Supplementary Material

How Issue Entrepreneurs Shape Public Discourse of Controversial Science:
Examining GMO Discussion on a Popular Chinese Q&A Platform

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I. The Structure of Zhihu

Similar to its American peer Quora, Zhihu is organized on a tree structure (Liang Liu, & Zhang, 2019) -- the general topic being the "root" containing a variety of related questions, and each question being the "root" containing answers. When users post questions, they can tag their questions with up to five most relevant topics. Zhihu officials suggest that tagging can help match questions with active users and get high-quality answers (Zhihu Guidance, 2020). Some meta-topics (e.g., Science, Art, Economics) are created by Zhihu officials and serve as the root-topics for most topics. Following the standard tree structure, each topic can serve as a parent topic that contains all answers captured by its child topics. Non-registered netizens can browse questions and answers on Zhihu but only registered users can edit topics, pose questions, provide answers to existing questions and vote (i.e., upvote) for satisfactory answers. Voting is the key determinant of the order to present the answers within the same topic or question (Hamm & Lin, 2019).

II. The Search Results from Zhihu

The first row shows the results returned by Zhihu API when we searched Gene Modification ("转基因"), and the second row shows topics we chose that are most related to GMO.

Table 1: Search results and selected topics

The return topics when the search keyword is Gene Modification ("转基因")	Gene Modification(转基因),Genetically Modified Food(转基因食品), GM Soybeans(转基因大豆), GM Rice(转基因水稻), Yongyuan Cui and GMO(崔永元与转基因), Harmful effects of GMO(转基因危害), GM technology(转基因技术), GM biology(转基因生物), Why should we import GM maize from the U.S.(为什么进口美国转基因玉米), Show my primitive understanding of GMO [Discourse](班门弄斧转基因[演讲]), Clone(克隆), Spider-Man[Movie](蜘蛛侠[电影]), Monsanto(孟山都), Clone Technology(克隆技术), Guangzhou Institute of Biomedicine and health, CAS(中国科学院广州生物医药与健康研究院), must trans(非转不可), The Table of Tomorrow[Book](明日的餐桌[书籍]), The Secret of Our Success[Book](人类成功统治地球的秘密：文化如何驱动人类进化并使我们更聪明[书籍]), The Placebo Effect[Book](安慰剂效应[书籍])
The topic list for GMO research	Gene Modification(转基因),Genetically Modified Food(转基因食品), GM Soybeans(转基因大豆), GM Rice(转基因水稻), Yongyuan Cui and GMO(崔永元与转基因), Harmful effects of GMO(转基因危害), GM technology(转基因技术), GM biology(转基因生物), Why should we import GM maize from the U.S.(为什么进口美国转基因玉米), Show my primitive understanding of GMO [Discourse](班门弄斧转基因[演讲])

III. The Issue Entrepreneurs of GMO in China

Following (Ferree et al., 2002)'s practice, we identified the issue entrepreneurs of GMO in China by two criteria: standing and framing. By standing, we mean the issue entrepreneur should have a long-standing voice in the Chinese media. Issue entrepreneur should gain the status of a regular information source whose interpretations are directly quoted. By framing, it means that the media should report the main arguments from the issue entrepreneurs. The frames preferred by issue entrepreneurs should be prominently displayed compared to rival frames. There are three main issue entrepreneurs that steer the GMO discussion in China over the past 10 years.

(1). Cui Yongyuan

Cui is a famous TV host and investigative journalist in China, who is skilled in arousing the emotion and applaud from the crowd on public issues. He is especially skillful in using laypeople friendly and emotionally charged language to challenge the scientific authority of GMO, and to promote his activities in GMO such as selling organic food. His opinions about GMO are widely covered by media in China because of his popularity.

