (see below).

2.3. *The nature of issues and events*

What is the nature of issues considered? Public attention can be attracted by virtually all topics that enter the information market. The selection of relevant issues and the decision how broadly these issues are defined is therefore entirely dependent upon research interest. Most measurement attempts are, however, restricted to political issues in the broadest sense, as the ultimate goal is to test theories on the interplay between the public and political arena. Popular empirical efforts like the Policy Agendas Project[2] track agenda setting behavior and public issue salience using predefined, broad categories like 'economy', 'unemployment', or 'environment'.

Abstract perceptions of issues do not necessarily match with what truly excites the public. News are usually not framed around these broad topics, but cover specific events or smaller sub-issues. For instance, the issue arena of 'economy' can comprise reports about annual GDP growth, daily stock market coverage and international trade negotiations, as well as actions of large corporations. In addition, issues and related events are not necessarily independent of each other—a nuclear catastrophe is certainly an environmental issue, but also affects economic and international issues. Newig (2004) has argued that issue-attention cycle theory can be applied to both single issues and their sum, e.g., a 'multitude of single issue-attention' cycles. Therefore, fine-grained measures of public attention ideally allow to identify both attention towards manifest topics and latent issues. The precision of measurement can affect the conclusions we draw on the dynamics of public attention—while it makes sense to expect that attention towards single issues fades away rather quickly after an associated event happened, attention towards a broader set of issues can last longer. Another perspective does not focus on attention to a single issue, but looks at the diversity of attention, i.e. how interest distributes over a vast set of items (Boydstun, Bevan and Thomas, 2014). This

[2] See www.policyagendas.org.

also requires within- and between-issue measurement of attention.

Regarding the importance of events to identify public issue attention, should we, then, not simply take events themselves as indicators of public attention? One way would be to extract events out of newspaper articles and, if needed, classify them according to previously defined issue groups. I argue that such an approach would ill-suited to capture public attention, as not all events can be expected to arise equal levels of interest, either because they interfere with other, more attention-grabbing events or are generally unspectacular. Therefore, a more direct measure of public attention is needed to separate meaningful from insignificant events.

2.4. *Theories of public attention*

Public attention plays an important role in several branches of research in political science. One of the most influential theories in this regard was brought forward by Downs (1972), who introduced his concept of the 'issue-attention cycle': "[A] systematic 'issue-attention cycle' seems strongly to influence public attitudes and behavior concerning most key domestic problems. Each of these problems suddenly leaps into prominence, remains there for a short time, and then—though still largely unresolved—gradually fades from the center of public attention" (Downs, 1972, 38). This theory already emphasizes the role of sudden events for issues to be put on the public and political agenda, but also makes the pessimistic prediction that after such events, complex problems remains largely unsolved when public attention gradually declines. Downs (1972) himself only provided anecdotal evidence for his case, but thereafter the issue-attention cycle has been under manifold theoretical scrutiny (Hilgartner and Bosk, 1988; Kingdon, 1995). Significant empirical follow-up studies include Peters and Hogwood (1985), who use changes in U.S. government organizations as indicators of political attention to study cycles across multiple issues, and Henry and Gordon (2001), who draw on a rolling sample survey covering roughly 150 days to model the function form of public attention. In doing so, the authors are well aware of the drawbacks of their empirical strategies: On the one hand, it is obvious that the expectable lag between public attention and institutional change makes this strategy hardly a strong test of the original theory. In the latter case, the authors themselves admit that "because interest is a function of time as well as media coverage, individual characteristics, and elite responses, static measurements may or may not capture the effects of change depending upon the timing of the administration of the survey" (Henry and Gordon, 2001, 158). What the issue-attention cycle theory calls for are measures of (1) the pre-problem stage, (2) politically relevant events, (3) public attention and (4) political activity. Given that the theory makes explicit claims about the short-term influence of events on attention as well as non-linear functional forms of attention and its influence on government activity, it is clear that it makes high demands to any measure of public attention, many of which existing measures can not fulfill satisfyingly.

Another enormously popular strand of research in which is public attention and salience plays a core role is the agenda-setting literature (McCombs and Shaw, 1972; Majone, 1989; Baumgartner and Jones, 1993). Whereas early work emphasized the nexus between media agenda-setting and public concern (Cohen, 1963), later research focused on policy agenda-setting or building, asking to what extend media and the public shape policy makers' agendas. More recent research in this area aligns with work on issue-attention, attaching more weight to the role of focusing events. Such events, specified as relatively uncommon, potentially harmful, and known to policy makers and the public simultaneously (Kingdon, 1995; Birkland, 1997, 1998), are considered to raise attention in the public, which again set political actors under pressure — just the kind of opportunity interest groups and political groups are waiting for (Baumgartner and Jones, 1993; Majone, 1989; Soroka and Wlezien, 2010).

This paper does not provide another test of the theory. Instead it hopes to provide foundations for a new measure of public awareness that can help investigate the issue-attention cycle and policy agenda-setting processes in previously unknown precision. To serve that purpose, it has become clear that any measure of public attention has to be distinct from common operationalizations of dynamic public opinion. For instance, Stimson's (1991) concept of policy moods is built to capture long-term trends in public opinion towards policy issues. Drawing on yearly surveys as main unit of analysis, it targets at identifying incremental rather than sudden changes in moods. By contrast, a valid measure of public issue attention should capture true attention, not opinion, allow identifying short-term volatility, be applicable to both general and specific issues, and provide an undistorted reflection of the latent concept, as the use of proxies may be in conflict with theories at stake. In addition, further desirable features are be that such a measure can be generated with low cost and is available over a long period of observation as well as for a multitude of political settings.

3. Existing Measures of Issue Attention

In this section, I review classical and more recently suggested approaches to measure public issue attention and discuss their distinct assets and drawbacks with regards to the previously discussed desirable properties. Table 1 provides an overview of all discussed approaches.

3.1. *Survey data*

Probably the most common measure are surveys that ask people about the 'most important problem' (MIP) a nation faces today (RePass, 1971; Miller et al., 1976; Burden and Sanberg, 2003).[3] This measure is used to identify salience at the level of individual voters (e.g., Macdonald, Rabinowitz and Listhaug, 1995; Fournier et al., 2003) as well as to generate aggregate MIP time series that represent public issue attention over time (e.g., McCombs and Shaw, 1972; McCombs and Zhu, 1995).

One of the main advantages of MIP-based measures is their long historical record. For example, Gallup surveys including the MIP item have been administered since 1954, which allows tracking trends over long time spans. Further, asking people directly about what they perceive as the most important problem is certainly a straightforward measure—especially in contrast to other, proxy-based measures I discuss below. Consequently, MIP measures have been attested high face validity. Probably most important, however, is the fact that they are (at least partly) available at the individual level, which is crucial for research on issue voting (RePass, 1971; Niemi and Bartels, 1985; Bélanger and Meguid, 2008; Clarke et al., 2012) and other models operating at the person level.

On the downside, scholars have pointed out the problems resulting from the sparseness of survey data, as existing poll time series commonly provide information at the monthly level and are not able to track weekly- or even daily-level shifts in issue interest (Henry and Gordon, 2001). This is, of course, mainly due to the costs associated with designing and administrating general population surveys. Regarding the instrument itself, the fact that respondents are limited in the number of issues they can report as important makes it difficult to identify relative attention to issues over time, in particular when the rate of issue turnover in the public increases (see McCombs and Zhu, 1995).

Most importantly, Wlezien (2005) criticizes the instrument for its lack of content validity, as it mixes an issue's status as a problem with the one of being important. As an example, he argues that while the (state of) the economy is widely regarded as a continuously important issue, it is considered problematic only in times of high unemployment or low GDP growth. His analyses demonstrate that variation in mentions of most of the MIP responses is mainly driven by *other* issues that are (or are not) currently seen as prob-

[3] For example, in the Gallup Poll surveys, voters are presented the open-ended question: "What is the most important problem facing the country today?"

Table 1: Advantages and disadvantages of issue attention measures

	Survey data (MIP)	Media data	Internet search data	*Wikipedia* traffic statistics
pros	• individual-level measure • long historical record • direct measure	• low cost • frequency • flexibility	• low cost • frequency • flexibility • broad coverage	• low cost • frequency • flexibility • broad coverage
cons	• costs • sparseness of time-series • limited coverage • validity concerns	• aggregate-level measure • bridging assumptions • media coverage 'burnt'	• aggregate-level measure • lack of transparency • limited time series	• aggregate level measure • language populations • limited time series

lems, but not by the perceived importance of issues themselves.

To sum up, while the use of survey data to measure issue attention is sometimes without alternatives, they can be problematic, especially when the interest is on short-term changes and specific or 'niche' issues. In addition, the fact that MIP questions are not agnostic towards the problem status of an issue might hide relevant trends in attention towards issues that are not per se perceived as problematic, but still important.

3.2. *Media coverage*

In order to mitigate some of the concerns related to survey data, researches have turned to the coverage of topics in the media as a proxy measure (e.g., Baumgartner and Jones, 1993; Epstein and Segal, 2000; Newig, 2004; Helbling and Tresch, 2011). This approach builds upon the observation that media coverage of and public attention towards particular issues tend to be highly correlated. Many different approaches exist, but one common method is to trawl newspaper archives for selected key words and then to count the number of articles containing a specific key word for a given time span. After standardizing the number of articles based on the total number of articles, trends in issue salience can be identified as time series of proportions of particular issues.

Media-based measures address two important concerns of MIP data: They are fairly cheap to collect and allow for much more frequent measures. It is basically up to the researcher to select the period and frequency of measurement. On the other hand, it is obvious that media coverage is not a direct measure of public attention, but a proxy instrument. The practical advantages are dearly purchased with a theoretically problematic assumption, namely that media and public attention are equivalent. The fact media pursue their own agenda by highlighting some issues and neglecting others questions the convergent validity of the measure; news media coverage mirrors media rather than public salience (Erbring, Goldenberg and Miller, 1980; Kiousis, 2004; Ripberger, 2011). While it is hardly imaginable that the public is excited by issues not covered in the media (at least when free press exists), not everything covered by the media actually implies or causes public attention. In addition, even if the measure was valid, it impedes investigating theories that relate agenda setting by the media with public issue attention.

3.3. *Internet search data*

In an attempt to overcome some of the drawbacks of both MIP and media-based measures, recent approaches have turned to new opportunities that are provided by vast amounts of web data. These efforts are part of a booming literature that uses web-based data to explain or forecast social, economic and epidemiological phenomena, such as

the spread of diseases (Ginsberg et al., 2008), consumer behavior (Goel et al., 2010), or civil unrest (Compton et al., 2014).

Ripberger (2011) is among the first to suggest the use of *Google* search data to infer on public attention towards particular issues. His argument for this proxy is twofold:

> "First, search behavior is necessarily motivated by some degree of thought about a particular issue. Second, searching for something on the Web requires that individuals invest some degree of time and energy in pursuit of their interest. When considering the definition of public attention—the scarce resources that citizens are willing to spend thinking about a public issue—aggregate search behavior appears to be a valid approximation." (Ripberger, 2011, 242-243)

Similar to media coverage data, information on Internet search volume comes at virtually no cost,[4] is available at the daily or weekly level and allow for great flexibility in the selection of issues. By now, awareness measures based on behavioral web data have been implemented to examine the impact of public attention on fundraising in U.S. Senate elections (Ellis, Swearingen and Ripberger, 2011), to forecast election outcomes (Graefe and Armstrong, 2012), and to assess the impact of abortion policies Reis and Brownstein (2010).

Several attempts have been undertaken to validate search volume data as a measure of public issue attention or salience (Ripberger, 2011; Scharkow and Vogelsang, 2011; Scheitle, 2011). In what is to date the most ambitious validation study of *Google Trends* data, Mellon (2014) compares weekly search volume in the United States with Gallup's MIP question and presents several validity checks. He finds satisfying performance for salience on fuel prices, economy, immigration and terrorism, and less satisfying results for other domains.

[4]For instance, *Google* provides these data publicly at http://www.google.com/trends/.

Using *Google Trends* data as a basis for measuring issue salience is not without significant drawbacks. Data are only available at the aggregate level and are transformed before they are released. *Google* normalizes and scales the time series, whereby the highest observed volume is set to 100. Raw data are not available. This makes it difficult to assess the relative salience of issues. Additionally, data older than 90 days are only available at a weekly basis. Perhaps most importantly though, the time series are limited, starting in January 2004. This renders research on long-term shifts in public issue salience impossible.

4. A New Approach

The approach to measure issue attention propagated in this paper is related to previous efforts to use web-based behavioral search data. My suggestion is to exploit *Wikipedia* page view statistics of article entries that can be attributed to specific topics. In line with the rationale behind previous approaches that have exploited search engine data, I argue that increased attention to a specific topic on *Wikipedia* indicates risen public interest.

Wikipedia ranks among the most frequently accessed domains on the Web.[5] It is one of the most popular sources for any kind of information. When Internet users decide to consult a search engine to inform themselves about a certain topic, one or more *Wikipedia* entries usually rank among the first search results.

The idea to exploit *Wikipedia* usage data as an indicator or predictor of offline phenomena is not entirely new. Moat et al. (2013) investigate whether the number of views or edits to selected articles on financial topics and companies helps predict stock market performance. Mestyán, Yasseri and Kertész (2013) use the data to forecast box office revenues. Tausczik et al. (2012)

[5]As of October 2015, http://wikipedia.org takes the 7th place according to Alexa Internet (see http://www.alexa.com/topsites; last accessed Saturday 17th October, 2015) and the 10th place according to SimilarWeb (see http://www.similarweb.com/global, last accessed Saturday 17th October, 2015).

show that the H1N1 outbreak in 2009 reflected in Wikipedia visits and other web-based information sources and take this as evidence for public anxiety. In a recent study, Yasseri and Bright (2015) suggest to exploit *Wikipedia* data to forecast electoral outcomes at European Parliament elections. In a study closely related to this paper, Wilkerson (2015) uses *Wikipedia* page views to measure the mass salience of US Supreme Court decisions.

