Tracking societal concerns on pesticides – a Google Trends analysis

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Abstract

We analyze public interest in pesticides and plant protection products over time utilizing Google Trends data for Switzerland from 2011 until 2019. We find that the aggregated public interest in pesticides and plant protection products has increased substantially in recent years, especially since 2017. This trend can be attributed to search terms related to pesticides, while the interest in search terms related to plant protection products remained stable. Since the term ‘pesticides’ has a more negative connotation than ‘plant protection products’, the increased public interest might be linked to a higher negative perception of environment and human health impacts of pesticides. We also find evidence which supports the hypothesis that growing public concerns on pesticide use contributed to the launches of two popular initiatives aiming to restrict pesticide use in Switzerland. At the same time, our results support that the launch of these initiatives amplified public concerns regarding pesticides. We conclude that Google Trends is a useful tool for the timely detection of ongoing environmental and agricultural discussions, which might otherwise be unobserved. Therefore, it can generate helpful insights and contribute to agricultural policy problem framing.

1. Introduction

Various actors, ranging from industry to NGOs to consumers, are exerting high societal pressure on the agricultural sector and agricultural policy. In addition, new information and communication technologies have changed the public’s access to information on these issues. This may also increase the relevance of public interest in and societal concerns on in agriculture-related environmental problems and is thus important when framing problems in agricultural policy development (e.g. Buckwell et al 2017).

Google Trends data has emerged as a powerful tool to quantify public interest in a topic. Public interest trends can be linked to changes in relative search volume of specific terms (e.g. Anderegg and Goldsmith 2014). Thus, Google Trends data has been suggested to complement other data for policy analysis (e.g. Blume et al 2014) and has been used to analyze people’s preferences (e.g. interest in climate change or conservation) and behavior (e.g. search inquiries as measure for unemployment measures or influenza outbreaks) as well as for price prediction (e.g. stock or agricultural commodity prices; Da et al 2011, Anderegg and Goldsmith 2014, Nghiem et al 2016, Mišečka et al 2019). However, little empirical knowledge exists on the development of public interest and perception in environmental externalities from agriculture.

In this paper, we contribute to close this gap and use Google Trends data to analyze public interest in pesticides over time in Switzerland. We identify structural breaks reflecting discontinuities in the mean and/or slope of public interest. In this context, our analysis includes national and international political activities and reports on pesticides. We examine two recently launched popular initiatives concerning pesticides (or plant protection products) use in Switzerland as representative of political activities. In addition, we exploit a semantic difference between the terms ‘pesticides’ and ‘plant protection products’ whereby the term ‘pesticides’ has a more negative
connotation than ‘plant protection products’ (Flury 1996). 3 In the paper, we address two questions: (a) how societal concerns on pesticides emerge over time and (b) how public discussions change the perception of agricultural practices. The use of Google Trends data to inform policy problem framing in agriculture provides several advantages. Firstly, as the data is not based on surveys, it does not contain some of those biases commonly existing in surveys and it is readily available. Secondly, it provides a long-term perspective covering coherent, freely accessible, real-time data collection over many years.

We find that the interest in pesticides and plant protection products increased considerably over time, and was driven by a growing interest in pesticides as compared to plant protection products. Moreover, our analysis shows structural breaks in these interests around the launches of the popular initiatives.

The remainder of this paper is structured as follows. In the next section, we outline the background of public interest in pesticides and describe specifically relevant political activities and reports in the period under review. This is followed by a method and data section and the presentation of our findings. In the last section, we present our discussion and conclusions drawn from our results.

2. Background

Information about pesticide use and its impacts on the environment and human health can intensify public interest and concerns in this matter. In turn, this public interest and concern can trigger demands for changes in agricultural policy problem framing and agricultural policies. Next to general elections, a way for the public to express these demands is by means of direct democracy, such as popular initiatives or referendums, which are important political instruments in several countries (Qvortrup 2014, 2017). These democratic means can then further increase public interest. To identify the relationship between public interest and information about pesticide use as well as with political activities, we considered dates of important report releases and activities related to popular initiatives recently launched in Switzerland (table S1, available online at stacks.iop.org/ERL/15/084049/mmedia).

In detail, we include the publication of national and international reports that received wide media coverage as reference dates in our analysis. On an international level, we consider two important reports released by units of the United Nations on glyphosate (IARC (International Agency for Research on Cancer) 2015, WHO (World Health Organization) and FAO (Food and Agriculture Organization) 2016). Interestingly, the first report (released in March 2015) presented a rather ‘negative’ and the second report (released in May 2016) a more ‘positive’ assessment of glyphosate. 4 The national reports include two important publications by the Swiss Federal Institute of Aquatic Science and Technology and one by the Swiss Association of Cantonal Chemists. These reports assessed the condition of creeks and drinking water in Switzerland with respect to pesticide contamination.