Evidence of Standing:

Mainstream media's coverage on Cui's GMO discourse over the years

Time	Event	Media Coverage
Sep, 2013	Cui held an online debate with Zhouzi Fang	Guancha: https://www.guancha.cn/Media/2013_09_10_171478.shtml
Dec 2013 to March 2014	Cui went to US to investigate GMO and published a documentary addressing this.	CCTV: http://jiankang.cntv.cn/2013/12/24/ARTI1387846887232835.shtml
April, 2014	Cui attacked GMO on The National People's Congress	Chinanews: http://www.chinanews.com/sh/2014/03-04/5905064.shtml
March, 2015	Cui went to Fudan University and had a fierce debate with Lu Daru	Ifeng news: https://web.archive.org/web/20151208073919/http://www.wfcmw.cn/html/cmwgn/404327.shtml
May, 2017	Cui opened the Puguton online market	Xinhua net: http://www.xinhuanet.com/fortune/2017-05/22/c_1121010608.htm
July, 2017	Cui resigned from Puguton	Sina news: https://news.sina.cn/gn/2017-07-26/detail-ifyinvyk1312861.d.html?from=wap

Framing:

In 2013, Cui's discourse on GMO was framed around whether US citizens eat GMFs, and the related report from CCTV covered the opinions about this frame from ordinary US citizens and FDA. When Cui attacked the Chinese Administration of Agriculture on blocking Chinese access to correct GMO information, the mainstream media (Chinanews) also covered the corresponding corruption issues. In 2015, his debate with Fudan professor arouse the media discussion on how scientists should communicate with lay people on GMO issues. In 2017, when Cui opened the online organic food market, media questioned the identity of Cui, whether he is purely an anti-GMO fighter or businessman. All in all, Cui is the long-time issue entrepreneurs who calls the netizens' attention to certain events and directs the attention away from others.

(2). Lu Daru

Lu is the professor and the Associate Dean at the School of Life Sciences at Fudan University. He is the leading scholar in Genetics research in China. He uses scientific reasoning and science epistemology such as citing academic works to teach people about the importance and contribution of GM technology.

Evidence of Standing:

Time	Event	Media Coverage
March, 2015	Cui-Lu debate	Science net: http://news.sciencenet.cn/htmlnews/2015/3/315905.shtm
Nov, 2016	Lu is interviewed for his new course: Genetics Science Around You	Sohu: https://www.sohu.com/a/117969671_507651
Aug, 2018	Lu gave a speech on the second Genetic Testing and Health Industry Conference	Biodiscover: http://m.biodiscover.com/talk/live/104066.html
Oct, 2019	Lu set up new course at Fudan University to identify pseudoscience	Xinhuanet: http://www.xinhuanet.com/2019-10/24/c_1125146397.htm

Framing

Lu first came to public attention when he debated fiercely with Cui about GMO on March 2015, and subsequent media reports on GMO also centered around how scientists could better communicate their opinions and the science of GMO. After this, his discourse focus shifted to the GM technology in the academic and education field. The media mainly cover his speeches in the conference and the introduction of his courses.

(3). Fang Zhouzi

Fang is a science communicator and on online influencer. He is primarily known for his campaigns against pseudoscience and academic fraud in China. His campaigns employ aggressive language such as attacks that some scholars accused him of using populist rhetoric.

Evidence of Standing:

Time	Event	Media Coverage
2006	Fang criticized Greenpeace for its misunderstanding on GMO	Sinablog: http://control.blog.sina.com.cn/myblog/htmlsource/blog_notopen.php?uid=1195403385&version=7&x
2010	Fang debunked Southern Weekly's demonization of GMO	Xinyusi: http://xys.org/xys/netters/Fang-Zhouzi/blog/transgenic4.txt
2013	Fang and Cui attacked each other for different standpoint on GMO	Guanchazhe: https://www.guancha.cn/Media/2013_09_10_171478.shtml
2017	Fang criticized Cui on his Puguton organic market	Agrogene: http://wap.agrogene.cn/info-4104.shtml

Framing

Fang is well known as a pro-GMO fighter who has almost criticized everyone who is against GMO. From 2006 to 2010, Fang attacked some renowned organizations for their misunderstanding on GMO and the media also later on covered the misinformation from these organizations. After the Cui-Fang debate after 2013, Fang discussed the scientific mistakes from Cui and media cited Fang's arguments.

We also acknowledge several Internet accidents where certain articles about GMO written by the netizens became popular. For instance, a journalist conducted a GM human experiment[1], and some students fought against Cui's attack on a Weibo netizen's wife[2]. However, we did not regard these netizens as the issue entrepreneurs because from the "standing" criterion, these netizens only drew public attention in a short period. And from the "framing" criterion, although their internet incident articles are highly popular in the original platform, we could hardly find mainstream media covering these. Other articles from these netizens on GMO topic draw neither mainstream media nor social media's attention.