In contrast to Wilkerson (2015), who focuses on a well-defined subset of issues that can be clearly related to specific article entries, my goal in this study is to identify articles for more general topics, as they are commonly coded in survey- or media-based measures of public attention (such as 'economy' or 'unemployment'). In doing so, I pick up the argument made by Ripberger (2011) (see the quote above) and others: Internet search activity reflects interest in particular topics, which can be identified a priori by selecting a relevant set of keywords or articles, or ex post when we observe increased activity linked to a certain topic. The desire for information should be particularly high when (1) the related topic is a generally interesting one or (2) when events related to the topic happen unexpectedly, creating an information deficit in the public.[6]

I expect web search data to be particularly useful to identify short-term public attention that is induced by focus events (Birkland, 1998). Sudden events like nuclear catastrophes, stock market crashes, or international conflict create a need for information that can be satisfied with private research on the Web. On the other hand, taking such events themselves as an indicator of public attention would neglect the impact of the media as agenda setter and limits of information capacity. I regard a behavioral measure like web search activity to be less confounded than previously used media-based measures and—under certain conditions—more flexible than MIP surveys. From a theoretical perspective, I regard public attention closely related to the observed collective search behavior, as it merely mirrors information deficit, not preferences (as assumed in, e.g., Yasseri and Bright, 2015).

Like any other approach to measure public issue attention, the suggested method rests on a set of conditions, some of which are testable while others are not, and some of which are easier to defend than others. As this is the first comprehensive attempt to use *Wikipedia* page view data for this purpose, I make these assumptions explicit and discuss their plausibility in the following.

(1) *Aggregate page view data reflect the average attention of issues among Wikipedia users.* While it is less clear why people consume certain *Wikipedia* articles more frequently than others, I argue that the search for a specific topic on *Wikipedia* has a straightforward implication: The person is interested in this topic. Following the argument that issue attention—perceived as the resources people devote toward thinking about a political issue—is closely related to people's efforts to inform themselves about an issue, it can be said that aggregate page views of articles that are in fact issue-related have a high face validity. This condition is most essential for the suggested approach to work, and rests upon additional assumptions—such as the possibility to link *Wikipedia* articles to latent issues. In a nutshell, this condition is equivalent to the validity of the measure and therefore subject to a variety of tests provided below.

(2) *Public issue attention of Wikipedia users and the general public is equivalent.* It is well known that Internet users are not representative of the general public (Gong, 2011; Duggan and Brenner, 2013; Barberá and Rivero, 2014), and the difference is aggravated when focusing on users of *Wikipedia*. According to data collected by the Pew Internet & American Life Project in 2010, *Wikipedia* users

[6] The website https://en.wikipedia.org/wiki/Wikipedia:Article_traffic_jumps provides some examples for article traffic jumps related to specific events; mostly the death of celebrities but also, for instance, the article on Great Britain after the announcement of the 2015 parliamentary election results.

in the United States are younger and better educated than Internet users who do not use *Wikipedia* and non-Internet users (Zickuhr and Rainie, 2011).[7] On the other hand, as of May 2010, about 53% of US Internet users or 42$ of the American adult population used *Wikipedia* to look for information, reflecting the enormous popularity of the site. Demographic bias in the use of *Wikipedia* turns problematic in my application if these differences also generate variation in the weights people attach to specific issues. While there is surprisingly little known about individual determinants of salience of political issues, there is no a priori reason to assume that *Wikipedia* users differ a lot in their perception of issue attention from non-Wikipedians, apart from the fact that, obviously, they use *Wikipedia* to satisfy their demands for information. Lacking individual-level information about *Wikipedia* users, it is not possible to directly test whether the attention to specific topics varies along demographic or ideological predispositions.

(3) *Wikipedia provides relevant information for the topic of interest.* This is not necessarily the case for every issue and language of the encyclopedia. It is subject to the validation exercise to examine whether it is possible to find plausible articles, i.e. articles users read to inform themselves about the assumed salient issue.

(4) *Volatility in page view volume reflects volatility in issue attention.* This is closely related to the reliability of the measure. Even if article page views are shown to be a valid proxy of issue attention, they can prove an improper measure if they are affected by noise due to seasonality in the time series or portions of page views that are not due to attentiveness. Lacking a gold standard measure, it is hard to judge whether changes in page view data reflect the signal of interest or should rather be considered noise. One approach to assess this issue would be to gauge the predictive power of changes in page views for, e.g., an external criterion that can be theoretically justified as a plausible effect of issue salience. To this end, I use event data that is assumed to be the main driving factor of volatility on the one hand, and data on political activities and other relevant outcomes as external criteria on the other and model them as a function of various measures of public issue attention to assess their predictive validity.

Similar to existing web-based proxy measures that have already been suggested, using *Wikipedia* page view statistics is promising in several ways. First, the data are made available for free. Secondly, while standard trend surveys are conducted only occasionally, page view statistics come at a daily basis, which provides a much more fine-grained view on trends and relative attention towards topics. Thirdly, while survey-based analyses of public attention are—because of costs and respondent fatiguing—restricted to small subsets of issues, behavioral web data in general and *Wikipedia* page view statistics in particular can be used to track awareness towards a wide range of topics simultaneously.

In comparison with *Google* search data, I see some additional advantages unique to *Wikipedia* page view statistics. For one thing, it is easier to argue that the access volume at Wikipedia actually reflects interest for a certain issue, while some search key words used may threaten validity if they are used with another intention. Mellon (2014) reports problems for certain search indices that are not necessarily obvious in advance. The example he offers is that *Google* requests for 'jobs' may reflect actual interest in employment—and could therefore be used as a proxy for the

[7] According to the survey, 56% of male and 50% of female Internet users use *Wikipedia*. The encyclopedia is most popular in the group of 18-29 year old Internet users (62%) and least poplar among 65+ year olds (33%). 69% of those Internet users that have a college degree or a higher education level use the *Wikipedia*, whereas just 30% of those with less than a High School Diploma do.

salience of the state of economy—, but is also frequently used to search for 'blow jobs' and 'Steve Jobs'. In contrast, it is possible on *Wikipedia* to identify articles with unambiguous meaning that are closer to the issue of interest (for example, an article on the unemployment rate or job-seeker's allowance). *Wikipedia* offers a search function that allows identifying articles related to a certain topic. This facilitates the process of finding suitable articles to track issue attention. In addition, the fact that knowledge on Wikipedia is organized as a very dense network—related articles are linked to each other—it is possible to identify relevant articles that can be subsumed under one issue domain. For another thing, the *Wikipedia* Analytics Team provides raw data, that is absolute counts on page accesses. While they may not be utterly precise (Zachte, 2015), they are still more transparent than search statistics from *Google Trends* and, more importantly, allow for relative estimates of importance between issues.

For sure, the data source is not free of drawbacks. The richness of available topics at a very high frequency comes at a certain cost. As is the case with other proxies, the measure provides no further information on individuals. An even greater concern for most substantively oriented research is that time series are not available before December 2007 in case of the English encyclopedia, and even later for other languages (e.g., February 2008 for the German *Wikipedia*). In contrast to measures based on search engine request data, *Wikipedia* page view data cannot be restricted geographically. The population of interest in studies of public issue attention is usually defined by political entities. However, the count statistics provided by the *Wikipedia* Analytics Team are language-, not country-specific. One solution to this problem would be to identify IP addresses of visits and derive the geographic location of user, but these data are currently not available.[8] While this problem might make it very difficult to assess issue attention in countries where the official language is spoken globally, it is less of a concern in countries like Japan, Italy, Poland, and others, where the overwhelming fraction of readers accesses the page from within a single country.[9]

Overall I argue that while these drawbacks might prohibit *Wikipedia* page view statistics from being used as a measure of issue attention in certain scenarios, the benefits might outweigh the costs in other applications by providing invaluable additional information. Reflecting aggregate information retrieval behavior, they should capture attention rather than opinion, are available for a multitude of issues at short-term intervals, come at virtually no cost and for many different language domains. In the next step, one of these language domains serves as the basis for more extensive validation efforts.

5. Data and Validation Strategy

To validate *Wikipedia* page view statistics as a measure of issue attention, I compare time series generated from this new data source with both survey-based data as a direct measure and several external criteria. I pursue this double-track strategy because, as discussed above, although MIP items are the most popular way to measure public issue attention, they should not be taken as an unambiguous gold standard.

As an empirical test case, I use German survey and *Wikipedia* data. As noted above, it is not yet clear whether it once will be possible to identify the country origin of page accesses, which makes it very difficult to judge whether the population under study is more or less part of the population of interest. However, this problem is mitigated in the German case, especially when compared to the United States and the United Kingdom. The German Wikipedia is primarily read by Germans.[10]

[8] From personal communication with Bill Wilkerson, 6th May, 2015.

[9] See Zachte (2015) for an up-to-date language-level overview of *Wikipedia* traffic by countries.

[10] According to the Wikimedia Traffic analysis report (Zachte, 2015), German users make up roughly 70% of the readers of the German Wikipedia. As a benchmark, the

5.1. *Data*

MIP data. Since 1977, the *Forschungsgruppe Wahlen* has been conducting the *Politbarometer* study in Germany, which includes the MIP item.[11] The study was conducted by CATI and RLD sampling in the period of interest and targeted the eligible voting population. The MIP item has been asked monthly since 1997 and bi-weekly since 2006. To get a reasonable benchmark for the daily-level *Wikipedia* measures, I rely on the cumulated dataset (Forschungsgruppe Wahlen, 2015) and restrict the analysis to the time period between February 2008 and December 2013. In this period, the open-ended responses were classified into 69 categories, some of which being specific to particular events (e.g., 'Foot-and-mouth disease', 'Rampage and computer games') and with relatively few mentions, some of which relating to more general issues (e.g., 'Unemployment', 'Inflation'), which tend to be among the most popular mentions.

To ensure comparability with the Wikipedia data, I normalize the time series in the period under consideration by rescaling values between 0 (lowest number of mentions) an 100 (highest number of mentions).

***Wikipedia* data.** *Wikipedia* traffic statistics can be accessed for any article of interest in all common (and some uncommon) languages at the daily level, and are available since February 2008 for the German sub-domain. They are collected and maintained by the *Wikipedia* Analytics Team.[12] In order to gather the data, I drew on the service at http://stats.grok.se which provides a comfortable interface to the data that returns the page-view statistics in JSON format. Further, I used the `wikipediatrend` package to import these data into R (Meißner, 2014). Tables A1 and A2 in the Appendix provide an overview of all articles collected, along with the total, average and maximum daily number of views. In the period under consideration, the daily average view count varied between 9 (for the article on the Asylum debate) and 5,536 views (for the article on the European Union).

To make the page view data comparable with the MIP data, I normalized them, too. In later applications, the raw counts might be used to assess the relative importance of issues. In this paper, I mainly focus on comparisons within issue domains.

Selection of issues. In the first part of the validation exercise, the selection of issues is restricted by pre-coded answers on the MIP. I selected twelve of the most popular mentions to get a diverse set of issues that vary in terms of popularity, volatility in the period under consideration, and content. Table C1 in the Appendix provides an overview of the 25 most frequently named categories along with an indicator of the selected issues. Altogether, they account for roughly 70% of all mentions in the period under consideration.[13] The selection of corresponding *Wikipedia* articles

around 36% of the users of English Wikipedia are based in the United States, 10% in the United Kingdom, and the remaining share scatters over other states of origin.

[11] 'In your opinion, what is the most important problem Germany faces today?' Originally, the question reads: *'Was ist Ihrer Meinung nach gegenwärtig das wichtigste Problem in Deutschland?'*

[12] See https://wikitech.wikimedia.org/wiki/Analytics/Data/Pagecounts-raw (last accessed Saturday 17th October, 2015) for further information.

[13] Note that the selection of MIP categories already reveals some weaknesses of both survey data and behavioral web data to measure issue attention: On the one hand, the categorization scheme underlying the category labels is not transparent and can be questioned—e.g., it seems arbitrary why 'Nuclear power' and 'Energy transition' are two distinct categories, whereas the residual label 'other domestic issues' seems to cover a lot of different sub-issues. In a future version of the paper, I will replace this coding scheme that comes along with the Politbarometer data set and replace it with the coding scheme that is used by the Policy Agendas Project. This ensures compatibility of both MIP and *Wikipedia* time series with common models of policy agenda setting. On the other hand, some of the issues were deliberately excluded from the validation exercise, as they are so abstract that it is difficult to identify corresponding *Wikipedia* entries. In a way, it is a disadvantage of behavioral web data used here that we cannot directly ask for awareness towards latent issues. One could argue though that this protects researchers from reification.

is already part of the validation process and described in more detail below.

5.2. *Validation criteria*

Lacking any unambiguous gold standard of salience and given the proxy nature of the proposed measure, the validation exercise proceeds in several steps. In doing so, I follow Mellon's (2014) painstaking validation study for *Google Trend* data in the first step, and extend it with external validation criteria in the second.

The first criterion is *face validity*, meaning that the selected articles represent a plausible information source for the issue of interest. In order to select issue-related *Wikipedia* entries, I initially looked for articles that resembled or came close to the issue title (e.g., the article on unemployment for the respective issue) and used *Wikipedia*'s search function to identify related articles that can be regarded similarly informative about the issue of interest. Next, I exploited the fact that *Wikipedia* entries make heavy use of hyperlinks to other articles on the page. As these links are used to organize networks of knowledge, they are likely to be related to the issue of interest as well. Therefore, I collected backward and forward links (i.e., articles linking to an article and articles that are referred to from the source article) within each domain and scanned the matches for further entries that satisfied face validity.

Another pre-assessment of validity targets the content, that is whether the selected measure—in this case, article views—in fact captures the content of the issue of interest. To assess whether the selected articles can be attested *content validity*, I (a) examine the articles' traffic histories and (b) scrutinize the content itself to ensure that the article is in fact issue-related. The idea is that articles which barely receive attention cannot be regarded as an important information source, in particular for the chosen, popular topics. Further, I expect trend estimates based on limited page views unstable and not very useful to distinguish noise from signal. With regards to the content itself, it might be plausible that people who are interested in the financial crisis also have a higher likelihood to stumble upon an article about a fictional movie that is, by accident, also named "The financial crisis." While this would reflect in the movie's page views, I would not consider the page views of this article to be a valid measure of issue awareness because it would represent a very far-fetched proxy with unclear bridging assumptions. After all, interest in the movie itself would blur the actual signal and likely dominate it.

Next, I use other existing measures as benchmarks. Despite its drawbacks, the well established MIP measure serves as a criterion of *concurrent validity*. Technically, I regress the MIP time series on the *Wikipedia* measure and assess (1) whether there is a significant relationship between both and (2) how much of the variation in the MIP series can be explained (identified through the coefficient of determination, R^2) using the series based on *Wikipedia* page view statistics. The closer both measures are related, the higher the measure's concurrent validity.

