

Media Representations and Public Attitudes towards
Nanotechnology in Taiwan

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Summary

In order to provide a comprehensive and clear investigation of media representation and public attitude toward Nanotechnology (Nano) in Taiwan, this thesis includes three studies.

Study 1 investigates the media representation of Nano in Taiwan and the relationship among different Nano-based themes, frames, and media attitudes in the Taiwan.

Study 2 is attempts to make salient the most visible actors of Nano-related news in the Taiwanese media discourse and how the relationship among main actors, framing effects, and media attitudes toward Nano

Study 3 explores the overview of the Taiwanese public attitude toward Nano and how the Taiwanese public attitude toward Nano is influenced by framing effects and public confidence in news sources.

In short, the results of the above studies showed that the Taiwanese media attitude and public attitude toward Nano are both overwhelmingly positive. The impression and role of Nano in the Taiwanese media has been shaped as an emerging scientific idol which not only benefits public daily life but also increases the national interest and competitiveness of Taiwan. This is of concern, since there is little evidence that the public understands the risks associated with Nano.

This lackluster public and media-related risk awareness regarding Nano is exacerbated by a weak connection between the public and scientists. Nano has become a vital component of future science and technology development and a potential competitive economic benefit for Taiwan in the global economy. However,

the importance and necessity of increased and enhanced science communication regarding Nano has not kept pace with public interest or commercial production of Nano-based products that are quickly becoming ubiquitous in Taiwanese society.

1 1. Introduction

2 Nano (Nano) has become a popular applied science in the 21st century. Its
3 popularity is manifested not only in increased research, resulting in a number of
4 breakthroughs, but also in its increased use by commercial industries to produce “Nano
5 products” that have sold well in recent years. However, even though researchers have
6 become increasingly aware of the potential risks that Nano presents, the general
7 public’s awareness of these risks has remained quite low. How should we frame our
8 considerations and arguments about this emerging science, especially after being
9 exposed to related news reports? Given its ubiquity, this gap in risk awareness
10 necessitates further discussion and investigation.

11 Nano is a popular emerging science that promises to help society overcome a host
12 of challenges (National Science Technology Council, 2000; Corley & Scheufele,
13 2010). In his 2006 State of the Union speech, US president George W. Bush promised
14 to increase funding for Nano research over the subsequent decade. In addition to this
15 increased governmental funding, the presence and use of Nano in US industries
16 accounted for US\$147 billion in 2007, with an annual global revenue expected to reach
17 US\$3.1 trillion by 2015(Lux Research 2008; Corley & Scheufele, 2010). The
18 Taiwanese government has also made large investments in Nano, totally more that 420
19 million British pounds, leading it to become one the world leaders in government
20 subsidization of Nano research and development (Hullmann, 2006; Huang & Rasters,
21 2011 Shin, 2015). This increase in government funding has been matched by a rise in
22 public interest in Nano-related products and technologies, prompting the Science,
23 Technology, and Society (STS) foundation and science communication researchers to

24 declare communication about Nano-related uses and risks should be a top priority in
25 Taiwan (Shin, 2015).

26 Like other emerging sciences, Nano has generated a fair amount of controversy
27 and debate among and between researchers. When viewed positively, Nano is framed
28 as a scientific innovation and breakthrough in the manipulation of atoms and
29 molecules at the nanometer level, a development that promises improvements to
30 advanced materials and manufacturing techniques and stronger competitiveness of
31 national industries (Kostoff, Koytcheff, & Lau, 2007; Miyazaki & Islam, 2007).
32 Viewed negatively, Nano presents a host of potential ethical, social, and
33 environmental concerns which have been raised by scientists and researchers
34 (Macnaghten, Kearnes, & Wynne, 2005; Scheufele et al., 2007). Examples of these
35 negative points of view are fears of artificial creatures (Preston 2005), fear of “grey
36 goo” (Joy, 2000), and concerns about potential toxicity (Dietram a Scheufele et al.,
37 2007; Wong, 2011), all of which bring into question the need for tighter regulations
38 toward Nano research and development. Similar debates have occurred in the United
39 States, European Union, and Canada (Dudo, Dunwoody, & Scheufele, 2011;
40 Tyshenko, 2013), and concerns about the risks of Nano have grown with the rise of its
41 use in the US and EU (Corley & Scheufele, 2010). These related health and
42 environmental problems, as well as the social, moral, and ethical concerns they
43 engender, have been widely discussed by researchers (Bainbridge 2003; Sententia
44 2004; PCAST 2005; Corley & Scheufele, 2010).

45 Given the potential misunderstanding of risks and controversies that surround
46 its development, this study uses Nano and its related applications and products as an
47 example of a new science that impacts our daily lives. Nano is presently at the center

48 of debates and conversation on scientific development and economic growth in
49 Taiwan (Lin, Li, Chou, & Tsun-Jen, 2010; Su, Lee, Tsai, & Chien, 2007; Su & Lee,
50 2008).

51 Public understanding and beliefs regarding scientific issues are heavily
52 influenced by news and media exposure (Hwang & Southwell, 2009), or, to put it
53 another way, by what the mass media want the general public to see, hear, and read.
54 Scheufele & Lewenstein (2005) point out the impact and influences of “media
55 framing,” especially when people lack practical information and knowledge related to
56 those scientific facts, on public opinions and judgments towards new science and
57 technology. We need to investigate the attitude of “news coverage” itself to better
58 understand Taiwanese media influence on public opinions toward new science and
59 technology. Ideas transformed and/or translated by the media are not just purely
60 “diffusions” or “distortions” when they move in time and space (Martin W. Bauer &
61 Gaskell, 2008).