[1] https://www.zhihu.com/question/38140589/answer/75070980
[2] https://www.zhihu.com/question/60083106/answer/172127681

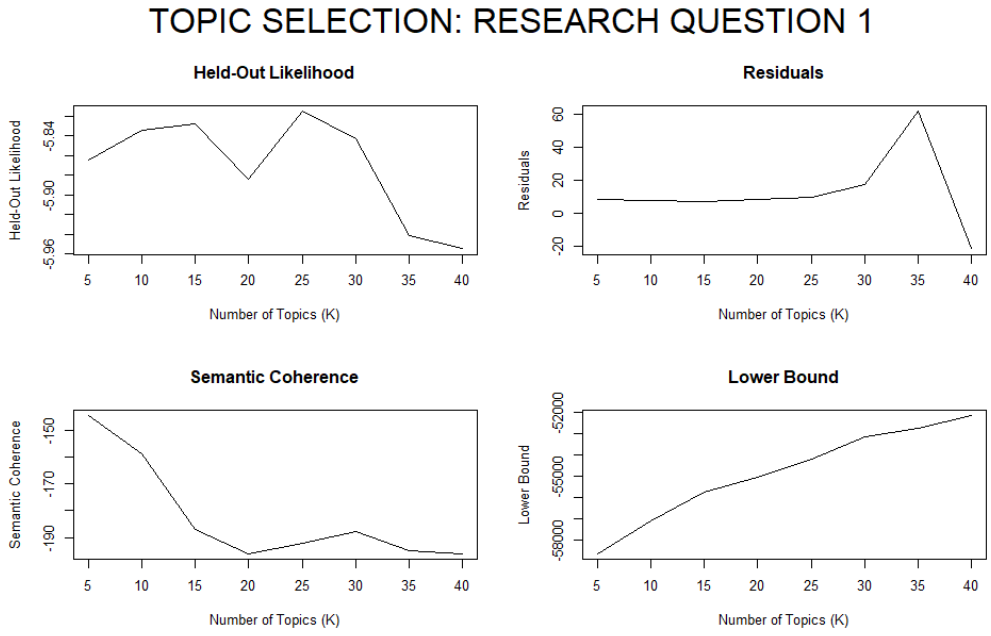
IV. Structural Topic Model Details – Research Question 1

Suppose k is the number of topics we choose, and d refers to the number of documents in the metadata, then the generalized linear model to estimate the event effect is:

$$X_d = \beta_0 + \beta_1 T_d \qquad (1)$$

Where X_d is the k-by-1 topic prevalence vectors, and T_d is the treatment indicator for document d. $T_d = 0$ when the answer was written before the event and $T_d = 1$ when it was written after the event. Thus, the regression coefficient β_1 is a k-by-1 vector represents to what extent each topic is affected. Figure A1 plots 4 important references to decide the number of topics: the held-out likelihood, residuals, semantic coherence and lower bound. This shows when topics range from 5 to 40, setting the number of topic equal to 10 balances between maximizing held-out likelihood, semantic coherence and minimizing residuals.

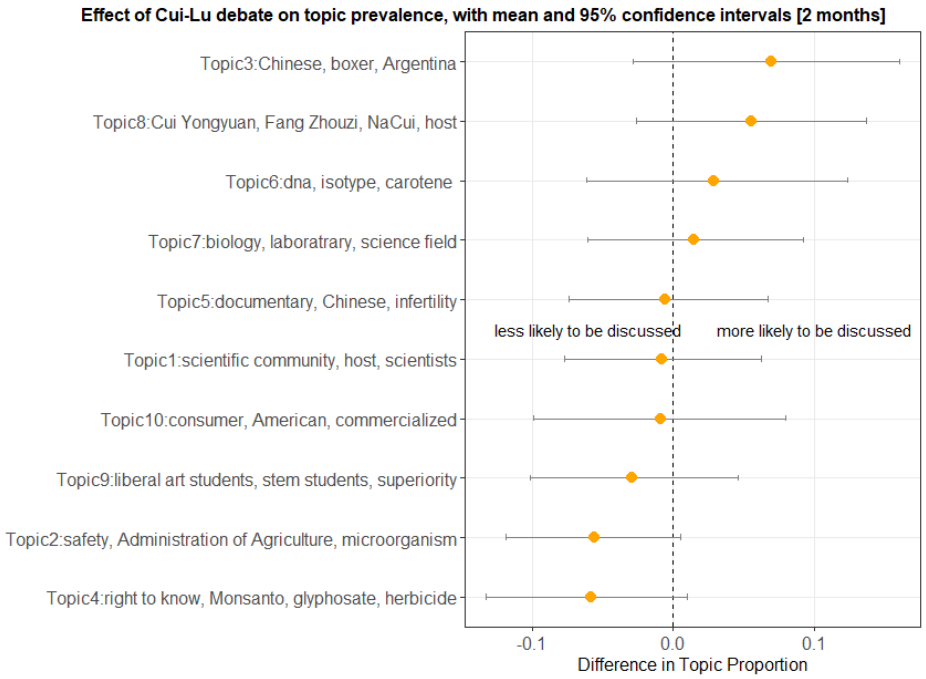
Figure A1: *Topic Selection: Research Question 1*