Assessing the validity of my measure using survey data is not entirely satisfactory, as the validity of both criteria can be questioned. It has been suggested to identify 'problem' criteria as an external source of validation (e.g., Wlezien, 2005). Therefore, I extend my evaluation with an assessment of *criterion validity* by utilizing other, issue-related quantities. One of the core advantages I expect to derive from the *Wikipedia*-based measure is that it provides a fine-grained measure which is, in principle, sensitive to sudden events. In order to test whether this is actually the case, I present a set of issue-specific validity checks in which I relate short-term event data (in this case data on refugee deaths) and more general indicators that may raise attention in the public (monthly unemployment rates, currency exchange rates) to issue-specific awareness indicators.

Finally, the criterion of external validity can be extended by taking issue attention as the explanatory variable. I assess *predictive validity* by regressing measures of political activity on MIP- and *Wikipedia*-based indicators of public attention. Therefore I use data from parliamentary in-

terpellations which arguably reflect agenda setting of parliamentary parties (and oppositional parties in particular) as well as governmental press releases, in which spokespersons of federal ministries comment on topical issues. I argue that political actors have incentives to carry in topics that are of importance to the public into the political arena. Thus, I expect the public attention of issues to reflect in subsequent political activity, which would in turn demonstrate the measure's *predictive validity*.

5.3. *Dealing with seasonality and non-stationarity*

Both *Wikipedia* and MIP data are time series data. This has to be taken into account in the comparison. For one, the *Wikipedia* time series exhibit a considerable amount of seasonality, that is patterns which are recurring over time but which are not necessarily a reflection of changes in issue salience. As an example, consider the time series plotted in Figure 1. The Data panel provides the normalized data for the German *Wikipedia* article on 'Arbeitslosengeld' (unemployment benefits). It shows considerable volatility over time. Using Seasonal Trend Decomposition by LOESS (STL; Cleveland et al., 1990), it is possible to decompose the time series into a seasonal, trend and remainder component with 52-week periodicity. The second panel reveals that page views seem to drop dramatically by the end of a year and in summer. Remarkably, the smoothed trend component virtually follows the actual unemployment rate in this period under consideration (see Figure 4).

It cannot be said a priori whether these changes are substantive, i.e. whether interest in the topic in fact decreases in these times of the year. However, in the case of unemployment benefits, it is unclear why people should be less interested in the Winter, where unemployment rates usually show a reverse pattern of seasonality. Additionally, the MIP series do not exhibit a comparable pattern (see also Figure D1 in the Appendix). I argue that the observed seasonal patterns in the *Wikipedia* series (which are similar among all selected articles) are an artifact of general activity of Wikipedia usage in these periods and not substantively related to any of the topics. Mellon (2014) finds similar patterns for *Google* search requests. I follow his strategy and remove the seasonal component as identified by STL and continue with the adjusted series, which are then a combination of the smooth trend component and the remainder.[14]

Another time series issue to address is that of non-stationarity. It is well-known that *Wikipedia* has become more popular over the past years, which would inflate measures of attention based on raw article traffic statistics. Therefore, I use time series of overall *Wikipedia* traffic volume to de-trend the article time series. These data are available for all different language platforms at the monthly level.[15] Figure B1 in the Appendix reports the increase of traffic volume for the German *Wikipedia*; Figure B2 illustrates the difference in using uncorrected versus corrected time series for the German *Wikipedia* article on unemployment. All time series of *Wikipedia* traffic presented in this paper have been corrected for seasonality and increase in global usage behavior.

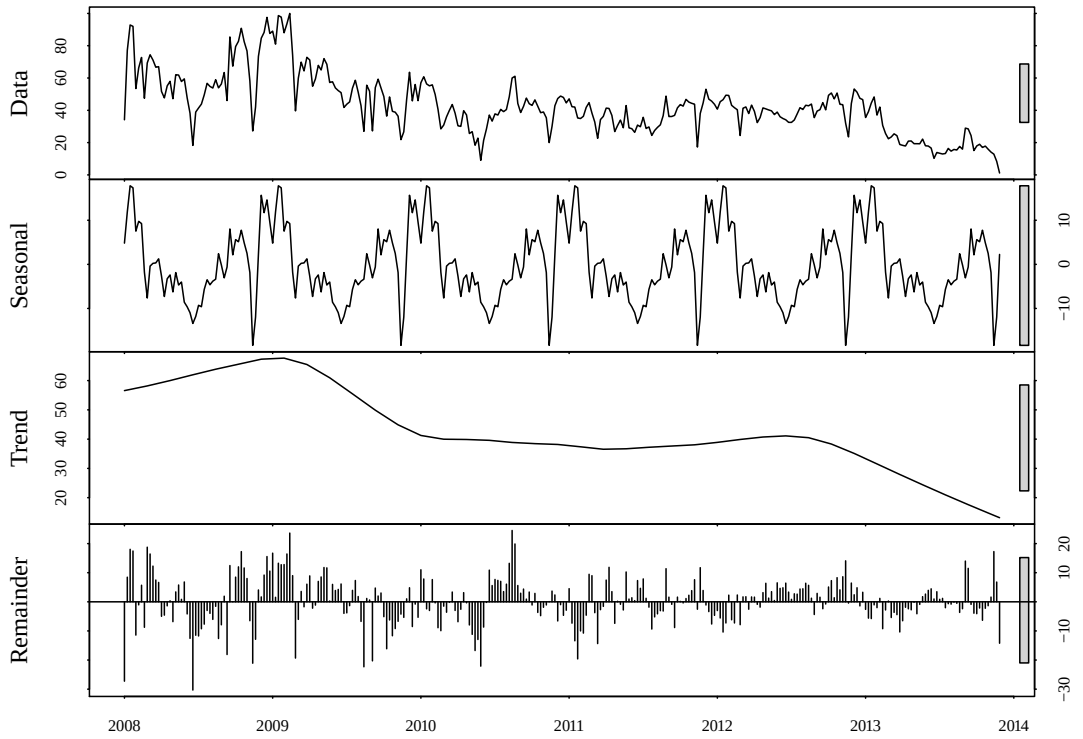
6. Results

To illustrate how political events reflect in *Wikipedia*'s page view statistics, Figure 2 shows the number of page views—aggregated at the weekly level—for the German article on the 'Energiewende' (energy transition) between February 2008 and December 2013. The first version of the article was published in August 2007. It received hardly any attention for over three years though, with the exception of a minor peak in June 2009 (marked (1) in the plot), which

[14] Note that the raw time series is affected by other, short-term seasonal patterns. When considering daily-level variation in article views, we see that at weekends the number of page views is about 50% lower than on weekdays, possibly due to the fact that many people access the page at work (for an example, consider Figure B3 in the Appendix). If the data are to be used at the daily level, these seasonal trends have to be taken into account as well.

[15] See http://stats.wikimedia.org/EN_Europe/TablesPageViewsMonthlyOriginalCombined.htm (last accessed Saturday 17th October, 2015)

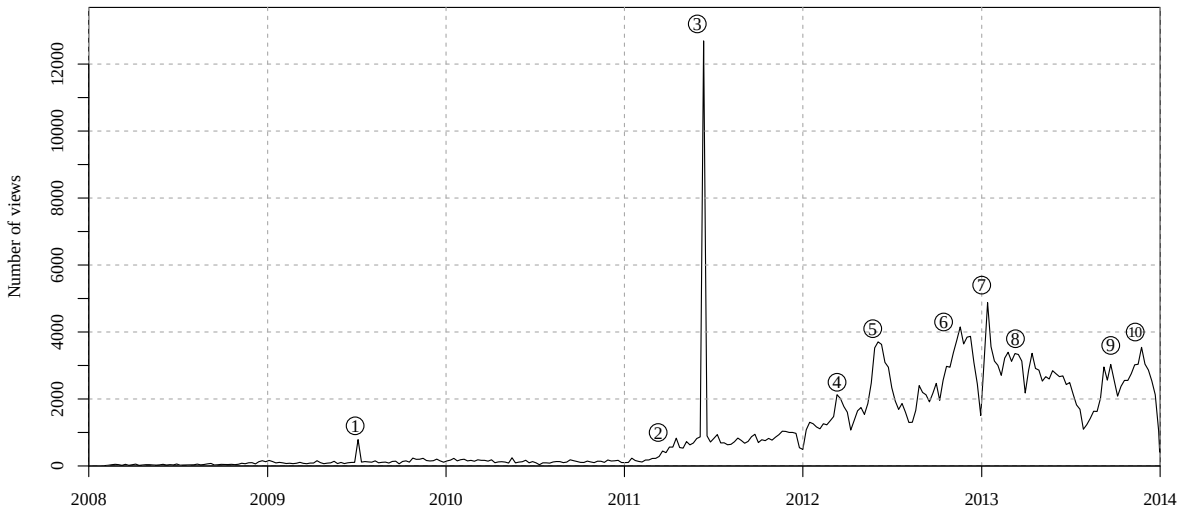
Figure 1: Seasonal trend decomposition by LOESS for views of the German *Wikipedia* article 'Arbeitslosengeld' (unemployment benefits).



is in line with the foundation of the International Renewable Energy Agency (IRENA) earlier that year the second session of its Preparatory Commission in Sharm El Sheik, which received a considerable attention in the media. Attendance to the article rose dramatically short after the Fukushima nuclear disaster in March 2011 (see (2)), when the German government determined the second nuclear phaseout after 2001 and the breakthrough of the energy transition (see (3)). In the respective week, the article got the attention of more than 12,000 readers. The one year anniversary of the Fukushima disaster (see (4)) reinforced the discussion on the energy transition. In May 2012, the Merkel government together with the Minister-Presidents of the German states met for a summit on the energy transition, which again received considerable attention in the public (see (5)). Later rises in the attention towards the article ((6) and (7)) can be attributed to intensive debates about the follow-up costs of the energy transition. In October 2012, the government had to admit that the project would be more expensive for the consumers, partly due to higher charges for renewable energies based on the German Renewable Energy Act (*Erneuerbare-Energien-Gesetz*). While the second anniversary of the Fukushima catastrophe did not show much of an impact on the page access statistics anymore (see (8)), the energy transition was one of the issues that dominated the 2013 federal election in September 2013 (see (9)). In December 2013, the new government agreed on further steps in the reform of the energy transition (see (10)).

The example demonstrates that certain political events indeed reflect in *Wikipedia* page views. Moreover, major events that are closely related

Figure 2: Wikipedia page view counts for the article 'Energiewende'. Circled numbers refer to events and are explained in the text.



to the article topic have the potential to cause dramatic eruptions in page views that vanish as quickly as they emerged. However, what can also be observed is that the attention stayed at a certain level—about 1,000 to 2,000 views per week—once the issue was put on the national political agenda in 2011. While the page view data certainly indicate short-term attendance that is caused by specific events, they may also reflect long-term issue interest. The main aim of the remainder of this paper is to investigate whether these observations are generalizable to other issues (and articles).

6.1. *Face and content validity*

Following the procedure described above, I selected a multitude of articles that are related to the twelve broad issues using *Wikipedia*'s search function and the link structure between the articles.

I excluded articles with less than 100 views per day on average.[16]. I make an exception for articles related to the childcare issue because otherwise, there would have been only one relevant article. Interestingly, among the excluded articles were many that explicitly focused on a particular policy area, e.g., currency policy ('Währungspolitik'), health care policy ('Gesundheitspolitik') or climate policy ('Klimapolitik'). Apparently, users of the German *Wikipedia* rather use articles related to a concrete issue rather than abstract policies.

Next, I examined the remaining articles based on their content. Most of the article titles were already revealing, so I could hardly find any threats to validity based on content. One exception was the article on the German Bank Crisis ('Deutsche Bankenkrise'), which informed about the collapse of German financial institutes in 1931, a historical event not directly related to events in the period under consideration.[17] However, this article would have been excluded anyway in the first step given the low average number of visits.

[16] While this is an arbitrary threshold, it turned out that these articles perform poorly in terms of criterion validity, confirming my expectations that they are not a valid indicator of issue salience. Therefore, they are dropped in advance here.

[17] However, one could argue that interested readers still visit this article to inform themselves about the infamous historical predecessor of the great financial crisis of 2007 and thereafter.

After this procedure, 47 articles remained (see Tables A1 and A2 in the Appendix).

6.2. *Validation with MIP data*

I use the remaining articles to assess concurrent validity.[18] Tables 2 and 3 provides the main results of the OLS regressions. The 'Coefficient' column reports the slope of the linear fit, the following column corresponding Newey-West standard errors, which are robust to autocorrelation and heteroscedasticity Newey and West (1987). The last column informs about the coefficient of determination, R^2.

There are several noticeable findings to be taken away from these results. First, most of the coefficients are positive, but some point in the other direction, indicating *higher* reading volume of the article when the MIP-based measure suggests *lower* public salience. Consider, for example, the article 'Wirtschaft_Deutschlands' (economy of Germany) with an estimated coefficient of -0.70, significant at $p < 0.01$. As illustrated in Figure D4 in the Appendix, this article was most popular in 2012, while survey respondents mentioned the economy as MIP most frequently in 2009, when Germany was in fact suffering from a recession. This points to a fundamental concern in interpreting information search behavior. While the survey item has a clear negative connotation in asking for 'problems' (see also Wlezien, 2005), behavioral web data do not. This does not render the corresponding measure useless, but has to be taken into account when interpreting the results.

Secondly, the fraction of variance explained by the articles time series varies tremendously, but is, on average, fairly low. If the survey data are taken for granted, we are left with no more than two articles for which the page view statistics provide a satisfactory share of variance explained—the 'Finanzkrise' article as an indicator for public salience of the financial crisis ($R^2 = 0.60$) and the 'Eurozone' article ($R^2 = 0.59$) for the Europe/EU issue. On the other hand, I regard it as remarkable that we observe considerable alignment of many time series in face of sudden changes.[19]

Thirdly, while many MIP time series can be mapped rather well on one or more *Wikipedia* time series, there are some issue domains for which survey data and traffic statistics do not align at all, in particular the inflation, pensions, environment, and taxes issue.

Without further empirical scrutiny, it is hard to tell why some of the articles perform better in terms of concurrent validity than others. One possible reason could be that significant shocks like the financial crisis can be captured easier than ongoing trends of more general issues (like, e.g., unemployment), because (1) articles exist that are event-specific and (2) the need for information is greater in times of unexpected or new events. The time series for the articles related to the financial crisis issue provide initial evidence for the latter argument, because most of them display a rapid eruption in views in late 2008 when Lehman Brothers declared bankruptcy—something that can also be traced in the survey data—, and a similarly rapid decline (see also Figure D2 in the Appendix).