62 Mass media play an important role to provide the primary scientific information
63 for the public (R. B. Carver, Rodland, & Breivik, 2012; National Science Board,
64 2010). The media representation, included media attitude and framing effects, agenda
65 setting effect...etc. can greatly influence the public’s attitude and opinion toward
66 certain issues, especially when the public have not yet constructed their own
67 perceptions, views and opinions (Brossard, Scheufele, Kim, & Lewenstein, 2008;
68 Dietram a. Scheufele & Lewenstein, 2005). Popkin’s (1994) stance is that public
69 consumers will invest an effort in seeking information, only if they foresee a
70 reasonable pay-off. Accordingly, when people form opinions toward new scientific
71 issues, the general public is predisposed to rely directly upon the views of the most

72 easily accessible information type: mass media (Popkin, 1994). That is to say the
73 mass media is a convenient and efficient way for the public to acquire primary ideas
74 about newly emergent scientific issues such as Nano. Thus, the scientific and
75 technological information provided by media and the attitudes of media toward
76 certain science and technology play a vital role in the science communication between
77 the public and scientists (Scheufele & Lewenstein, 2005; Scheufele, 2015).

78 This means investigating the local development and variety of media attitudes
79 and attention toward emerging science and technology such as Nano is a worthy step
80 toward figuring out the important factors that drive these relationships (Scheufele &
81 Lewenstein, 2005). Following the view of Bauer (1996 & 2002), mass media are the
82 stage which provide different actors to perform their actions and views, and the
83 characters of actors will contribute different voices toward certain issues. The media
84 exposure of particular actors indicates that a particular actor's view toward certain
85 issues can be heard in public debate (M. Bauer et al., 1996). Thus, usage of different
86 media effects and the main actors who participate or are mentioned in public
87 discourse should be taken into account in this study for investigating the trend of
88 media attitudes toward Nano in Taiwan.

89 In the meantime, like many other new emergent scientific issues, Nano is now
90 facing the scrutiny of public attitude. Since government funding and policies are both
91 strongly influenced by public opinions, researchers point out that the "social
92 acceptance" of this emerging science by the general public is critical for Nano's
93 future development (Scheufele & Lewenstein, 2005). The literature points out that in
94 order to avoid obstructions and controversial debates like developing and promoting
95 gene technology and stem cell research in the US and EU, the public's perception

96 should be taken into account when developing of emerging science. Furthermore, it is
97 necessary to invite the public to engage in the decision-making processes at different
98 stages of emerging science development (Shin, 2015). In other words, the views and
99 opinions from the society toward an emerging science like Nano, which may change
100 public's life and challenge the moral and ethical value, should be considered and the
101 research from the social science which investigate the relationship among science,
102 technology, and society should become the important base for developing emerging
103 science (Macnaghten, Kearnes, & Wynne, 2005; Shin, 2015).

104 The future of Nano depends on the degree of public acceptance, so the Nano
105 research community should listen to public opinions (Toumey, 2006). In order to
106 further investigate the relationship among public, society and emerging science, in
107 this study, the author chose Nano as a representative, and also tends to focus on what
108 is the Taiwanese public's attitude toward Nano. And, since the media became the
109 main way for public to receive scientific information, knowledge and impact public to
110 form their opinions and attitude toward emerging science and technology (Scheufele
111 & Lewenstein, 2005), this study also attempts to illustrate the relationship among the
112 public's degree of trust toward media, the framing effect in the media and public
113 attitude toward Nano.

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117

119 2. Literature Review

120 (1) Nano as an emerging issue in the news

121 Nano: a novel trans-discipline technology involving the research, development,
122 and application of devices and constructions with a size range between 1 nm to 100
123 nm, is now one of the most dominant technological forces in the twenty-first century
124 and transforming the world's economy (Dudo, Dunwoody, & Scheufele, 2011; Su,
125 2008). Even though there is an emphasis on government investment and scientific
126 community and popularity surrounding their related products in today's daily life
127 (Dudo, Dunwoody, et al., 2011), results of a national survey among adults suggested
128 the public understanding of Nano is still absent in the US (Peter D. Hart Research
129 Associates, 2007). According to results from a cross-sectional telephone survey
130 carried out in Taiwan on a sample of 1,251 adults aged 18 and older, 81.3% of
131 participants self-reported that they had heard of nano-products. However, it was found
132 that as participant's age and educational level increased, their perceptions of the
133 perceived risks and benefits of Nano decreased (Lin et al, 2010^{ab}).

134 Nevertheless, the potential concern of Nano in terms of ethical, social, and
135 environmental concerns have been advanced by scientists and researchers
136 (Macnaghten et al., 2005). For example, since the nano- particle is the manipulation
137 of matter with at least one dimension sized between 1 to 100 nanometers, it is
138 suggested that the material embodiments of human intentionality may create new
139 creatures and this "playing God" game not only challenges the public's ethical
140 boundaries but also brings an environmental risk (Preston, 2005), furthermore the fear
141 of "grey goo" (Joy, 2000) and the potential toxicity bring into question the need for

142 tighter regulations towards researchers development of Nano (Macnaghten et al.,
143 2005). In the meantime, the occupational health risks and toxic effects caused by
144 Nano particles evoke the need for tighter regulations towards researcher's
145 development of Nano (Macnaghten et al., 2005; Maynard & Kuempel, 2005; Wong,
146 2011).

147 The scientific nature of Nano as an emerging science may mislead the public to
148 form implicit perceptions and beliefs that are merely reliant on information provided
149 by a small group of scientific experts and journalists (Dudo, Dunwoody, et al., 2011).
150 As the media now acts as a primary source for the public to obtain information related
151 to science and technology (National Science Board, 2010; Rundgren, Rundgren,
152 Tseng, Lin, & Chang, 2010), the manner in which scientific issues are represented in
153 every daily news is a vital concern of increasing relevance.