In Switzerland, citizens can influence public policy using popular initiatives. Popular initiatives allow any citizen to launch a proposal to revise the Federal Constitution. Such popular initiatives have considerable influence on agricultural policy developments in Switzerland (Huber and Finger 2019). In recent years, two popular initiatives relating to pesticide use have been launched by interested citizens: the ‘Save Switzerland from Synthetic Pesticides’ initiative (launched in November 2016) and the ‘Clean Drinking Water and Healthy Food’ initiative (launched in March 2017). While the two popular initiatives differ in their wording and their origin,5 their shared goal is to drastically reduce pesticide use in Switzerland (see e.g. Schmidt et al 2019, FCh (Federal Chancellery) 2020). The political process of popular initiatives foresees four main steps: (a) start of collecting signatures, (b) the submission of the initiative after sufficient signatures have been collected, (c) publication of the official response by the Swiss Federal Council and (d) the public vote on the popular initiative (which in the case of the initiatives considered here will probably take place in 2021). We consider the dates of the first three steps as important political activities in our analysis.

3. Methods & data

3.1. Estimation of structural breaks

We estimate a linear model of relative search volume as a function of time with m structural breaks \((m + 1)\) regimes (Bai and Perron 2003): 6

\[
y_t = x'_t \beta_j + u_t \quad t = T_{j-1} + 1, \ldots, T_j
\]

for \(j = 1, \ldots, m + 1\). \(y_t\) is the relative search volume at time \(t\), \(x'_t\) is a \((k \times 1)\) vector of dependent variables, including the intercept and time, and \(u_t\) is the disturbance at time \(t\). \(\beta_j\) and \(T_{j-1}, \ldots, T_m\) are the

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4 We classify the first report as ‘negative’ as it reports ‘Glyphosate is probably carcinogenic to humans …’ (IARC 2015) and the second report as ‘positive’ as it reports ‘…glyphosate is unlikely to pose a carcinogenic risk to humans from exposure through the diet.’ (WHO and FAO 2016).

5 Clean Drinking Water and Healthy Food’ popular initiative is initiated and rooted in the German part of Switzerland while the ‘Save Switzerland from Synthetic Pesticides’ popular initiative is initiated and rooted in the French part of Switzerland (see www.initiative-saubereres-trinkwasser.ch and www.manifest-futurex.ch).

6 We use the R package ‘strucchange’ (Zeileis et al 2002, 2003) for the estimation.

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3 This semantic differentiation applies for all Swiss languages.
unknown coefficients and structural breaks, respectively, and are estimated jointly. Furthermore, we select the number of structural breaks based on the Bayesian information criterion.

3.2. Google Trends data

Google, which hosts the most widely used search engine (Sterling 2015), provides Google Trends data. Note that this data represents the relative search volume ranging from 0 to 100 in a specific time span (Google 2020). Our analysis is based on monthly Google Trends data covering the period between January 2011 and December 2019 for search terms related to pesticides and plant protection products and the two initiatives in Switzerland. We downloaded the data using the R package ‘gtrendsR’ (Massicotte and Eddelbuettel 2019). The main search term group, ‘pesticides and plant protection products’, was divided into two subgroups, ‘pesticides’ and ‘plant protection products’. We used search terms in the main official languages in Switzerland (i.e. German, French and Italian) for download requests from Google. However, only German and French search terms yielded any available data (see table S2). Next, we computed the relative search volume (Supplementary Information 2) for each main group (i.e. ‘pesticides and plant protection products’ and ‘initiatives’) and subgroup (i.e. ‘pesticides’ or ‘plant protection products’). The data provided by Google are random samples of all search inquires (Google 2020). To check and avoid biased inference due sampling noise, we downloaded the data on 33 d following the procedure proposed by Carrière-Swallow and Labbé (2013) (see Supplementary Information 3 for details). Using this procedure, we show that sampling noise is of no, or only minor, concern in our case (figure S1). Moreover, we use the mean relative search volume of the different downloads in our analysis.

4. Results

We find that public interest (measured in relative search volume) in pesticides and plant production products clearly increased between 2011 and 2019 (figure 1, Panel A). Indeed, it doubled during this period. The increase over time is characterized by two structural breaks at the beginning of 2014 and 2017. The first structural break occurred roughly three years before the launch of the two initiatives. The second structural break occurred at about the time of their launch.

The interest in the topic of pesticides and plant production products peaked after political activities associated with the popular initiatives. However, these political activities often concur with national report releases assessing pesticide contamination in Swiss creeks and drinking water. The interest in the popular initiatives increased steadily after they were launched. We detect an increased interest in the pesticide topic following the release of the first international report presenting a ‘negative’ assessment of glyphosate and a decreased interest in the topic after the second report presented a ‘positive’ assessment. However, these changes were fairly moderate.