Another problem of the validation strategy becomes visible after a closer inspection of both the energy transition and environment issues (see Figures D5 and D8 in the Appendix): The Wikipedia time series classified as articles about the energy transition clearly capture the sudden events related to the Fukushima disaster. On the other hand, this issue received barely any attention in the MIP time series before 2013. Instead, respondents concerned about these events were obviously coded into the environment category. This makes clear that information drawn from *Wikipedia* can be more valuable than survey data when public attention towards rather specific issues is to be studied. And even if researchers focus

[18] For further scrutiny, I provide time series plots in Section D in the Appendix.

[19] Note, for example, the significant amplitudes in the financial crisis time series (Figure D2).

Table 2: Assessment of criterion validity: OLS regressions of MIP on *Wikipedia* time series

Issue	Article	Coefficient	N-W s.e.	R2
Unemployment	Agenda_2010	0.80	0.26	0.16
Unemployment	Arbeitslosengeld	0.58	0.09	0.32
Unemployment	Arbeitslosenstatistik	-0.12	0.11	0.01
Unemployment	Arbeitslosigkeit	0.61	0.09	0.29
Unemployment	Hartz_IV	-0.30	0.09	0.13
Europe/EU	Euro	-0.85	0.17	0.17
Europe/EU	Europa	-0.43	0.30	0.03
Europe/EU	Europäische_Union	-0.81	0.14	0.18
Europe/EU	Eurozone	1.07	0.11	0.59
Financial crisis	Bad_Bank	0.90	0.19	0.14
Financial crisis	Bankenkrise	1.59	0.20	0.47
Financial crisis	Finanzkrise	2.03	0.29	0.60
Financial crisis	Finanzkrise_ab_2007	0.56	0.23	0.15
Economy	Bruttoinlandsprodukt	1.79	0.43	0.19
Economy	Konjunktur	0.75	0.21	0.25
Economy	Wirtschaft_Deutschlands	-0.70	0.15	0.18
Economy	Wirtschaftswachstum	0.54	0.15	0.14
Energy Transition	Energiewende	1.29	0.23	0.45
Energy Transition	Erneuerbare_Energie	-0.88	0.28	0.15
Energy Transition	Atomausstieg	-0.25	0.18	0.01
Energy Transition	ErneuerbareEnergienGesetz	0.36	0.16	0.05
Foreigners	Flüchtling	0.11	0.10	0.01
Foreigners	Einwanderung	0.33	0.16	0.19
Foreigners	Ausländer	0.30	0.20	0.10

Note: Each row reports the result of an OLS with the MIP variable (Issue) as the dependent and the Wikipedia page view variable (Article) as the independent variable. n = 114 for all regressions. Newey-West standard errors reported.

on broader issue domains, the use of pre-coded categories in surveys can be questionable.

Certainly, when it comes to comparative assessments of public issue attention, attention towards sub-topics is of less interest than the overall trend in public awareness towards more general issues. Therefore, I combine information from all selected articles. To do so, I aggregate the seasonally adjusted article view counts by issue domain and normalize them afterwards, ending up with one *Wikipedia* measure per issue. Figure 3 displays MIP versus *Wikipedia* trends on all twelve issues. There is remarkable overlap on the financial crisis, child care, and health care issue. For a statistical assessment of concurrent validity, I again set up bivariate linear regressions of MIP on the aggregated traffic volume time series. The results are reported in Table 4. With one exception, the slopes point in the positive direction. On the EU/Europe issue, the three generic articles on the Euro, Europe and the European Union dominate the Eurozone article which had a much better fit in the disaggreated models. Depending on the interest of measurement, aggregating traffic data from multiple articles may in fact drown the signal instead of filter the noise. In principle, we should expect a smoothing of the time series as a result from combining diverse articles, whereas the combination of very similar articles (which provide information on the same topic) may amplify shocks.

Table 3: Assessment of criterion validity: OLS regressions of MIP on *Wikipedia* time series

Issue	Article	Coefficient	N-W s.e.	R2
Child care	Kinderbetreuung	-0.29	0.18	0.02
Child care	Betreuungsgeld	0.58	0.14	0.22
Child care	Bundeselterngeld_und_Elternzeitgesetz	0.35	0.07	0.32
Child care	Kindertagesstätte	0.53	0.13	0.19
Inflation	Inflation	0.25	0.16	0.08
Inflation	Deflation	-0.05	0.03	0.00
Inflation	Preisindex	0.24	0.11	0.06
Inflation	Leitzins	0.77	0.38	0.25
Pensions	Pension_Altersversorgung	0.31	0.14	0.07
Pensions	Rentenversicherung_Erlebensversicherung	-0.00	0.21	0.00
Pensions	Gesetzliche_Rentenversicherung_Deutschland	-0.01	0.24	0.00
Pensions	Altersvorsorge	0.27	0.24	0.02
Environment	Umweltschutz	-0.01	0.21	0.00
Environment	Umweltpolitik	0.04	0.11	0.00
Environment	Klimaschutz	0.05	0.11	0.00
Environment	Naturschutz	-0.00	0.12	0.00
Environment	Globale_Erwärmung	0.02	0.10	0.00
Taxes	Steuerrecht_Deutschland	0.43	0.17	0.11
Taxes	Einkommensteuer_Deutschland	0.14	0.13	0.01
Taxes	Umsatzsteuer_Deutschland	0.15	0.09	0.03
Health care	Krankenversicherung	0.36	0.10	0.23
Health care	Gesundheitssystem_Deutschlands	0.61	0.13	0.32
Health care	Private_Krankenversicherung	0.62	0.17	0.25

Note: Each row reports the result of an OLS with the MIP variable (Issue) as the dependent and the Wikipedia page view variable (Article) as the independent variable. n = 114 for all regressions. Newey-West standard errors reported.

Consequently, from a conceptional point of view, combining thematically diverse traffic time series can help capture the overall salience of an issue and diminish the influence of short-term interest, whereas pooling information from a limited sub-issue can carve out attention bursts. We find examples for both phenomena when we compare the aggregated time series in Figure 3 to article-level trends in Section D in the Appendix.

Other combination approaches are imaginable. The current approach favors highly frequented articles over less popular ones. At the risk of making an almost tautological argument, this makes sense insofar as popular articles often provide most useful information and rank higher on search engine queries, which makes them more likely to be read when people react to a particular event. On the other hand, less popular articles may still provide useful information under certain circumstances. Note, for example, the enormous peak in the MIP time series on taxes in April 2013 (see Figure D12 in the Appendix). The selected *Wikipedia* time series pick up this trend only weakly (if at all). However, the peak can be easily explained: On April 20, 2013, a German newspaper magazine made public that Uli Hoeneß, then-president of football club FC Bayern Munich, was accused of massive fiscal evasion. The case received exceptional attention in the German public for several weeks. Naturally, these events also had a massive impact

Table 4: Assessment of criterion validity: OLS regressions of MIP on *Wikipedia* time series, aggregated by issue

Issue	Coefficient	N-W s.e.	R2
Unemployment	1.13	0.21	0.28
Europe/EU	-0.85	0.19	0.16
Financial crisis	1.26	0.14	0.61
Economy	1.27	0.27	0.21
Energy Transition	0.06	0.17	0.00
Foreigners	0.33	0.17	0.16
Child care	0.71	0.13	0.32
Inflation	0.31	0.22	0.08
Pensions	0.14	0.22	0.01
Environment	0.02	0.10	0.00
Taxes	0.24	0.12	0.04
Health care	0.60	0.13	0.34

Note: Each row reports the result of an OLS with the MIP variable (Issue) as the dependent and the Wikipedia page view variable (views aggregated by domain) as the independent variable. n = 114 for all regressions. Newey-West standard errors reported.

on the *Wikipedia* article on Uli Hoeneß: the number of visits jumped from about 600 at April 19 to an all-time peak of over 58,000 at April 22, and remained at a significantly higher level than before the revelation for many weeks.[20] Should we, then, include this and similar articles in Wikipedia-based measurements of public attentiveness? If the goal is explanation, not forecasting, this could be a useful if not necessary strategy. Otherwise, we can hope that more general articles (e.g., on fiscal evasion) pick up the trend, too, and are already part of our sample of articles.

6.3. *Validation with external criteria*

As noted above, survey data provide no fully satisfying gold standard to assess the validity of public awareness measures. Therefore, I perform a series of external validity checks in the following.

(1) **Granger causality tests of economic indicators**: monthly German unemployment rates, weekly stock market data, weekly Euro/Dollar exchange rate — are *Wikipedia*-based and survey-based measures affected by incremental or sudden change in these indicators? **Why economic indicators?** Related with one of the most popular MIP issues, precise measures available for both gradual and sudden change in economic performance. **Expectation**: if change is sudden, this should reflect in information behavior. As *Wikipedia* data provide a more fine-grained picture on specific issues than survey data, I expect this to mirror in the test results. First results confirm this expectation (see also Figure 4).

(2) **Relationship between events and attention**: Core postulation of issue-attention cycle theory and similar conjectures: External shocks (e.g., catastrophes) drive public attention towards new issues. If this is true, measures of public attention should be sensitive towards such shocks. *Strategy:* Use of the Migrants' Files Database (http://www.themigrantsfiles.com/) to identify refugee tragedies. How do they reflect in MIP and *Wikipedia* time series? **Expectation:** Reflection in both, but due to restricted affect, the impact should diminish more rapidly over time. This should

[20] See http://stats.grok.se/de/201304/Uli_Hoene%C3%9F.

Figure 3: MIP item (black curve) vs. normalized *Wikipedia* page view counts (red curve) time series. *Wikipedia* article statistics are pooled by issue.

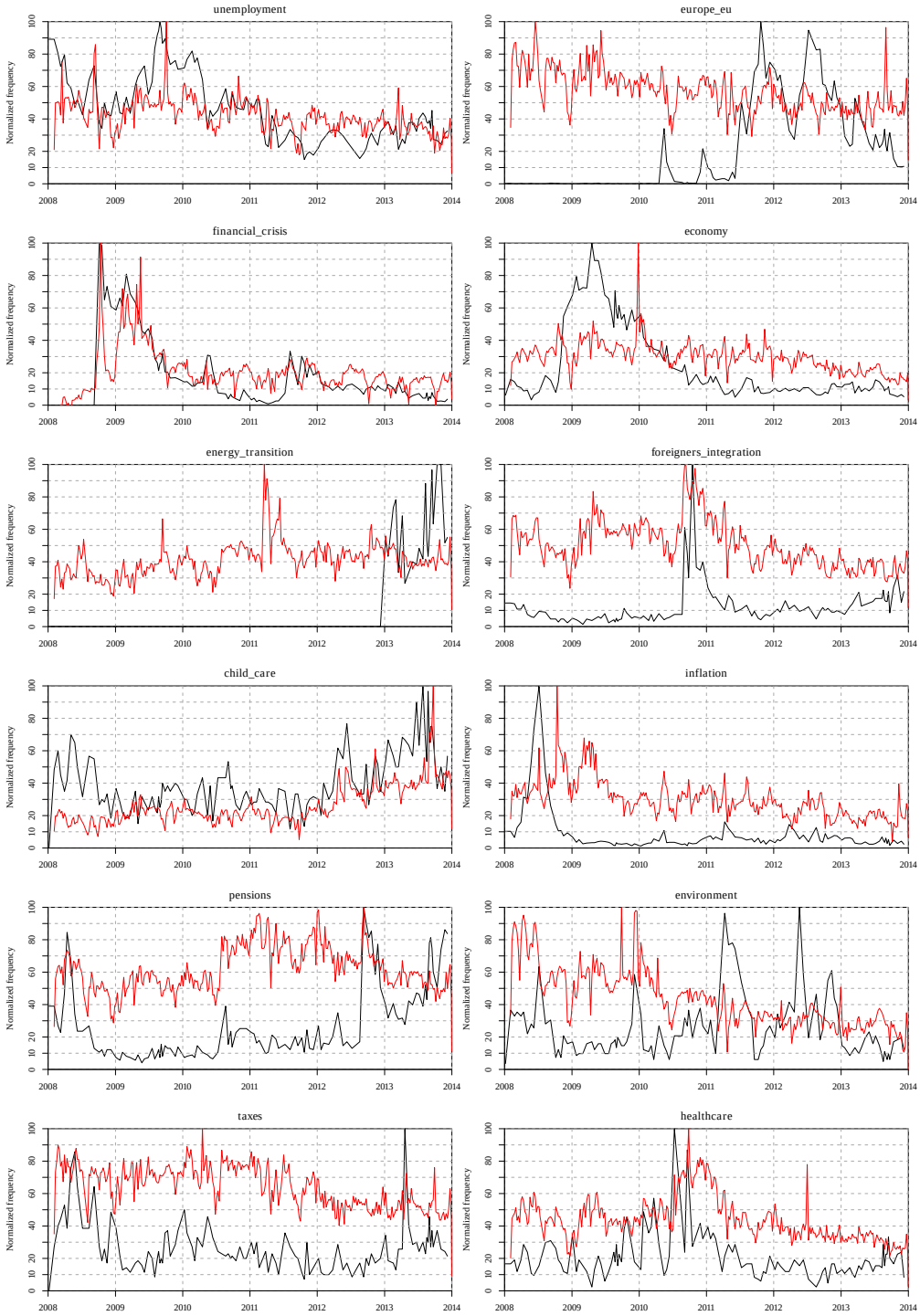
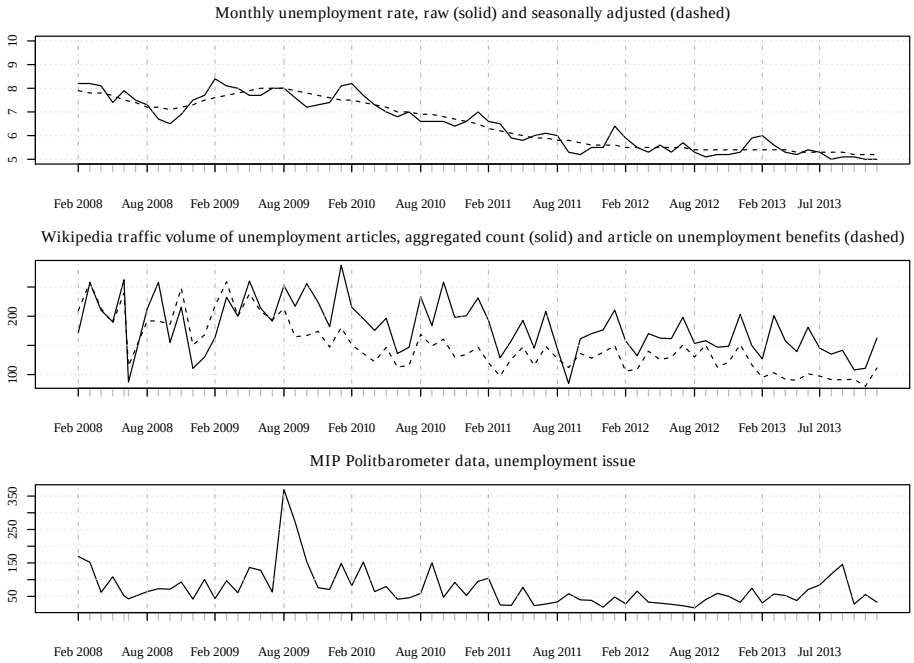


Figure 4: Time series of monthly German unemployment rates and measures if public attention towards unemployment.



be mainly visible in *Wikipedia* time series because these data are available at the daily level.