154 Dudo et al. (2011) ascertained that presentations of media press coverage will
155 contribute towards audience's perception, knowledge, and understanding of certain
156 issues. In particular, with novel and new issues, such as Nano, the public tend to be
157 more reliant on media press to obtain the related information and presentations, which
158 is subsequently used to help form their own opinions and aid their decision making.

159 In term of the media's effect on the public's awareness and perceptions of
160 science, Dudo et al. (2011) suggests that, especially with novel and new issues, the
161 media's presentations serve to enhance public awareness and perceptions towards
162 certain issues. According to agenda-setting theory, increasing media exposure of
163 certain issues can contribute to increased public awareness of such issues.

164 The media's presentations, as the public's primary source for scientific and
165 technological information (National Science Board, 2010), provides a relatively

166 convenient reference point for the public to construct and develop their own
167 perceptions and opinions of issues where the relevant information is novel and
168 complex, such as scientific and technological research (Dudo, Dunwoody, et al.,
169 2011; Dietram a. Scheufele & Lewenstein, 2005). The effect of media framing;
170 referring to how the media represent and frame certain issues, can greatly influence
171 public's attitude and opinion toward certain issues, especially when the public have
172 not yet constructed their own perceptions, views and opinions (Scheufele &
173 Lewenstein, 2005).

174 Nano products are not only the applications of academic scientific and
175 technological research but also the products ubiquitous in daily life (Dudo,
176 Dunwoody, et al., 2011; Lin, Wu, Li, Chou, & Cheng, 2010). Nano has now been
177 used in more than 1,000 consumer products (Dudo, Dunwoody, et al., 2011).
178 However, as an emerging science, the related information toward Nano is novel, and
179 sometimes, obscure for the public (Dudo, Dunwoody, et al., 2011) and according to
180 the survey results from Peter D. Hart Research Associates (2007) and numerous other
181 research findings, the public's awareness and knowledge of Nano is still lacking and
182 in its infancy (Elizabeth A. Corley, Scheufele, 2010). Furthermore, several
183 researchers have suggested the tone of media coverage towards Nano in the US, UK,
184 and Taiwan tends to be positive or neutral (Dudo et al., 2011; Lin, Tseng, Liu, &
185 Chang, 2012; Stephens, 2005).

186 Given the uncertainty of research, advanced development of Nano and huge
187 Taiwanese government investments, Nano is currently a worthy issue warranting
188 public awareness and research interests. Considering the significant influential effect
189 the media can have on informing the public's opinions toward novel scientific and

190 technological issue and media attitude toward Nano, as a way of media representation
191 of emerging science, it is critical and influential for public to form their own attitude and
192 perceptions (Brossard et al., 2008), thus, it is essential to examine what the media's
193 representation toward Nano in Taiwan is and how the Taiwanese public opinions are
194 effected by the media.

195 (2) Nano in Taiwan

196 Since Nano has become a vital science and technology topic around the world
197 and is largely related to the development and competitiveness of the national economy
198 (Su, 2008; Su, 2006), the Taiwanese government is eager to enhance our national
199 competitive edge. Thus the Taiwanese government has invested approximately US\$
200 98 million to start a six-year national program (from 2002 to 2008): The National
201 Program of Nano (NPNT), which was approved in June 2002 at the 5th Science and
202 Technology Congress of the National Science Council, while the program office was
203 established in Oct. 2002, in order to encourage the development of Nano in Taiwan.
204 The program office consists of eight working groups including four execution groups,
205 and four research and development (R&D) programs. The four R&D programs are;
206 (1) Academic Excellence Research Program, (2) Nano Industrialization Program, (3)
207 Core Facilities Program, and (4) Education Program. With their traditional hi-tech
208 industries background which is highly related to IC business (Nanoscience and
209 Technology Program Office, 2007), the proportions of Taiwan's government funding
210 towards Nano is 17% for academic R& D research, 2% for education, 17% for core
211 facilities and government laboratories, and provides 64% for Nano Industrialization
212 Program in 2005(Su, Lee, Tsai, & Chien, 2007). Furthermore, the government's
213 funding for Industrialization provides 64% of the total funding. Additionally,

214 according to the industrial ecology of small and medium enterprises (Su & Lee,
215 2007), Taiwan's industrialization funding follows the 20/60/20-rule (Roco,
216 2005). Specifically, 20% of funding is invested in academic research and
217 development and education, which focuses on the exploratory studies for potential
218 applications that will generate innovative and new technologies; 60% of funding is for
219 industrial research and development, which intends to enhance our future
220 competitiveness of current Taiwan hi-tech industries, and finally 20 % of funding is to
221 target Nano by creating short-term commercial potentials, which tend to help
222 promote the competitiveness of traditional industries (Su & Lee, 2008).

223 Since the industrial investment accounts for 64% of total funding and the
224 governments' main focal point of NPNT is on Nano Industrialization Program, all the
225 above evidence indicates NPNT as an industrialization driven program (Su et al.,
226 2007; Su & Lee, 2008; Su, 2006). At present, Phase II of the NPNT has been
227 approved, on April 2008, to extend for another six years, from 2009 to 2014
228 (Nanoscience and Technology Program Office, 2007). This phase is aimed at turning
229 R&D results into industrial competitiveness, and building a foundation for the
230 development of high-tech industries. After efforts from the government, related
231 scholars, and cooperative companies, Taiwan appears to be emerging as a
232 distinguished developer of Nano at present. In support of this, Taiwan was ranked
233 sixth in the top 10 countries with the largest number of Nano patents between 1976 to
234 2002 (Huang & Chen, 2003). In addition, Taiwan's academic paper production and
235 citation impact has experienced a rapid growth in previous years (Youtie & Shapira,
236 2008).