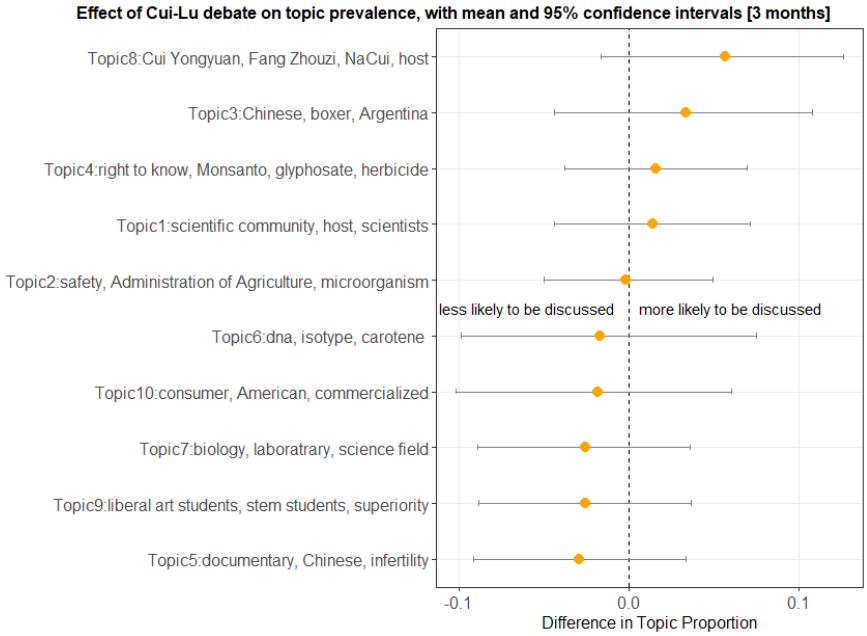


V. Examining the Long-term Effect of the Issue Entrepreneurs' Debate on Public Discourse

To examine the long-time effect of Cui-Lu debate, we extend the metadata to three months after the Cui-Lu debate. Similar to what we have done in examining the effect of Cui-Lu debate, all the time windows are one-month width and the one month before the Cui-Lu is set as the baseline. We studied two periods (2 months after the Cui-Lu debate and 3 months after the Cui-Lu debate) separately and found that there are no significant topics differences 2 months after the debate, suggesting that the effect of issue entrepreneurs' debate on public discourse is not long term.

	Begin Time	End Time	Dummy Variable	Explanation
Period 1	2015-02-26	2015-03-25	/(baseline)	One month before Cui-Lu debate
	2015-03-26	2015-04-25	S_1	One month after Cui-Lu debate
Period 2A	2015-04-26	2015-05-25	S_{2A}	Two months after Cui-Lu debate
Period 2B	2017-05-26	2017-06-25	S_{2B}	Three months after Cui-Lu debate