(3) **Relationship between public attention and political activity**: one of the core relationships for substantive research on policy agenda setting. **Strategy**: Use political activity (governmental press releases; http://archiv.bundesregierung.de/Webs/Archiv/DE/Startseite/startseite_node.html, parliamentary interpellations) to measure political outcome— does sudden change in attention induce political reaction?

[To be written.]

7. Discussion and Conclusion

In this paper, I suggested the use of *Wikipedia* page view statistics as a new aggregate measure of public issue attention. Initial validation efforts demonstrated that single article statistics as well as aggregated volume data can provide internally and externally valid measures.

The paper also pointed to potential avenues for future research. While this study targeted at a validation approach covering a broad set of issues, one of the core strengths of *Wikipedia* as a data source is that it provides information at incredible detail. We can access information and, as in this study, meta information about a virtually unlimited range of topics. Therefore, I regard approaches as fruitful which focus on very specific issues to identify interest in them. A promising example has been given by Wilkerson (2015) and his study on the attention towards supreme court decisions. For research strategies like these, it is easy to argue that page view counts are directly related to public awareness towards a particular issue. As demonstrated in this paper, it is less straightforward to find articles for more general and fuzzy issues. On the other hand, the

Wikipedia platform also provides a great opportunity to pursue comparative approaches on public attention across countries.

Another way to go is to make explicit use the raw count data. Measures that are based on normalized information (like *Google Trends* data) or questionable items that hide second- or third-order interest (like survey data) are difficult to calibrate when one is interested in assessing the relative importance of issues. It is subject to future research how baseline usage activity for the single *Wikipedia* subdomains can be gathered and used to identify the relative popularity of articles.

Finally, some of the results indicated that not only does the fine-grained data allow to capture daily-level dynamics, but also can to open a window to new perceptions of public attention towards political and other issues. Common interpretations of survey-based data on public opinion include that public belief systems are relatively stable (Herron and Jenkins-Smith, 2006; Druckman, Fein and Leeper, 2012). Measures of awareness map interest, not opinion, but to date it has been difficult to empirically identify the highly volatile ups and downs in public attention that was already postulated (theoretically!) by Downs (1972). The *Wikipedia* time series indeed indicate that a short-term perception of issue attention can be the quite realistic description of reality, in particular if certain shocks or unexpected events rapidly shift attention towards a specific issue.

For sure, the presented approach and validation efforts have limitations. Most obviously, *Wikipedia* time series are fairly limited at the moment, only reaching back for about seven years. This data source is continuing to grow. Differences between the population of interest and the observed populations can be a concern—not much is known about the impact of sociodemographic factors on selective attention towards political issues.

Further, the reliance on one platform to establish a measure might involve long-term risks researchers are not willing to bear. Additionally, *Wikipedia* articles are continuously being created and it is not clear a priori which of them remain relevant or which new articles should be considered. Whatever proxies are derived from vast sets of articles should be subject to continuous validation, and the theoretical link between interest in a specific article and importance of an issue has to be continuously re-examined.

Behavioral web-based measures of issue salience that cover a virtually unlimited number of issues with high levels of granularity can help test existing theories on public issue attention. It has been argued earlier that the public issue agenda has beomce more and more diverse and the attention to issues more volatile (McCombs and Zhu, 1995). Further, experiments have shown that the effect of political messages on public opinion tends to be short-lived (Chong and Druckman, 2010). With regards to these findings, (Mellon, 2014, 49) rightfully notes that "studies of the effects would ideally use much more frequent measurements of issue salience." Recently proposed web proxies—one of which suggested in this paper—can provide such frequent measurements and therefore contribute to our understanding of public demand.

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Supporting Materials

Appendix A Descriptive Statistics on collected Wikipedia article data

Table A1: Utilized Wikipedia articles by issue and descriptive statistics. The last three columns report the total, average and maximum daily number of views between February 2008 and December 2013.

Issue	Article name	# views	avg. views	max. views
unemployment	Arbeitslosigkeit	1,372,336	641.0	2,434
unemployment	Arbeitslosenstatistik	1,000,568	467.3	2,515
unemployment	Agenda_2,010	728,966	340.5	8,046
unemployment	Arbeitslosengeld	638,748	298.3	990
unemployment	Hartz_IV	459,114	214.4	1,598
taxes	Einkommensteuer_(Deutschland)	3,073,272	1,435.4	9,417
taxes	Umsatzsteuer_(Deutschland)	1,583,643	739.7	2,369
taxes	Steuerrecht_(Deutschland)	358,191	167.3	524
pensions	Gesetzliche_Rentenversicherung_(Deutschland)	2,755,671	1,287.1	3,826
pensions	Pension_(Altersversorgung)	853,575	398.7	1,987
pensions	Altersvorsorge	497,913	232.6	553
pensions	Rentenversicherung_(Erlebensversicherung)	222,401	103.9	250
inflation	Inflation	3,990,138	1,863.7	9,510
inflation	Deflation	1,519,495	709.7	9,100
inflation	Leitzins	926,044	432.5	12,352
inflation	Preisindex	739,752	345.5	1,087
healthcare	Private_Krankenversicherung	1,681,397	785.3	13,765
healthcare	Krankenversicherung	1,507,589	704.2	2,201
healthcare	Gesundheitssystem_Deutschlands	237,830	111.1	286
foreigners_integration	Einwanderung	871,058	406.8	1,597
foreigners_integration	Ausländer	464,084	216.8	1,457
foreigners_integration	Flüchtling	261,845	122.3	1,158
financial_crisis	Finanzkrise_ab_2,007	1,282,737	599.1	4,287
financial_crisis	Finanzkrise	549,077	256.5	5,567
financial_crisis	Bad_Bank	280,080	130.8	6,029
financial_crisis	Bankenkrise	172,782	80.7	1,860

Table A2: *Continued:* Utilized Wikipedia articles by issue and descriptive statistics. The last three columns report the total, average and maximum daily number of views between February 2008 and December 2013.

Issue	Article name	# views	avg. views	max. views
europe_eu	Europäische_Union	11,852,661	5,536.0	19,922
europe_eu	Europa	10,789,076	5,039.3	27,434
europe_eu	Euro	7,793,578	3,640.2	41,217
europe_eu	Eurozone	1,227,032	573.1	6,342
environment	Globale_Erwärmung	2,050,443	957.7	6,709
environment	Umweltschutz	878,132	410.2	8,219
environment	Naturschutz	319,665	149.3	843
environment	Klimaschutz	288,695	134.8	1,434
environment	Umweltpolitik	252,952	118.1	661
energy_transition	Erneuerbare_Energie	2,594,182	1,211.7	12,156
energy_transition	Erneuerbare-Energien-Gesetz	1,898,122	886.6	7,471
energy_transition	Atomausstieg	500,231	233.6	4,504
energy_transition	Energiewende	315,281	147.3	3,338
economy	Bruttoinlandsprodukt	5,104,758	2,384.3	37,026
economy	Konjunktur	2,804,993	1,310.1	14,191
economy	Wirtschaft_Deutschlands	874,777	408.6	1,412
economy	Wirtschaftswachstum	821,496	383.7	1,390
child_care	Kindertagesstätte	429,119	200.4	753
child_care	Bundeselterngeld-_und_Elternzeitgesetz	164,870	77.0	426
child_care	Kinderbetreuung	83,222	38.9	695
child_care	Betreuungsgeld	79,878	37.3	1,855

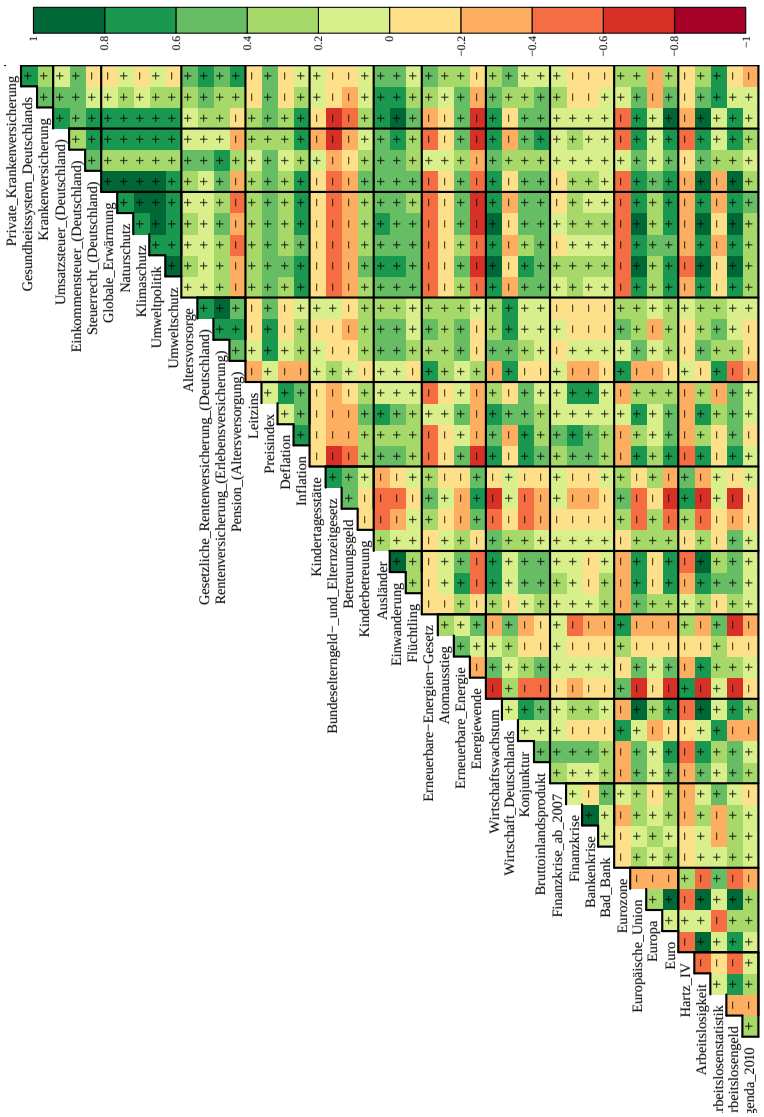


Figure A1: Pearson correlations between *Wikipedia* article time series.

Appendix B Time Series Adjustment

Table B1: Monthly traffic on German Wikipedia, in million page requests. Counts from November 2009 until March 2010 were corrected to account for server overload in that time period. Source: http://stats.wikimedia.org/EN_Europe/TablesPageViewsMonthlyOriginalCombined.htm

Month	Traffic	Month	Traffic	Month	Traffic	Month	Traffic
Jun 2015	1114	Jul 2013	1074	Aug 2011	999	Sep 2009	889
May 2015	1191	Jun 2013	1134	Jul 2011	992	Aug 2009	840
Apr 2015	1186	May 2013	1143	Jun 2011	1009	Jul 2009	846
Mar 2015	1249	Apr 2013	1107	May 2011	1070	Jun 2009	909
Feb 2015	1143	Mar 2013	1195	Apr 2011	902	May 2009	905
Jan 2015	1310	Feb 2013	1181	Mar 2011	1034	Apr 2009	817
Dec 2014	1195	Jan 2013	1399	Feb 2011	943	Mar 2009	1011
Nov 2014	1159	Dec 2012	1290	Jan 2011	1194	Feb 2009	916
Oct 2014	1198	Nov 2012	1271	Dec 2010	998	Jan 2009	1313
Sep 2014	1202	Oct 2012	1183	Nov 2010	1063	Dec 2008	1482
Aug 2014	1192	Sep 2012	1075	Oct 2010	1006	Nov 2008	1008
Jul 2014	1200	Aug 2012	1058	Sep 2010	990	Oct 2008	882
Jun 2014	1139	Jul 2012	1110	Aug 2010	968	Sep 2008	818
May 2014	1176	Jun 2012	1107	Jul 2010	932	Aug 2008	804
Apr 2014	1155	May 2012	1108	Jun 2010	955	Jul 2008	780
Mar 2014	1241	Apr 2012	1049	May 2010	1020	Jun 2008	825
Feb 2014	1188	Mar 2012	1103	Apr 2010	957	May 2008	828
Jan 2014	1298	Feb 2012	1107	Mar 2010	920	Apr 2008	845
Dec 2013	1071	Jan 2012	1232	Feb 2010	914	Mar 2008	822
Nov 2013	1030	Dec 2011	1073	Jan 2010	1042	Feb 2008	806
Oct 2013	1029	Nov 2011	1079	Dec 2009	863		
Sep 2013	996	Oct 2011	1063	Nov 2009	994		
Aug 2013	996	Sep 2011	988	Oct 2009	914		

Figure B1: Seasonal trend decomposition by LOESS for traffic on the German *Wikipedia* platform. Reported figures are in Million views. Source: http://stats.wikimedia.org/EN_Europe/TablesPageViewsMonthlyOriginalCombined.htm.