237 As NPNT is an industrialization driven program, many Taiwan researchers have
238 stated their concerns regarding the absence of related regulatory policies and
239 supervision concerning Nano (Su, 2008). Lin and Li (2010^{ab}) emphasized the
240 importance of investigating public risk perceptions and attitude toward Nano, while
241 Wong (2011) highlighted the potential risks and damage to occupational health in the
242 process of developing the Nano industry.

243 Despite the above concerns over Nano, the results of Lin (2010)'s study also
244 suggested that the media's attitude in Taiwan reflects an entirely favorable opinion
245 towards nano ceramic related science. Specifically, Lin (2010) found all 114 nano
246 ceramic news reports in Taiwan were in fact commercials, and while 54 news reports
247 were coded as positive, 60 news items were coded as "non-related", and no reports
248 were considered negative. The fact that Nano news reports are essentially product
249 commercials may explain why the media's attitudes are completely positive and only
250 talk about the advantages and benefits of Nano. The diversity and objectivity of
251 reports in media seems to be strongly affected by commercial sponsorship (Lin,
252 2010).

253 **(3) Nano and nuclear power in Taiwan – comparison of the media effect on**
254 **historical public debates on social scientific issue in Taiwan**

255 Similar to Nano, nuclear energy was the most important developing scientific
256 project in Taiwan since 1970 (Ho, 2003); the government invested large funding to
257 build a nuclear power plant. However, since the potential for environmental damage
258 and concern of nuclear disaster, debate over nuclear energy has increased since late
259 twentieth century in Taiwan. In the early stages (1979-1986), the controversial voices

260 and discussions toward nuclear development in Taiwan were mainly put forward by
261 academics and politicians. In order to raise public awareness, academics brought
262 their anti-nuclear message to local society, and three public speeches were held in
263 Taipei, Hengchuen (the location of third nuclear power plant), and Kongliao on
264 March and April in 1986 (Ho, 2003). Through the efforts of anti-nuclear participants,
265 and despite the effect of media exposures or large-scale campaigns, academics were
266 gradually able to voice their concerns regarding nuclear power to lay people, and
267 further evoke and concentrate public awareness and perception. At the time of the
268 second anniversary of the Fukushima nuclear disaster, on 9th March, 2013, the anti-
269 nuclear group organized the anti-nuclear demonstrations in Taipei, Taichung and
270 Kaohsiung. However, during this time there was not only the support of scientists,
271 politicians and non-governmental environmental groups, but many high-profile artists
272 and celebrities expressed their support for anti-nuclear. The 0309 anti-nuclear
273 demonstrations attracted two hundred and twenty thousand people participated. As a
274 result of this, under the pressure of public opinions, the Taiwan government, held a
275 referendum regarding retention or abolition of the Taiwan fourth nuclear power plant,
276 in this case, the state returned right to the public to decide on this historical social
277 scientific issue (Appledaily, 2013; Lihpao Daily, 2000)

278 Academics, politicians and journalists represented their points and articulated
279 related information (e.g. the damage of nuclear, the accidents of nuclear disaster)
280 through media press (Taiwan Environmental Protection Union, 2013; The Liberty
281 Times, 2011). Taiwan Celebrities, including Grand Prize director at the Torino Film
282 Festival: Wu Nien-Jen, Best actress at the Asia Pacific Film Festival and Taipei
283 Golden Horse: Gwei Lun-Mei, famous Singer: Zhang Xuan, and famous model: Lin
284 Chi-ling, all stated their anti-nuclear position in the media. Whether a publicity

285 strategy for attracting spotlights or not, the celebrity statements certainly increased
286 public attention and awareness of anti-nuclear issues, and may have also exposed the
287 commercial effect relating to social scientific issues (The Liberty Times, 2012, 2013)
288 The public also gained information from news media to form their perceptions and
289 opinions toward this issue. Essentially, the media provided for public debate, and the
290 representations in the news were convenient information sources for the public while
291 they engaged in this issue.

292 Following the experience of public debates and social movements toward
293 nuclear energy in Taiwan, when considering how to bring a public debate concerning
294 the development of high risk and innovative technology, we should take into account
295 the media's effects as a vital factor for raising public awareness and opinion
296 formation (Huang, 2003). Chen's research, in 2002, suggested Taiwan's media's
297 framing effect significantly impacted Taiwan government's policy toward the
298 development of nuclear.

299 Although the potential damage and uncertainty of the development of Nano can
300 be recognized by scientists and social researchers, the media's attitude in Taiwan
301 remains nurturing or even comprehensively positive (Lin, Tseng, Liu, & Chang,
302 2012b). Thus it is a worthy step to begin by investigating media representation itself,
303 in order to identify what the media emphasis and attitude is which may influence
304 public formation of opinions while they consider the development of Nano in Taiwan.
305 Also, through investigating Taiwan's news relating to Nano, this study would like to
306 point out the important but absent view of the media, in order to promote attention
307 and discussion into public discourse, in the hope to provide a reference for future
308 establishment of a government Nano policy.

309 (4) The Nano researches in the US and the EU

310 The numerous studies have paid attentions to investigating media attitudes
311 toward Nano, and claim the media has strong impacts on the public's formation of
312 their attitude and supportive toward Nano (Gaskell et al, 2004; Stephens, 2005;
313 Scheufele & Lewenstein, 2005; Corley, 2010). According to content analysis
314 research, Gaskell et al (2004) point out that a significantly positivetone is the main
315 trend in the reporting of the benefit of Nano over discussing the risk in the news of the
316 New York Times from 2000 to 2003. After the examining nanotech coverage in the
317 US and Non-EU major newspapers, the research results show the proportion of the
318 news reports which highlight the benefits of nano are overwhelming higher than the
319 news report mention about the risk of Nano (Stephens, 2005). The above researchers
320 both concluded that media coverage has a positive influence on the public's formation
321 of attitudes and opinions toward Nano, which may lead the public to ignore the
322 perception of risks toward Nano (Scheufele & Lewenstein 2005; Nisbet & Scheufele
323 2007).