VI. Main Arguments made by Cui and Lu from their March 2015 Debate (Chinese Version)

Lu (Chinse Version)	Cui (Chinese Version)
不要 “妖魔化”转基因	
不要将黄金大米的 “程序问题, 伦理问题”和转基因 “混为一谈”	
黄金大米有 “科学需求”:对贫困发展中国家儿童的重要性	
转基因的科学性不是个人意见，而是业内专家共同体观点	质疑共同体. “新闻共同体认为你们这个东西不靠谱儿”
黄金大米中间有胡萝卜素代谢酶，同时有两代黄金大米，转的基因有两个的还有一个的	舒伯特教授说的是 7 个，这也是生物科学的专家
多种代谢途径，转的基因不全是崔说的 7 个	连转了几个基因都不知道，你就说安全呀？’
“讲老实话，崔永元你有什么资格跟我谈这个黄金大米的科学问题呢？”	“没学过播音主持，有什么资格跟我争论呢”
崔 “在细节上不断纠缠”	卢”用这种方式推广转基因，就是没”’
	三个观点: “不能滥种”, “公众要有知情权”, “安全性需要经过非常严谨的科学实验”

VII. Examples for Deliberation Styles Content Coding

	Answer	回答
No Reasoning	Cui only did a good job in his talk show, and the show could only invite comedians. Academic? He is far away from qualified. I don't know why he had the courage to talk about genetic modification with others.	小崔只适合搞他的小崔说事，并且只邀请笑星来上节目。学术业？他真没资格。也不知道他哪来这么大勇气跟别人谈转基因。
Narrative	As a student of Mr. Lu ... So it is the case that Mr. Lu was not well prepared, he counted on his accumulating knowledge on ordinary days. Our laboratory does not specialize in Gene Modification…So when it came to the boring question of how many genes has been modified, Teacher Lu couldn't answer it immediately and accurately. After all, a scientist 's literacy told him that he couldn't talk about uncertain things with certainty.	作为卢老师的学生……所以要说是准备不充分，的确是这样，卢老师全靠平时积累。我们实验室平时也不是做转基因的……所以说到几个基因这种无聊的问题，卢老师不能马上准确地答出，毕竟一个科学家的素养告诉他，不能信口雌黄，不确定的东西不能一口咬定。
Citing fact	How many genes did Golden Rice transfer? The answer is 3 in 1st generation and 2 in 2nd generations. The official website of the International Rice Research Institute (IRRI) found ... The first generation of golden rice in 1999 transferred two daffodil genes and one crtl gene from a bacterium, so there are three in total. To be honest, anyone who has learned the principles of molecular biology or gene manipulation couldn't understand Cui's way to calculate gene.	黄金大米到底转了几个基因？答案是 1 代 3 个，2 代 2 个。国际水稻研究所(IRRI)的官网上查到……1999 年的第一代黄金大米转入了两个黄水仙 (daffodil)中的基因，以及一个细菌中的 crtl，所以一共是三个。说实话任何一个学过分子生物学或者基因操作原理的人都想不到小崔会这么算"基因"吧。"
Sarcasm	The long-time insufficient sleep does have a serious negative impact on his brain…	长期睡眠不足确实会对大脑产生严重的负面影响……

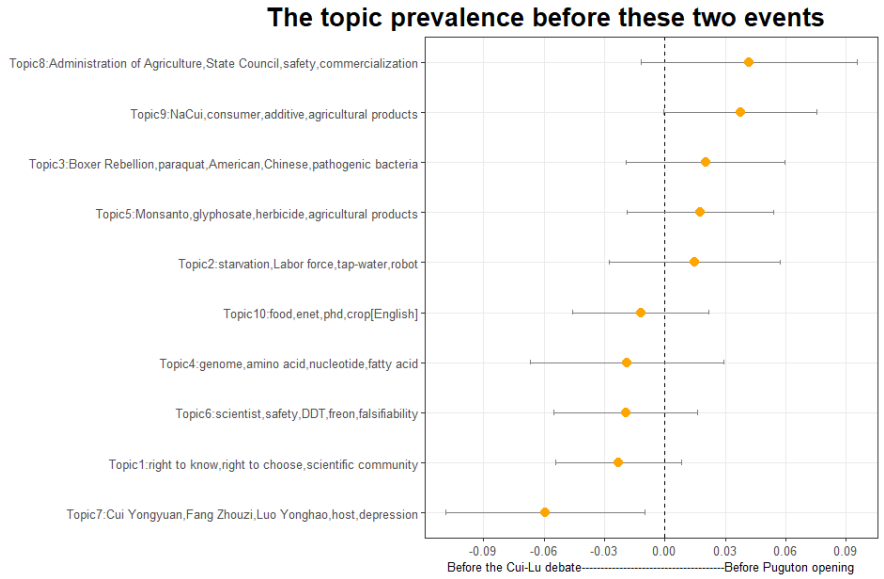
VIII. The Intercoder Reliability Score

	Agreement Percentage	Krippendorff's Alpha (nominal)	N Agreements	N Disagreements
Support whose arguments (Cui vs Lu)	98.90%	0.981	272	3
Attitude towards GMO (Support, Neutral, Oppose)	97.10%	0.953	267	8
Rhetoric Skills (No reasoning, Narrative, Logical argument, sarcasm)	95.60%	0.936	263	12