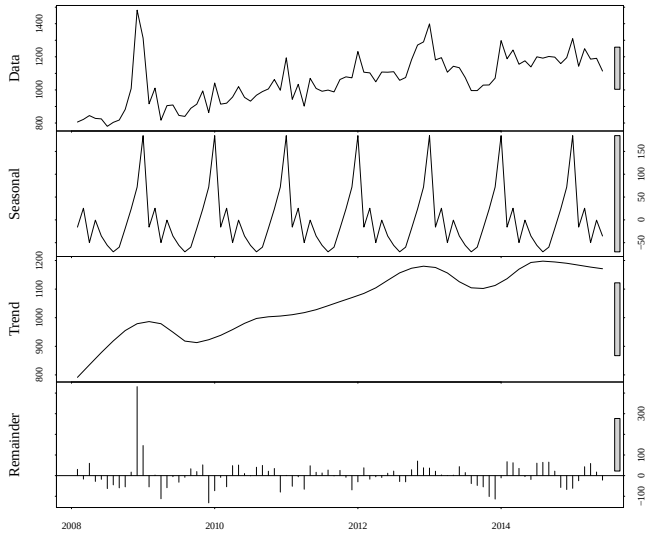


Figure B2: Time series adjustment of Wikipedia page view counts, exemplified with article on unemployment benefits ('Arbeitslosengeld'). Panel (a) provides the uncorrected (black) and adjusted (red) time series. Adjustment is based on total traffic statistics (see Table B1 and Figure B1). Panel (b) plots weekly normalized frequencies of the raw versus the adjusted time series.

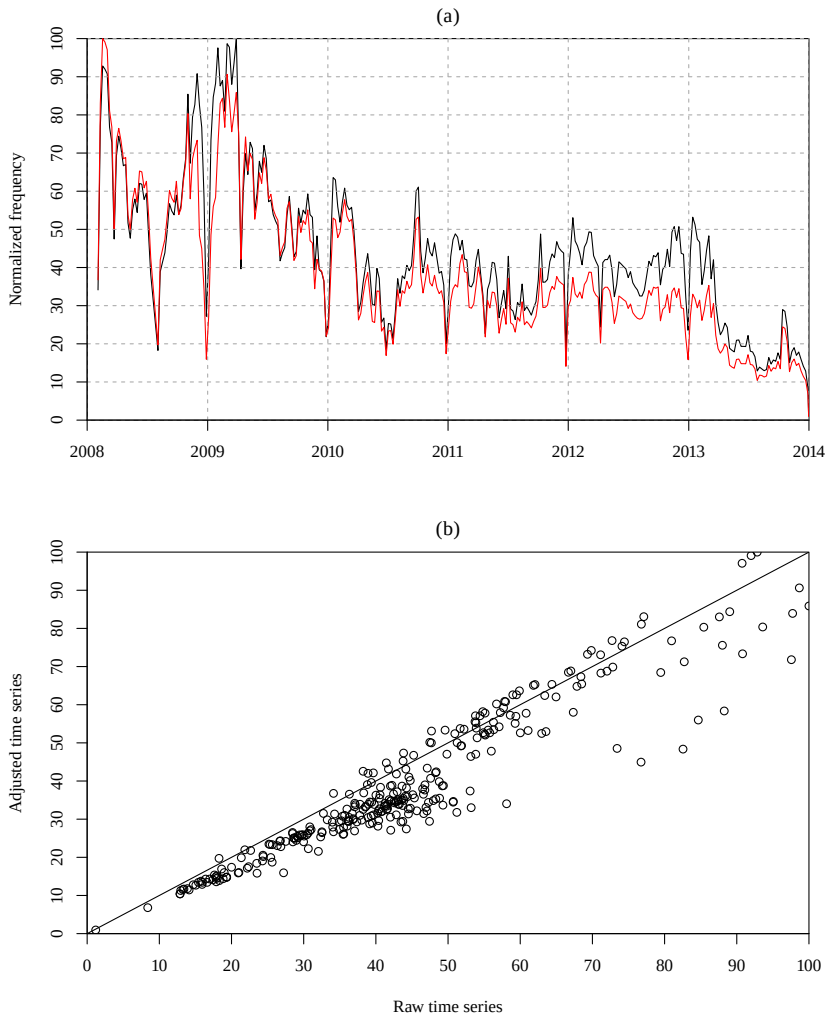
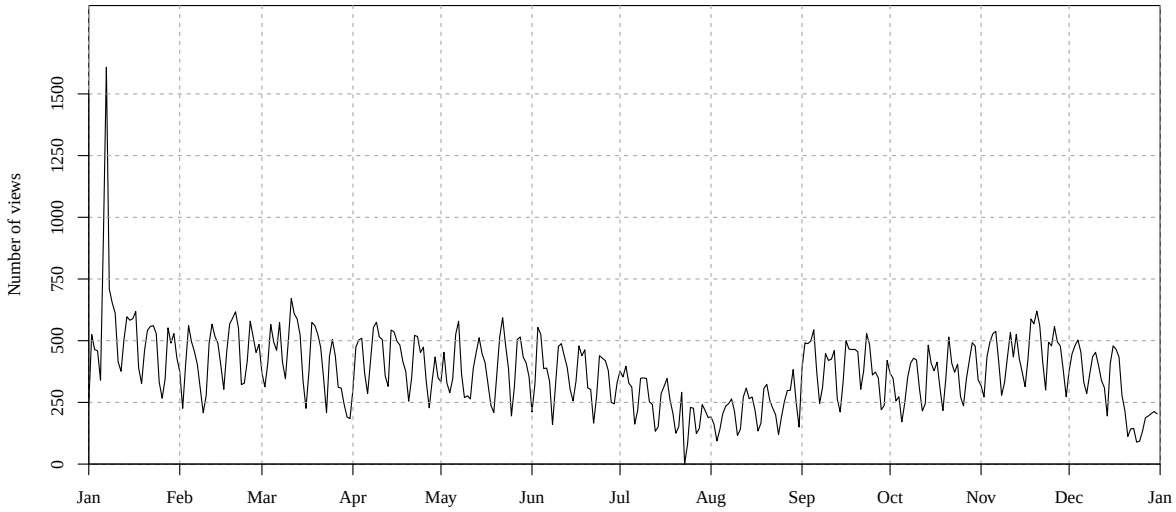


Figure B3: Wikipedia page view counts (red curve) time series for the article on energy transition ('Energiewende') in 2013. The time series exhibits considerable seasonality because page view statistics use to drop at weekends.



Appendix C MIP survey data

Table C1: Top 25 MIP categories in Politbarometer studies

Category labels, German	Category labels, English	# mentions	% mentions
Arbeitslosigkeit	Unemployment	23,847	22.1
EG, Europa, Binnermarkt	EU, Europe, internal market	11,422	10.6
internationale Bankenkrise	International banking crisis	9,442	8.7
Wirtschaftslage	Economy	8,689	8.0
Politische Moral	Political morality	5,924	5.5
soziales Gefälle	Social inequality	5,732	5.3
sonstige innenpolitische Dinge	Other domestic issues	4,976	4.6
Inflation, Preise, Zinsen	Inflation, prices, interest rates	3,982	3.7
Renten und Alte	Pensions and the elderly	3,947	3.7
Staatsverschuldung	State debt	3,843	3.6
Ausländer	Foreigners	3,052	2.8
Kindergartenplätze	Child care	2,761	2.6
Löhne und Einkommen	Wages and incomes	2,395	2.2
Umweltschutz	Environment	2,372	2.2
Kernkraftwerke	Nuclear power	2,275	2.1
Sonstiges, allgemein	Other, general	2,171	2.0
Steuern, Steuerreform	Taxes, tax reform	2,125	2.0
Gesundheitswesen	Healthcare	2,061	1.9
Sozialpolitik	Social policy	1,566	1.4
Streit in der Regierung/ Koalition	Government crisis	1,277	1.2
Moral, Werte	Moral issues	1,270	1.2
Energiewende/erneuerbare Energien	Energy transition	817	0.8
Energieversorgung, -problem/ Russland	Energy supply	796	0.7
Innere Sicherheit	Inner security	778	0.7
Pessimismus, Jammern, Perspektivlosigkeit	Pessimism	587	0.5

Appendix D Time series, MIP vs. Wikipedia data

Figure D1: MIP item (black curve) vs. Wikipedia page view counts (red curve) time series for the *Unemployment* issue. Captions describe the article name.

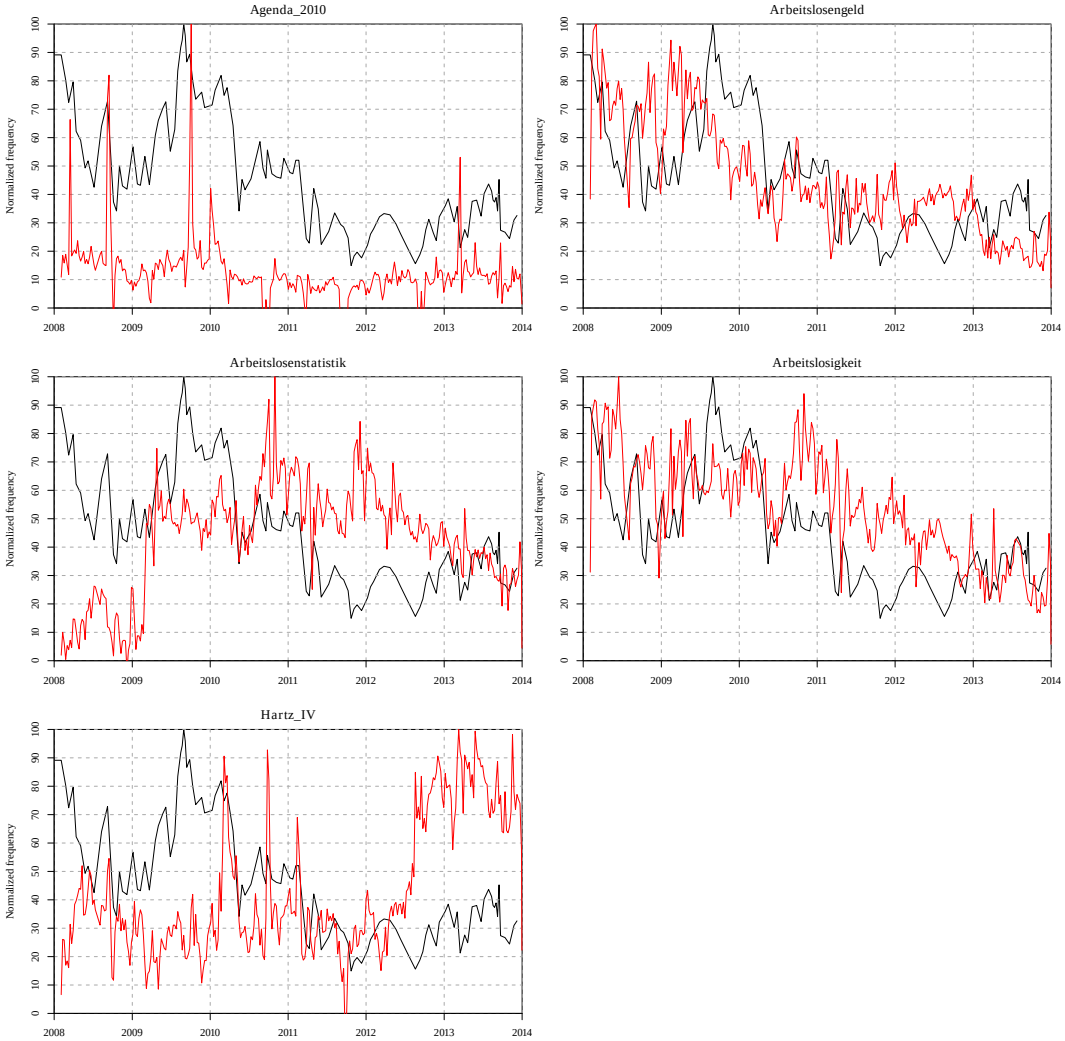


Figure D2: MIP item (black curve) vs. Wikipedia page view counts (red curve) time series for the *Financial crisis* issue. Captions describe the article name.

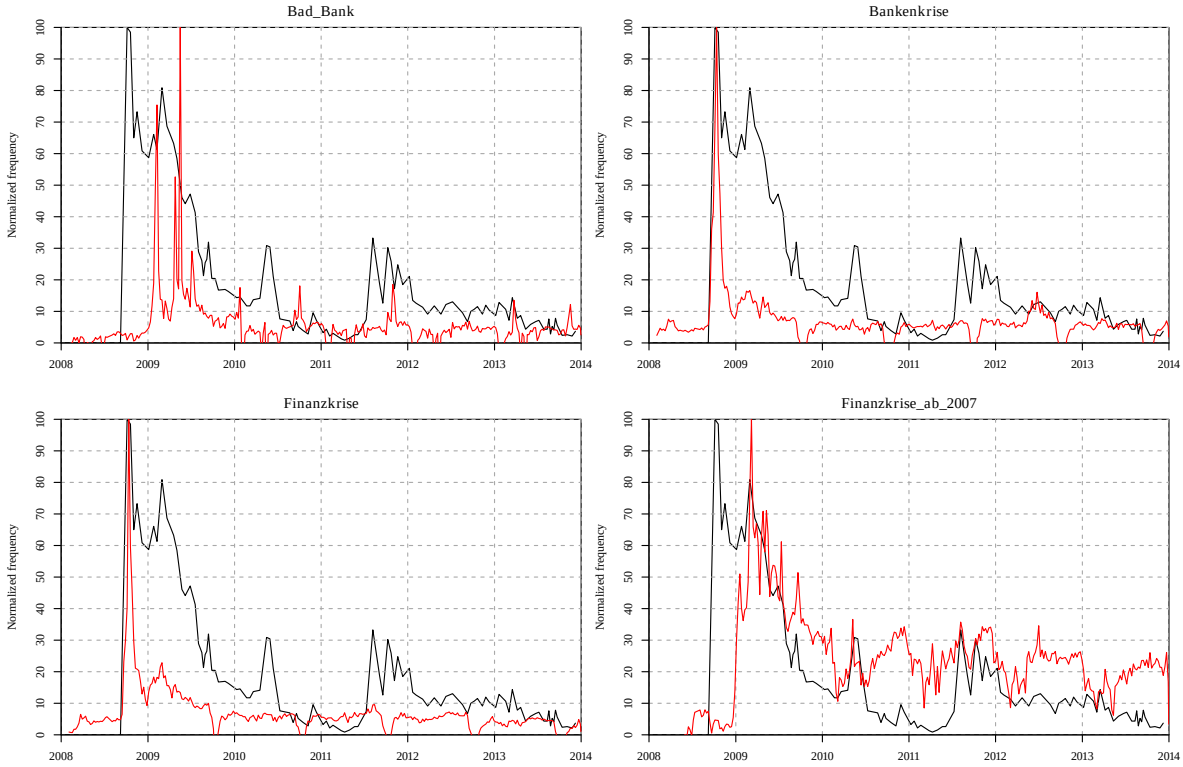


Figure D3: MIP item (black curve) vs. Wikipedia page view counts (red curve) time series for the *Europe/EU* issue. Captions describe the article name.