324 Even though positive media attitudes are the norm in the US and EU, the United
325 States and European public tend to hold more conservative and sceptical views toward
326 new science and technology (Shin, 2015). The research of Ho, Scheufele, and Corley
327 (2010) points out the religious degree of individuals will affect their support of
328 funding of nanotech, and the highly religious public are more supportive than the less
329 religious ones. The research result also points out the individual's degree of deference
330 toward scientific authority plays an important role in influencing their support toward
331 the funding of this merging technology.

332 Given the rapid development of Nano, the US and the EU governments have all
333 expressed concern about Nano-related health risks, and have declared regulatory
334 policies toward Nano products. The US Food and Drug Administration (FDA) (2012)
335 announced an non obliged draft guidance on Nano which provide safety suggestions
336 toward the food and cosmetic products manufactured using Nano. In 2013, formal
337 legal regulations announced by the EU clearly specified all the cosmetic products
338 which contained nano material should be reported to the EU within six months of
339 product launching. Also, if there is any concern regarding these products, the EU has
340 the power to intervene and does a comprehensive safety evaluation, and all the nano
341 material which used in the products should be labelled (Shin, 2013).

342 **(5) The Media affects theories- agenda setting and framing**

343 As agenda setting and framing theories of media effect both explain the
344 correlation and relationship between media representations and public understanding
345 on certain issues, these two theories are considered to be loosely based on similar
346 premises (Scheufele & Tewksbury, 2007) or even seen to only have terminological
347 difference between the concepts (Hamill & Lodge, 1986.) Thus, it is important to
348 specify the difference and relationship between these two concepts before using these
349 two concepts as a literature background in this study. Also, the ambiguity of the
350 definition of “framing” are be pointed out by Cacciatore, Scheufele, and Iyengar
351 (2016). Thus, the operational definition of framing will be clarified in this section.

352 Focusing on the relationship between mass media and its audience, *agenda*
353 *setting* is concerned with the consistency between the media’s emphasis on certain
354 issues and the audience’s consciousness toward the importance of these issues
355 (McCombs & Shaw, 1972; Scheufele & Tewksbury, 2007). Thus essentially, mass

356 media chooses and constructs the salience and accessibility of certain issues, by which
357 mass media brings and shapes public attentions. According to a famous memory-
358 based model, people form attitudes and considerations based on information that can
359 be encoded and stored into mind and retrieved more easily. Thus, through giving
360 priority to certain issues over others, the media strongly influences public attitude and
361 opinion, regardless of whether they consider a certain issue seriously (Scheufele &
362 Tewksbury, 2007).

363 *Framing*, as a widely used concepts in different research disciplines, can be
364 trace back to two unrelated traditions concepts in psychology and sociology
365 (Cacciatore et al., 2016).

366 Scheufele(1999) developed the typology of framing research that classifies the
367 applications of framing into two dimensions: **media versus audience frames**. In the
368 midst, **frames could be the independent or dependent variable**.

369 Since the framing effect is embedded in the interplay between the representation
370 of news by the media and the comprehension of news by an audience, the empirical
371 research can be divided into two categories: **media versus audience frames**. On the
372 one hand, for those who take the media frame as the dependent variable, the media
373 context is the focus to explore. The research tends to ask: how are the media frames
374 formed and influential? What are the frames the media use for presentation?

375 Contrary to the above, researchers who regard media frames as the independent
376 variable tend to explore what the influences of media frames toward public perception
377 are. However, for those who consider individual frames as the dependent variable,
378 researchers focus on the media context itself, and tend to ask: what are the individual
379 frames? How are they influenced? Then again, for those regarding individual frames

380 as the dependent variable, investigations of media framing tend to explore how
381 individual frames influence others. Despite these different approaches, according to
382 Scheufele (1999), the above typology of framing research provides a consistent
383 concept of framing which constitutes framing as a research paradigm and, by
384 integrating the previous framing research, this typology helps to build framing as a
385 media effect theory.

386 In terms of examining media effects, Scheufele (1999) developed a process
387 model of framing as guidelines for framing research. He posits a four process model
388 of framing: (1) frame building, (2) frame setting; (3) individual-level effects of
389 framing; and (4) a link between individual frames and media frames. Highlighted by
390 this process model, researchers can develop and locate their studies into different
391 stages of framing, by which, one can avoid the deficits of previous studies. Following
392 this idea, this research intends to focus on what is the media presentation of Nano in
393 Taiwan (the progress of frame building and frame setting) and if the public hold their
394 individual frame to consider Nano, how individual's frame influence their attitude
395 toward Nano (the progress of individual-level effects of framing) and does the media
396 presentation of Nano and public attitude toward Nano have a connection?

397 In terms of the definition of framing itself, the framing effects can also be
398 generally classified in to two definition based on their traditions of thinking:
399 "equivalency framing" and "emphasis framing (Cacciatore et al., 2016). In the field of
400 psychology, the most widely recognized definition of framing is credit to Kahneman
401 and Tversky (1979; 1983), who defined framing is the effect of how description or
402 contextualized of choice problems can affect the audiences' responds and choices to
403 the problems, even under the same equivalent information (Cacciatore et al., 2016).

404 This definition in the psychology field has been extended in research in
405 communication field, framing as McCombs, Shaw, and Weaver (1997) stated is an
406 extension of agenda setting. The term "framing" can be divided into the macro and
407 micro construct (Scheufele & Tewksbury, 2007): (1) as a macro construct, framing
408 refers to the ways of presentation that the media uses to resonate with audience's
409 schemas, and shape their understanding toward a certain issue (Shoemaker & Reese,
410 1996). (2) In terms of the micro-construct, framing guides and implies to the public
411 how to use information and presentation, to construct their understanding, attitudes,
412 and opinion toward certain issues.