IX. Parallel Trend Test

The reason we conducted the parallel trend test is to ensure that it is the personalization of GMO framing rather than any other prior contexts that lead to the different topic prevalence after these two events. Based on the regression equation (2) in Supplementary Material VIII, we checked the deviation of regression coefficient for $\boldsymbol{S}_{2d}$ and $\boldsymbol{S}_{1d}$. And when we set the answers just before the Cui-Lu debate as the baseline answers, then the coefficient for $\boldsymbol{S}_{2d}$ represents the topic prevalence difference before Puguton opening and before Cui-Lu debate. Figure 1 below showed the parallel trend test result. We can see the personalized tag topic (Topic 7) is even less discussed before the event, which can further strength our conclusion that the popularity of Cui's personal tags topic results from the Puguton opening event itself. The other topics are not significantly different before these two events.

Figure 1. The topic prevalence difference before Cui-Lu debate and before Puguton opening



X. Topics Significantly Affected Regarding their Prevalence by the Cui-Lu Debate (Chinese Version)

Topic #	Key Words	Representative Answers
Topic 9: More popular after the debate	Yongyuan Cui, documentary, Zhouzi Fang, journalism, host (崔永元，纪录片，方舟子，新闻学，主持人)	To tell the truth, I feel that Yongyuan Cui can control the scene and grasp the flaws of the opponent's deputies. He is worthy of being a well-known media figure. I feel pity for the Fudan Professor that can't present his ideas clearly. Think about if he came to the University of Science and Technology of China (USTC), how could he perform "the sophisticated debating skills"? Remember that another "sophisticated debater" Zhouzi Fang is the alumni of USTC. (…我感觉崔永元掌控场面能力，抓住对方辩友破绽能力超一流，不愧为著名媒体界人士，可怜了那位茶壶煮饺子，有理倒不出的复旦教授遇到的是这样的对手。想想他要是来中科大，哪里由得了他这般"极其优秀的诡辩家"撒野。蜗壳生命科学学院可也是诞生过方舟子这样"伟大优秀的辩论家"的…)
Topic 6: More popular after the debate	science community, host, NaCui, isotope (共同体，主持人，崔化钠，同位素)	… Professor Lu told Cui earnestly that Cui had made a mistake, Cui was arrogant, Cui was not qualified to be an expert... This should have been an open and frank discussion, but the collision between the public intellectual and the front-line researcher reflected the strength of pseudoscience and the weakness of scientific truth in the laypeople' minds. It was such a sad story. The first step to promote popular science bases on the publics' respect and trust in science, but NaCui questioned all this. The Cui-followers had not respect on science either. There is still a long way to go to improve national scientific literacy and popularize scientific knowledge.... (…卢教授苦口婆心地告诉小崔你搞错了啊，小崔胡搅蛮缠;你不配当专家…这本应是一场开诚布公的讨论，然而公知和一线科研工作者摩擦出的竟是在非专业人士嘴里心中伪科学神圣不可侵犯的伟大和科学真理的苍白，让人痛心。推进科普的第一步，是民众对科学的尊重和信任，然而崔化钠质疑这一切。崔化钠身后只吃不含氯化钠的食盐的追随者们同样失去了对科学最起码的尊重。国民科学素养的提高、科学知识的普及任重而道远...)
Topic 7: Less popular after the debate	Administration of Agriculture, safety, demonize, ordinary people (农业部，安全性，妖魔化，老百姓)	Only when we have sons and daughters, or those GMO experts have their grandchildren, and we are able to buy non-GM foods but still happy to feed these babies GM milk, GM rice noodles or GM soy milk, the sincere approbation of GMO can be said, otherwise how comes that GM food is equally safe, or safer than non-GM food?"