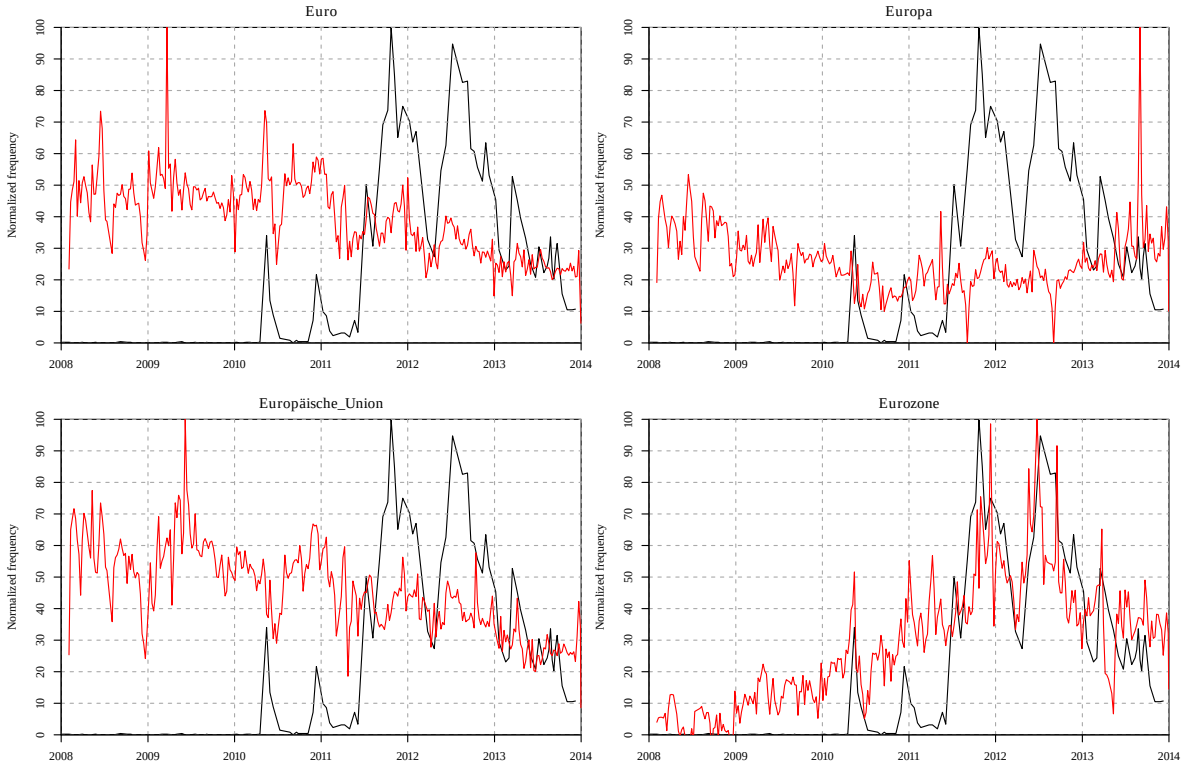


Figure D4: MIP item (black curve) vs. Wikipedia page view counts (red curve) time series for the *Economy* issue. Captions describe the article name.

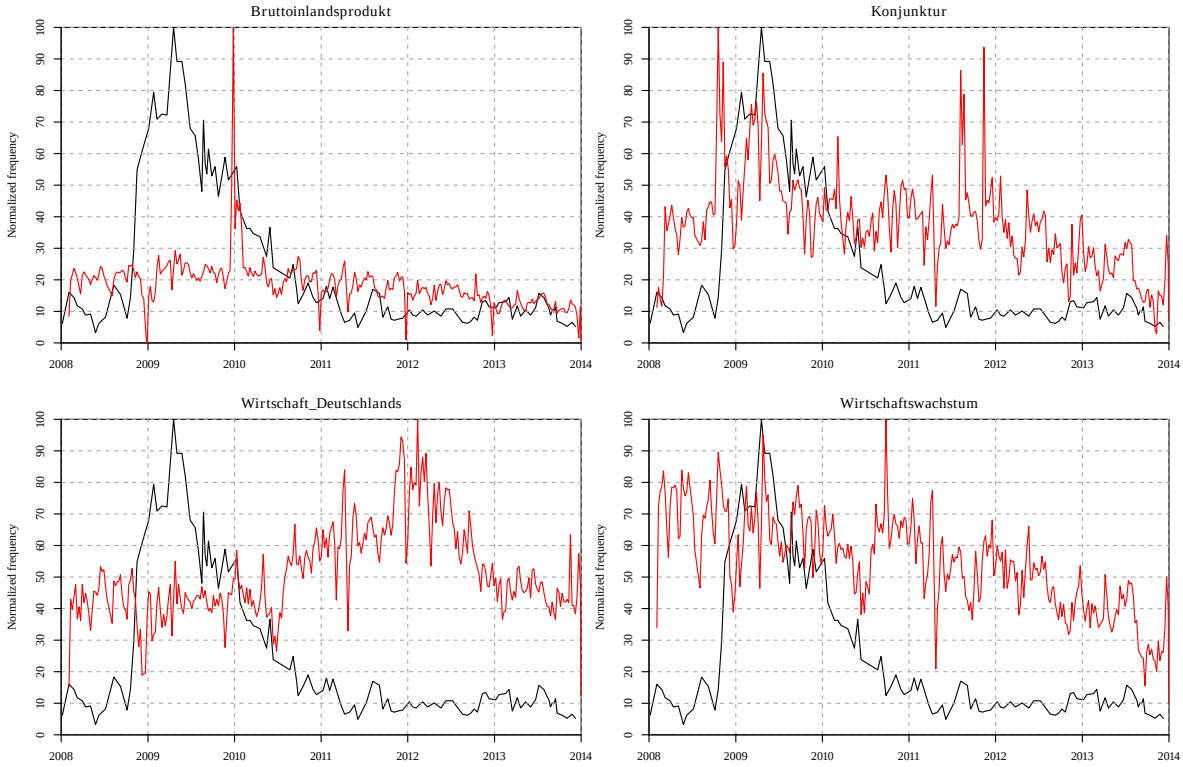


Figure D5: MIP item (black curve) vs. Wikipedia page view counts (red curve) time series for the *Energy transition* issue. Captions describe the article name.

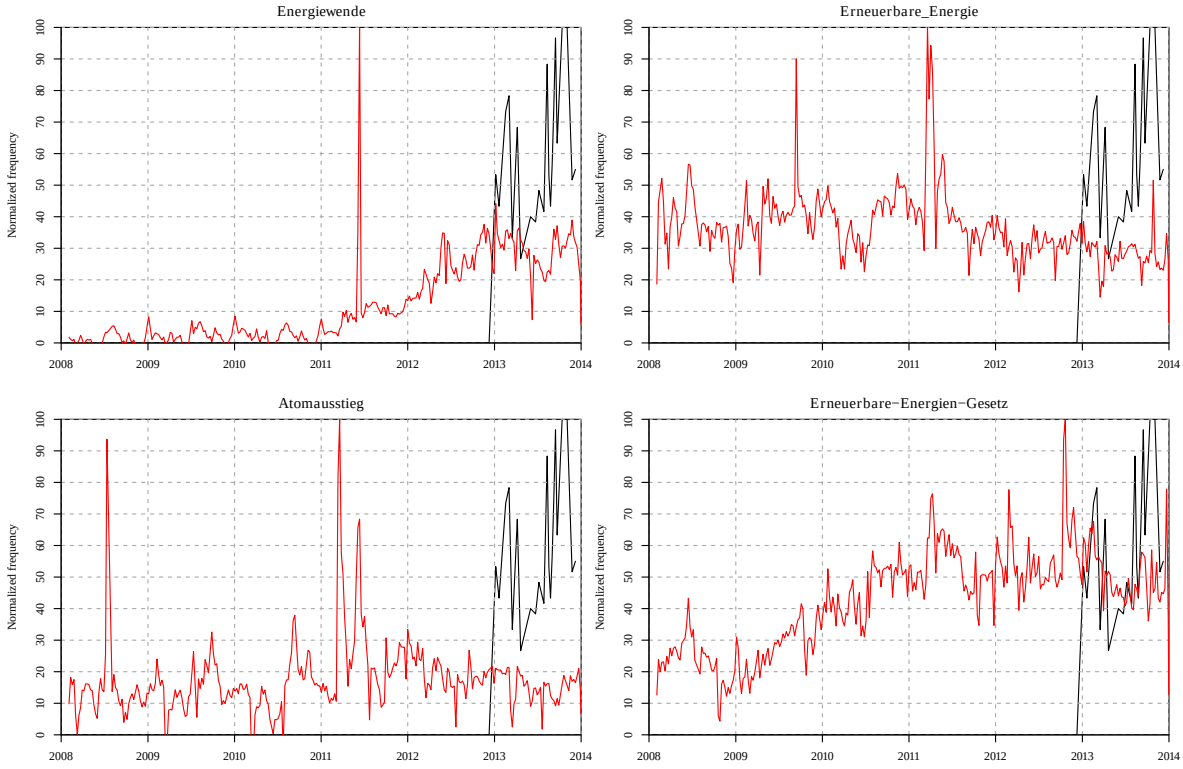


Figure D6: MIP item (black curve) vs. Wikipedia page view counts (red curve) time series for the *Child care* issue. Captions describe the article name.

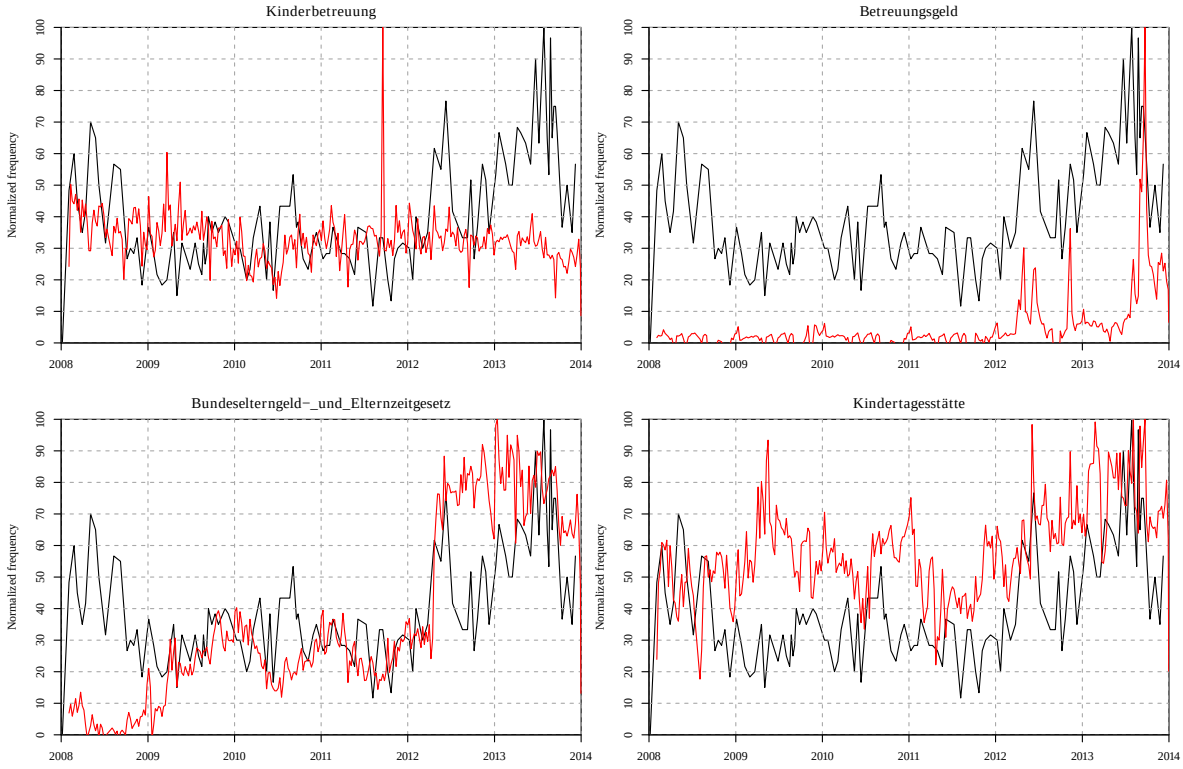


Figure D7: MIP item (black curve) vs. Wikipedia page view counts (red curve) time series for the *Foreigners/integration* issue. Captions describe the article name.

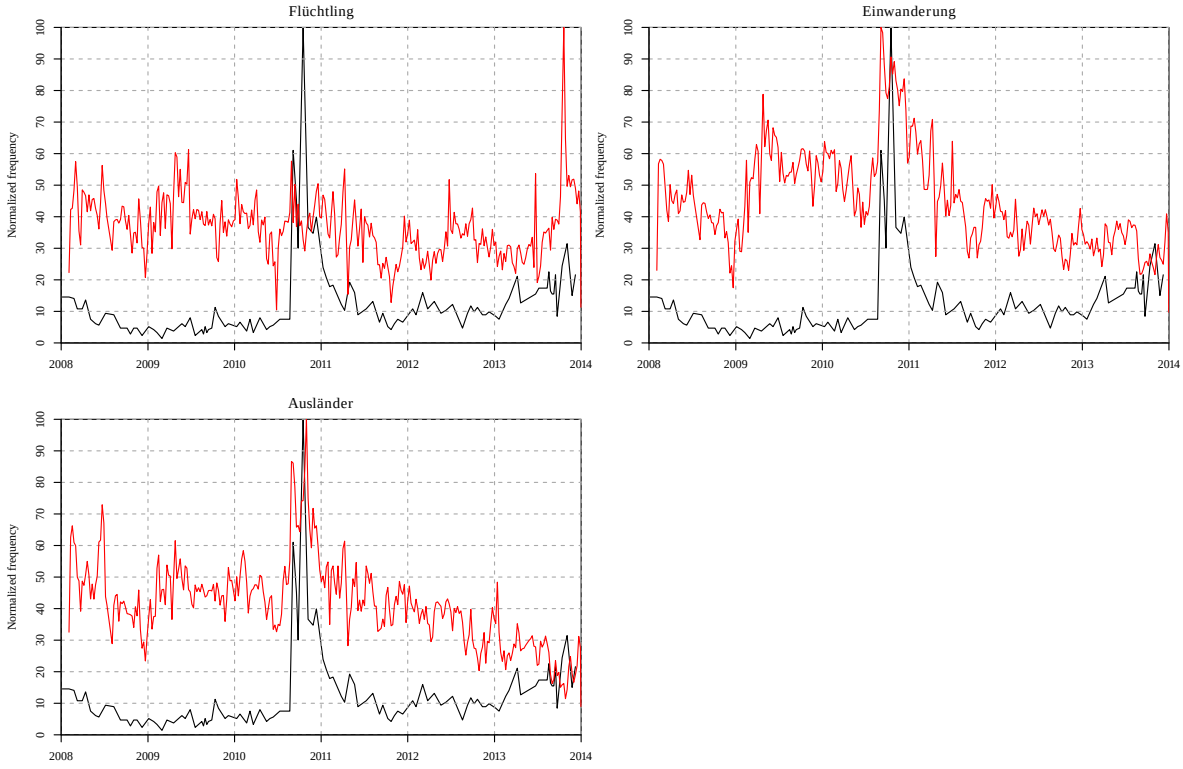


Figure D8: MIP item (black curve) vs. Wikipedia page view counts (red curve) time series for the *Environment* issue. Captions describe the article name.