413 In sociological research, framing is defined as how individuals use the different
414 interpretive schemas to explain the classified to the information they faced in
415 everyday life, a definition of framing that can best be traced back to Goffman (1974)
416 who describes "frame" is a tool which individuals use to view and interpret certain
417 issues/ information/situations in their everyday life. This tradition of the definition of
418 framing is followed by Gamson (1985), who defined framing as a meaning of how
419 individuals construct meaning and understand the information in their everyday
420 world. A sociologically rooted definition of framing is widely employed in several
421 culture and cognition research projects. Schor (2004)'s study focus on the impact of
422 different narrative frames toward cosmetic surgery in media coverage are hugely
423 shaped cosmetic surgery as an innovation technology which change the bad image
424 and meaning of cosmetic surgery. The changing of narrative frame toward cosmetic
425 surgery in media lead a change of media/public acceptance and attitude toward
426 cosmetic surgery from negative to positive. The other important example of
427 sociologically rooted definition of framing employed is that of Snow, Worden and
428 Benford (1986), who pointed out one of the keys factor to impact the success or

429 failure of a social movement is how an organization develops an effective framing
430 which illuminates the situation and goals to align with participants' frames toward the
431 social issue (Wayne H. Brekhus, 2015). A final sociologically rooted definition of
432 framing is focused on how the individual's thinking and definition for certain issues
433 can shift and transform under the impact of different culture and social values (Wayne
434 H. Brekhus, 2015), which is labeled as "emphasis framing" (Cacciatore et al., 2016).

435 The sociologically rooted definitions of framing are used to emphasize the
436 information or facts that individuals choose to explain or understand the world.
437 Compared to the tradition of psychology, the definition of framing in the field of
438 sociology is more comprehensive and wide, and it puts more emphasis what an
439 individual views or receives from the process of observation on certain issues, but
440 does not focus on the effect of how the same information is presented/constructed in
441 different ways (the definition of framing in psychology) (Cacciatore et al., 2016).

442 In summary, agenda setting approaches the issue of how the media constructs the
443 higher importance and priority for certain issues compared to others for the public,
444 whereas framing can be classified into two definitions: (1) In psychology, framing
445 approaches the question of how the media guides the public to think about a certain
446 issue and, (2) in sociology, a frame is a tool and schema for individuals to construct
447 and interpret certain issues/ information/situations. The difference of framing choice
448 by individuals is like everyone having their own camera. Each person has his/her
449 unique preference of angles, composition, and framing to take a picture of the same
450 world. The definitions of agenda setting and framing based on the psychological
451 tradition will be used to explore the media representation toward Nano in Taiwan in
452 study 1 and 2. The definition of framing based on sociological rooted will be used to

453 investigate how public's selection of different frames affected their attitude toward
454 Nano in study 3.

455 **(6) Who and How -The Actors and their preferred use of frames in Taiwanese**
456 **Nano news**

457 With the accelerated rate of the development of interdisciplinary sciences like
458 Nano, more and more ethical, legal, moral, and political problems are raised (e.g.,
459 vaccines). However, as of yet no clear scientific answers to these problems exist
460 (Scheufele, 2014). Since Nano is a rapidly emerging interdisciplinary science (e.g.,
461 Nanomedicine), the public communication of Nano is political. (Scheufele, 2014).
462 Scheufele(2014) pointed out three different models to portray science communication
463 between scientists and the public: (1)Knowledge deficit model: intends to fill the
464 scientific knowledge gap between lay public and scientist, with the assumption that if
465 the public have "good" scientific literacy and knowledge, they will provide more
466 support for scientific research and development, (2) Public Engagement with Science
467 model: which focuses on engaging public voices in the scientific decisions that might
468 impact everyday life. The first model encourages the public to learn fundamental
469 scientific knowledge necessary for considering the works and research of science,
470 while the second model accelerates the process by which the public engages in
471 dialogues between scientists and, encourages the public to be more positive about
472 engaging with scientific issues related to everyday life, specifically not only scientific
473 facts. Both models fail to take into account the political effect on the progress of
474 science communication, however.

475 Thus, the third model: Science Communication as Political Communication
476 model: Which points out that mass and online media (and the potential actor: like

477 media sponsors or advertisers) preselected the information for our lay audiences to
478 learn about science and technology – instantly or not- which is based on their
479 preference, ideological stances, or benefit. (D. a. Scheufele, 2014)

480 Mass media provide a stage for different actors to perform their own characters,
481 intentions, and more importantly, their impact (M. Bauer et al., 1996). Thus, media
482 evaluation toward Nano, as a way of representation of media, presents the tones from
483 actors who have visibility in the media and also is sculpted by different story telling
484 styles in order to convey the actor’s intentions.

485 Molotch and Lester wrote: “What is ‘really happening’ is identical with what
486 people attend to” in news media which also points out the importance of mediated
487 reality ((Molotch, Lester, Molotch, & Lester, 1974; Scheufele, 2014) and how much
488 vital influence does the actors in the news have. In the meantime, since 1970's, many
489 empirical research of "agenda setting" have summarized the selection of news issue as
490 the process of the competition between different stakeholders such as interest groups,
491 nonprofits, (scientific) associations, policy makers, corporations, and many other
492 entities for a strategic effort but not only the professional function in the news rooms
493 (D. a. Scheufele, 2014;R. W. Cobb & Elder, 1971).

494 Following the research of Latour (1988), the different actors, in order to “extend
495 their library”, are using different ways to translate their intentions and beliefs in the
496 network to attract audiences for supporting their position. In this article, the author
497 tends to focus on the relationship among different actors and Nano, by using the
498 different preference of usage of frame from each actor in nano news as the
499 demonstration of how different actors “translate” Nano into their use for attracting an

500 audience's support. In other words, the different types of frames can be seen as
501 different ways to portray Nano for each actor's benefit.