		(当我们有了儿子女儿，或是那些研究转基因的生物专家们有了自己的孙子孙女，在我们能够具有购买非转基因食物的能力与条件，却依然乐于喂这些婴儿，转基因牛奶、转基因米粉或是转基因豆浆，才能说是真正从心底认同了转基因的安全性，不然何来转基因食品同样安全，或是更安全).

XI. Topics Significantly Affected by Cui's Opening of His Online Store (Chinese Version)

Topic #	Keyword	Example documents highly associated with each topic	Example documents highly associated with each topic（中文）
Topic 1: Less likely to be discussed after Cui opened his online store	English: right to know, right to choose, scientific community Chinse: 知情权，选择权，共同体	Yes, my education level and knowledge level are indeed inferior to you, but it has nothing to do with my point of view. It seems that you neither have the ability to explain the problem clearly to someone with lower knowledge, nor lack the ability to debate with someone wiser than you. You are determined to be refuted by someone smarter than you.	没错，我的学历，知识水平确实不如你，但和我的观点对不对没有任何关系。看起来，你既没有向一个比自己学识低的人解释清楚问题的能力，也缺乏跟比你聪明的人辩论的能力，只有被比你聪明的人驳倒的命。
Topic 6: less likely to be discussed after Cui opened his online store	English: scientists, safety, DDT, certainty Chinese: 科学家，安全性，DDT,确定性	Some people say that we should believe the scientist who said that there is no harm. OK, then I talk about this aspect. In the past, there are many cases that some global scientists said that it is harmless but ends in harming the entire earth 's biosphere. And it was impossible to clean up the mess. One shitty example is DDT.	有人说科学家说了没害处。我们要相信他们。OK， 那我就说说这方面，以前也有全球科学家都说了没害处，最后结果害了全地球的生物圈，而且没法收拾残局，这种狗屁倒灶的事情也不少，比如 DDT
Topic 4: less likely to be discussed after Cui opened his online store	English: protein, DNA, amino acid, Chinese: 蛋白质, DNA，氨基酸	The anti-nutritional factors in soybeans and their processed products are glycinin, β-conglycinin, trypsin inhibitor (TI), soybean lectin (SBA), anti-vitamin factors,	大豆及其加工产品中存在的抗营养因子有大豆球蛋白（Glycinin)、β-伴大豆球蛋白（β-conglycinin）、胰蛋白酶抑制因子（TI）、大豆凝

		Urease, phytic acid, saponin, isoflavone, tannin, oligosaccharide, etc.	集素（SBA）、抗维生素因子、脲酶、植酸、皂甙、异黄酮、单宁、寡糖等
Topic 5: More likely to be discussed after Cui opened his online store	English: Monsanto, glyphosate, herbicide, agricultural products Chinese: 孟山都，草甘膦，除草剂，农产品	The current safety reports of genetically modified products are not disclosed to consumers, and Monsanto believes that it is a trade secret.	目前的转基因产品的安全监测报告都是不向消费者公开的，孟山都们理直气壮的认为那是商业机密
Topic 7: More likely to be discussed after Cui opened his online store	English: Yongyuan Cui, Zhouzi Fang, host, documentary, depression Chinese: 崔永元，方舟子，主持人，纪录片，抑郁症	Let's evaluate Yongyuan Cui's personal ethics first and then talk about Yongyuan Cui's online market. 1. Personally I feel that Cui Yongyuan is a shady, vicious but clever man. His insight into human nature, knowledge of society, and control of the right to speak are indeed one of the cancers of a civilized society.	先评价一下崔永元的私德。再说说崔永元的商城。一、崔永元其人个人觉得，崔永元本就是一个阴损、狠毒却又聪明得一塌糊涂的人。他洞察人性、知悉社会，掌控话语权，实为文明社会之一大毒瘤。
Topic 9: More likely to be discussed after Cui opened his online store	English: agricultural products, consumer, NaCui, additive Chinese: 农作物，消费者, 崔化钠，添加剂	Let's watch the comedian "Working Adventures" by Lirong Zhao and Hanlin Gong. Any similarity is purely coincidental. Cui, please don't cyber manhunt me. ..... The price of the vegetables is high, too high!	小品《打工奇遇》表演者: 赵丽蓉、巩汉林如有雷同，请小崔别挂我 ……菜价是，黑呀，真黑呀!

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