The increase in public interest differed between the search terms related to pesticides and to plant protection products. While interest in pesticides increased strongly over time, the interest in plant protection products remained fairly stable (figure 1, Panel B). This indicates that changes in the aggregated search volume of these search terms is generally linked to changes in the search volume for search terms related to pesticides. In contrast to the overall results, we find three structural breaks for interest in pesticides in our data analysis. The second structural break of interest in pesticides was identical to the first break of the aggregated interest in pesticides and plant production products. This break interestingly happened at the time of the initiative launches and just before interest in the initiatives started to increase. The third structural breaks of the subgroup pesticides occurred about one and a half year after the initiative launches.

5. Discussion & conclusion

Firstly, we find that overall public interest (measured in relative search volume) in the topic of pesticides and plant protection products increased substantially between 2011 and 2019 in Switzerland. Secondly, this trend was driven by a growing interest in pesticides, while the interest in plant protection products was fairly stable over time. Thirdly, our analysis shows that the relative search volume for pesticides started increasing at a higher rate about the time of the launches of the popular initiatives. This rate increased again about one and a half year after their launches.

The trends identified here for Switzerland contrast to those observed in most of the neighboring countries, i.e. Austria, Germany and Italy (figure S2). In these three countries, interest in pesticides and plant protection products was fairly constant and, in
Figure 1. Public interest over time (measured in relative search volume) for search terms related to pesticides, plant protection products and the popular initiatives in Switzerland. Panel A shows public interest over time in the two main groups of search terms (pesticides and plant protection products as well as initiatives). Related political activities and report releases are indicated by abbreviations. In detail, PI1 indicates activities related to the popular initiative ‘Save Switzerland from Synthetic Pesticides’, while PI2 relates to the popular initiative ‘Clean Drinking Water and Healthy Food’. Lower-case letters refer to the political process of popular initiatives, i.e. start of collecting signatures (a), initiative submission (b) and publication of the response by the Swiss Federal Council (c). NR1 and NR2 indicate national report releases by the Swiss Federal Institute of Aquatic Science and Technology and NR3 by the Swiss Association of Cantonal Chemists. IR1 and IR2 indicate the international UN reports. Panel B shows public interest in the subgroups of search terms over time (pesticide as well as plant protection products).

In general, there was no divergence over time between public interest in pesticides and plant production products. Among the neighboring countries France represents an exception and shows similar trends to Switzerland. Indeed, France, as Switzerland, faces animated high societal and political discussions on pesticides (e.g. Stokstad 2018).

Our findings suggest that, on average, plant protection has an increasingly negative image. Moreover, our findings provide evidence that supports the
hypothesis that increasing concerns about pesticide use contributed to the launching of the popular initiatives. Next to this, our findings also support that the launch of the popular initiatives amplified these concerns. The uses of Google Trends data allowed us to perform a cost-efficient analysis of a large share of the population; but the data does have some limitations. Firstly, the results are restricted to that part of the population that uses Google as tool to acquire information about agricultural and environmental topics, such as pesticides. Thus, it does not include people who strictly use other sources (e.g. newspapers or TV) or are not interested in the topic at all. Secondly, our results might also indicate that different individuals are conducting the search inquires (e.g. farmers vs. general public), in addition to an increasing public interest in pesticide use, its environmental impacts and pesticide policies. Thirdly, Google provides no absolute search volume data and does not disclose details about its data processing algorithm. While absolute search volume would be interesting, our focus is on relative changes (i.e. over time and between search term groups).

Our findings have two important policy implications. Firstly, a clear communication highlighting both negative but also positive aspects of plant protection might help to reduce the public’s strong perception biases towards plant protection. In turn, this can help in political problem framing processes. Moreover, in these processes, it could be helpful to use a more value-neutral vocabulary by employing more specific terms for pesticides and plant protection products, e.g. herbicides, insecticides or fungicides, whenever possible (Flury 1996). Secondly, Google Trends data is a useful tool for the timely detection of ongoing discussions (e.g. before initiatives are launched), which might otherwise pass unnoticed, and to complement traditional data sources. Since the agricultural and environmental sectors are of great societal and political relevance, it is extremely important to consider societal concerns early on in the policy process. Therefore, Google Trends data could help authorities and stakeholders to react in good time and communicate their viewpoints. Thus, Google Trends data can be very useful for setting the agenda of policy processes.

Our analysis of societal pesticide concerns and public initiatives in Switzerland also highlights important areas for future research, including: The investigation of societal pesticide concerns over time, between countries and the reasons for national and temporal differences. The analysis of societal concerns of other (agricultural, environmental, etc) topics connected to popular initiatives (or other forms of direct democracy) on the national and local level, in Switzerland and in other countries. Moreover, future research should empirically address the (negative) connotation of the term pesticide compared to plant production products and the development of the relationship over time.

**Code availability**

The R-code for reproduction of this study (data download and analysis) is available online on GitHub ([https://github.com/AECP-ETHZ/pesticides-interest-trends](https://github.com/AECP-ETHZ/pesticides-interest-trends)).

**Data availability**

The data that support the findings of this study are openly available at the following URL/DOI: [https://trends.google.com](https://trends.google.com). Note that the random sample Google provides can change between downloads. The data we downloaded from Google Trends is available upon request.

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