502 In Taiwan, the research and development of Nano is mainly seeded and
503 supported by the government, a trend similar to the USA. As Scheufele (2014) claims,
504 science communication has become political communication in the modern era. When
505 investigating the scientific-social issues in public debate, we should not ignore the
506 influence of political context and beware the process of issue choosing in public
507 debate. The formation of attitudes toward particular issues is all impacted by the
508 political environment. In order to provide a more comprehensive view for further
509 investigating media evaluation toward Nano, the political context which can possibly
510 influence Taiwanese media evaluation toward Nano are taken into account. The
511 author raises the following questions: Whose voice can have been heard in public
512 Nano discourse? And how do the different actors use their preferred storyline to
513 describe Nano in public discourse?

514 The media exposure of actor indicates the influence of that actor's prescription
515 toward certain issues in public discourse (M. Bauer et al., 1996). In other words, the
516 more media exposure, the more possibility the voices and opinions from particular
517 actors can be heard by the public. In this study, the actors are defined as the
518 participants who play the main role in each the Nano news articles, which include the
519 organization (government, companies and schools) or individual persons (scientists
520 and researchers). Different actors' characters contribute to different influence in
521 public debate (M. Bauer et al., 1996; M. W. Bauer, 2002). Thus, by investigating who
522 has stronger power and impacts to participate in Taiwanese Nano news, this study can

523 begin to explore why the media evaluation toward Nano is overwhelming positive in
524 Taiwan.

525 In addition to knowing “who”, the author is also concerned with “how”. How
526 different actors use their preferred frames to sculpt and highlight the certain features
527 of Nano implies the related intentions and interests for the actors own self. Framing,
528 through the lens of media effect theory, has been demonstrated to influence the
529 formation of public attitudes and opinions (M. D. Cobb, 2005; Dudo, Choi, &
530 Scheufele, 2011).

531 (7) **The theories of Public Opinions**

532 Moy and Bosch (2013) pointed out the modern concepts of “mass media” and
533 “public opinions” need to be given the new definitions as times have changed. When
534 we want to understand how the public forms their opinions, investigating the theories
535 of public opinions that explore how media content is constructed and disseminated is
536 one of the necessary steps (Moy & Bosch, 2013). In this study, the research goal is to
537 investigate the media representation of Nano and also, under this media context, the
538 nature of public opinions toward Nano in Taiwan. Therefore, the definitions of what
539 are “public opinions” will be reviewed and clarified in this chapter from previous
540 research, in order to provide a landscape for this study.

541 According to Ziman's idea from his book *Real Science: What it Is, and What it*
542 *Means* (2002), the academic science environment has changed such that after the
543 transition from “Academic science” to “Post-Academic science”, the roles of
544 “scientists” and “public” in the process of developing science and technology have
545 also changed.

546 Previously, scientists didn't perceive the need to pay a lot of effort to
547 communicate with the public, and the most scientists concerned themselves with the
548 discovery of knowledge for its own sake. The role of the public was invisible in the
549 whole process of science and technology development.

550 We are, however, currently in the period of "Post-Academic science", especially
551 in democratic countries, where the public is the main taxpayer. This gives the public
552 the ability to use their opinions as leverage to impact their government's strategy
553 toward national science and technology development, which means the presentation
554 of science should be more varied and connected to the needs of the public, industries,
555 and the government. Scientists need to step out of their academic ivory towers and
556 pay more effort to attract the attention of industries and the public. Scientists need to
557 be more positive in their communications with the public and not only produce
558 knowledge, but also provide the problem solving for scientific society issues, and use
559 plain language and try to explain the connections between science and our daily lives
560 to the public, in order to seek the support and funding from the public (voters, state
561 and, foundations). In the other words, the public's attitudes, awareness, and opinions
562 toward science, especially emerging science like Nano, will impact the political
563 decisions for future funding and support for the development of this certain science
564 and technology.

565 Even in the current "post-academic science" period, a question remains: Will
566 science and technology serve only certain investors' needs and lose the objective and
567 comprehensive focus of science and technology?

568 Moy, Bosch, & and May (2013) pointed out the academic community's research
569 on public opinion is not completely objective. The researchers' hypotheses in the

570 public opinion area are colored by existing assumptions which come from their own
571 academic communities. Moy, Bosch, & and May (2013) especially noted some
572 examples in their studies of the effect of normative assumptions from previous
573 scholarship, like: “How to define public?”, “What level of literacy is ideal for the
574 public to participant in political discourse?”, “Whether the opinions formed by
575 emotions or based on information should be treat differently?” By going through
576 above questions before constructing research questions toward public opinions, we
577 can have more awareness to avoid the bias and established impressions from
578 normative assumptions (Moy et al., 2013).

579 In the meantime, through different writing styles (e.g., metaphors and rhetoric)
580 or the author’s un/conscious ideology (framing and agenda setting effects), scientific
581 facts can be elaborated upon differently and not mention that the nature of science is
582 essentially uncertain and varied. In order to figure out how to encourage public be
583 more positive and willing to participate the scientific discourse, one question that
584 should be investigated in today’s post-academic science period is: “What informs the
585 public in today’s scientific discourse?”.

586 With the rapid pace of development of science and technology and glut of
587 information overwhelming today’s society, modern citizens need to rely on some
588 people’s voice from the political specialization community to follow the political
589 issues related to science and technology (Miller, 1998). Miller (1998) pointed out that
590 participation of political discourse on certain issue is only one of many demands in
591 our daily life. When political issues are related to science and technology, the
592 requirement of background knowledge and familiarity for people to join the political
593 discourse will need to have more specialized literacy toward science and technology.