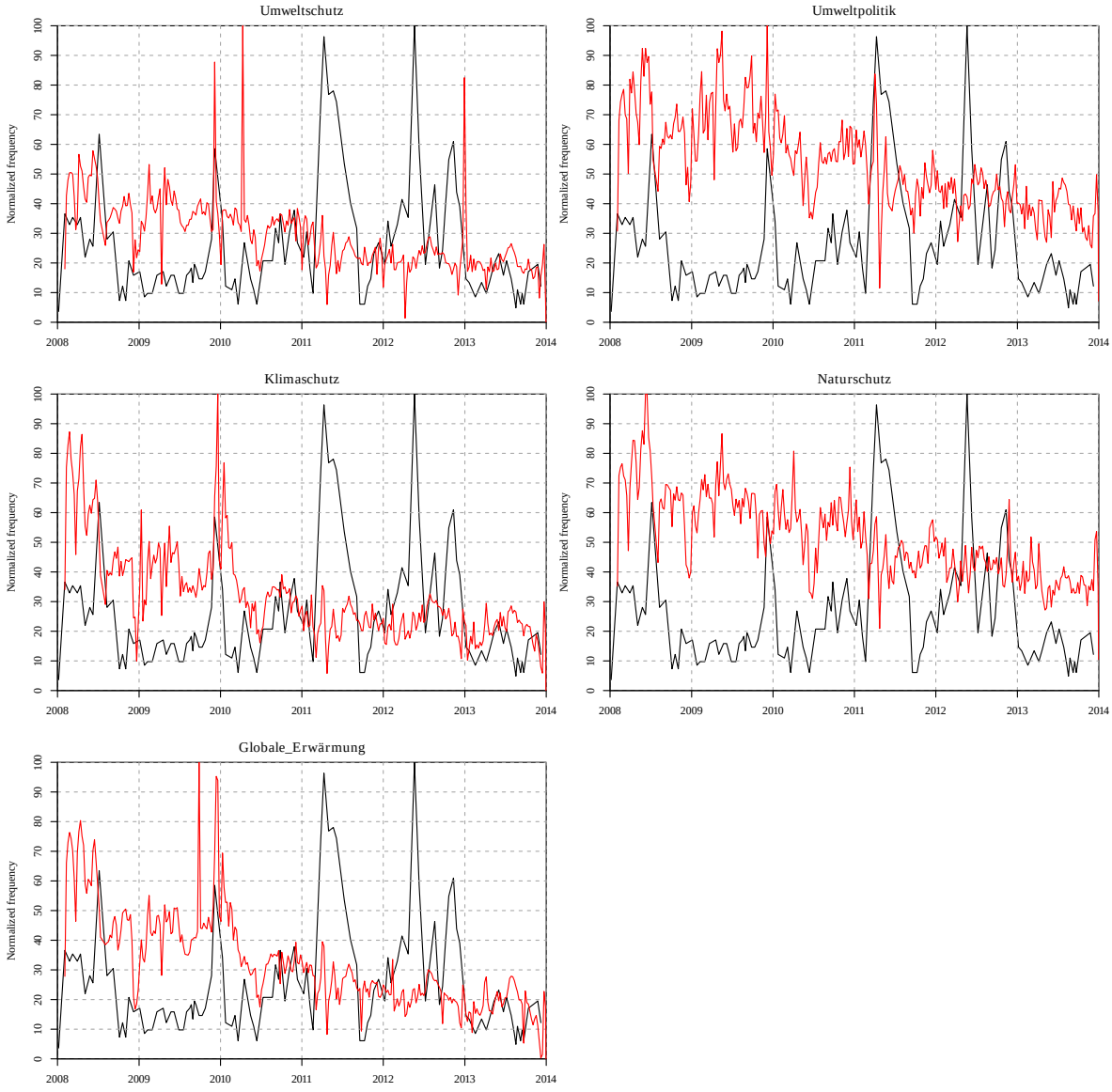


Figure D9: MIP item (black curve) vs. Wikipedia page view counts (red curve) time series for the *Healthcare* issue. Captions describe the article name.

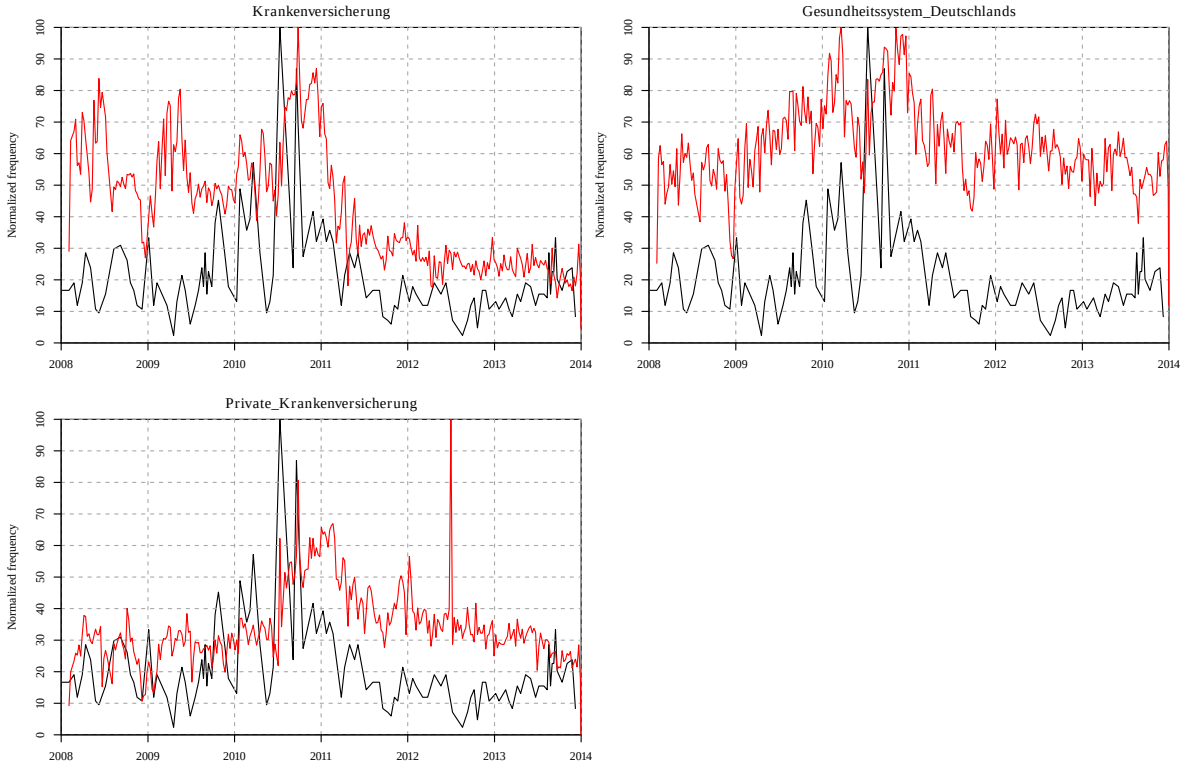


Figure D10: MIP item (black curve) vs. Wikipedia page view counts (red curve) time series for the *Inflation* issue. Captions describe the article name.

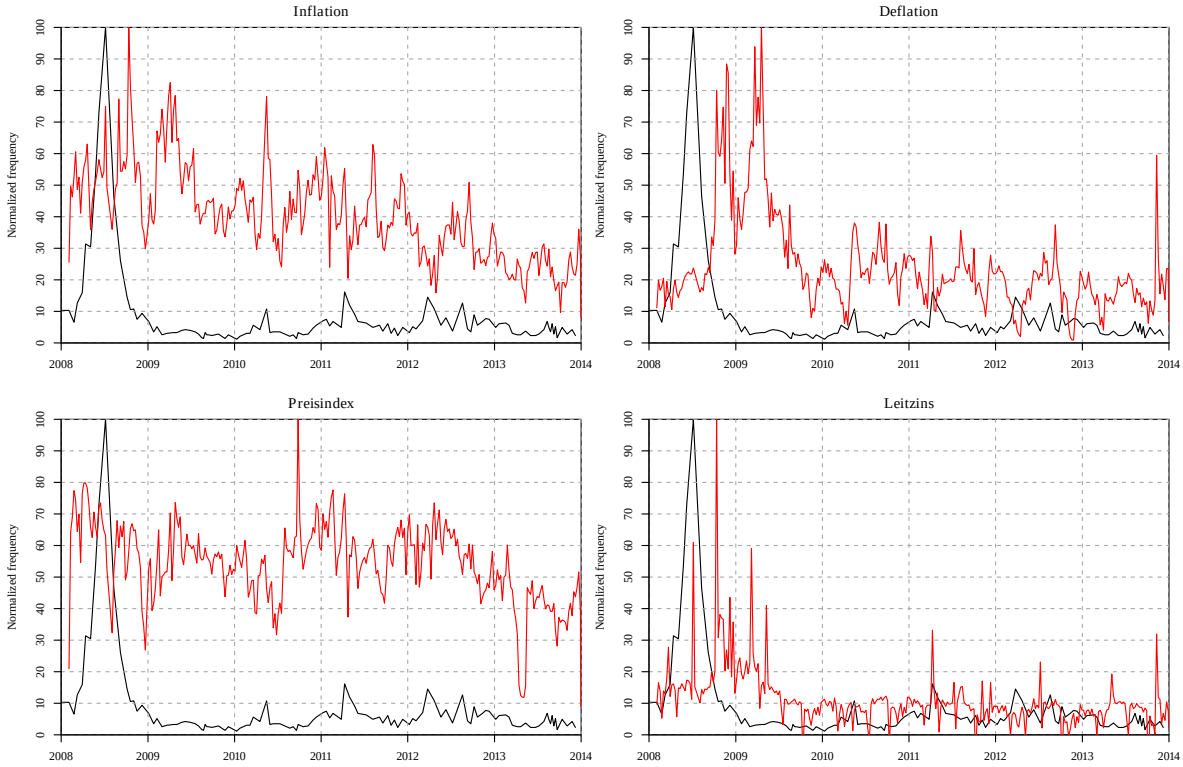


Figure D11: MIP item (black curve) vs. Wikipedia page view counts (red curve) time series for the *Pensions* issue. Captions describe the article name.

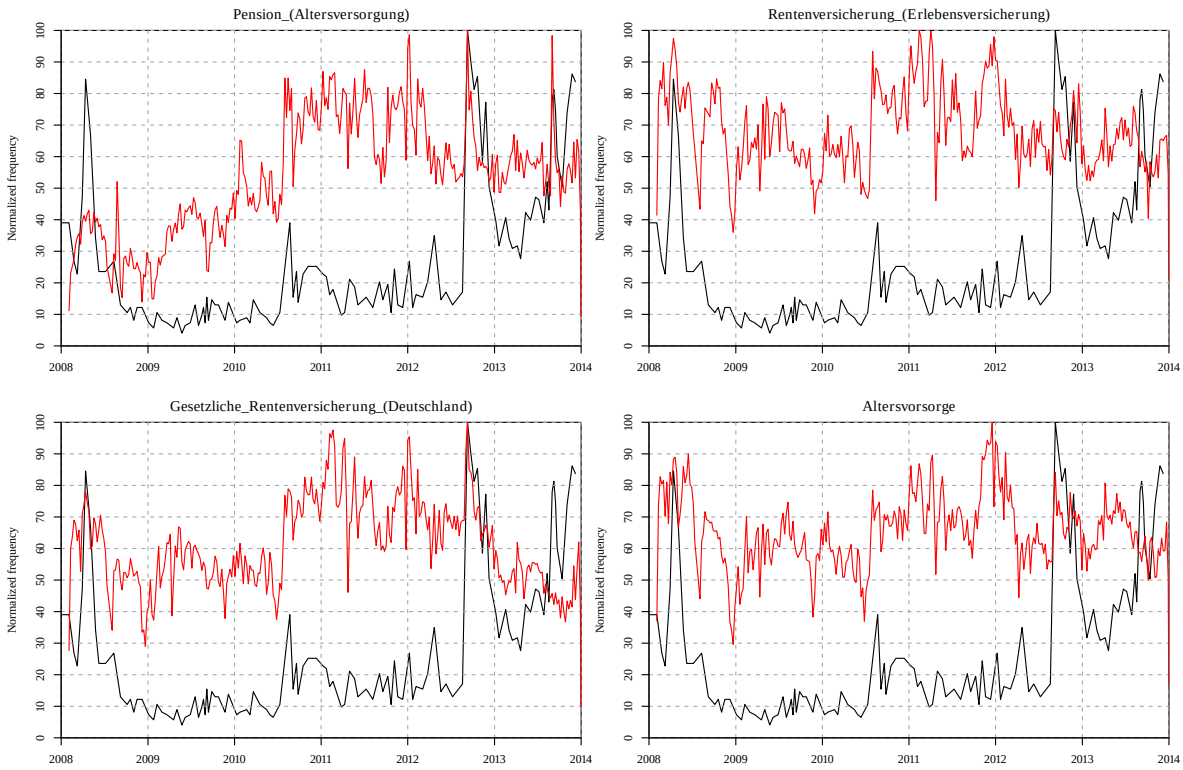


Figure D12: MIP item (black curve) vs. Wikipedia page view counts (red curve) time series for the *Taxes* issue. Captions describe the article name.