594 If the political issues are more closely related to innovational science and technology,
595 the need for specialization in certain field to join the related discourse will be even
596 higher. Thus, it seems a reasonable decision to invest limited time and resources to
597 become and remain informed by relying and following on some specialized people's
598 voices (Miller, 1998).

599 And then, the following problem will rise: when the political discourse
600 related to science and technology becomes more and more specialized, the public's
601 view toward those issues will be more and more narrow and unidirectional. The
602 impact of specialization of public discourse can be explained by using the stratified
603 pyramidal form (figure 1) proposed by Almond (1950), and further used to described
604 Model of Science and Technology Policy by Miller (1998).

605 The groups of Decision-Maker (constructed by government units, a mix of
606 executive, legislative, and judicial officers who have power to make politic decision
607 legitimately) and Policy Leader (nongovernmental, mostly form by elites in political
608 science) have high level of concurrence, and the members of the Policy Leader group
609 will flow into the Decision-Maker group from time to time, while the public is hardly
610 able to participate in the policy progress. When well-matched devised opinions show
611 between Decision-Maker and Policy-leader groups, the group of Attentive Public (i.e.,
612 Individuals who are interested in a particular policy areas and willing to become and
613 remain knowledgeable about the issue. In our case, is means the individuals who
614 interested in scientific and technology issues.) will be summoned by the Policy-
615 Leader group to join in the policy progress, who wish the pressure of public opinions
616 will impact the Decision-Maker group. So far, the scientific and technology policies
617 seem be dominated by a few specialization groups. However, Miller (1998) describe

618 the group ablest to avoid the overwhelming elite domination of scientific and
619 technology policies.

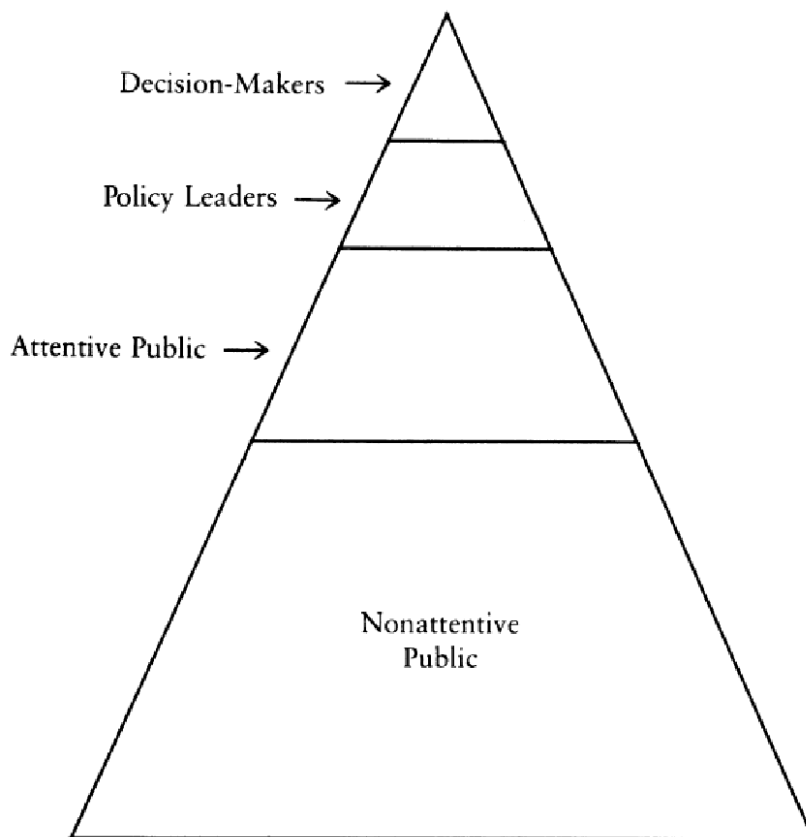
620 The bottom group of the stratified model of science and technology policy
621 formulation is Nonattentive Public group, which is a majority of the public.
622 Nonattentive public means those individuals which have little interest toward science
623 and technology policy. Miller (1998) especially pointed out the Nonattentive public
624 group doesn't mean those individuals possess low-scientific literacy, they can in fact
625 be very educated, and partake in manifold intellectual activities. They can also be
626 positive participators to other political issues who are just not as involved in the
627 public discourse on science and technology. And, since the Nonattentive group is a
628 majority of the public, this group is the most powerful group to influence the
629 Decision-Maker group. When they are sufficiently not satisfied with the policies
630 which are supported by the Decision-Makers, Policy-Leaders, and the Attentive
631 public, the power of Nonattentive Public can be exercised as a political veto. This
632 very power of the general population to intervene and veto political policies is a check
633 and balance of specialization and sustains the democratic nature of the policy
634 formulation process (Miller, 1998).

635 In the meantime, the agency of audience has become the important
636 consideration.

637 In a short summary, in today's "Post-Academic science" society, the
638 relationships between "scientists", "scientific policies decision maker and leader" and
639 "public" have become more and more entangled. The positive political wrangling
640 toward scientific and technology issues between public and specialization

641 communities (scientists and government) can help us to build a more nuanced
642 political discourse toward our scientific and technology-based policy decision. Thus,
643 raising the interests in and encourage the participation of the general population
644 toward scientific and technology issues has become a firewall to avoid unidirectional
645 and minority decision making by specialized communities. In this study, the author
646 will focus on the Attentive and Nonattentive public's views and attitudes toward
647 Nano, and hopes that, by exploring the overview of the Taiwanese public attitude
648 toward Nano and how the Taiwanese public attitude toward Nano is influenced by
649 framing effects and public confidence in news sources, to develop the base for
650 investigations in Taiwan for future research.

651



652

653 Figure 1. The Stratified Model of Science and Technology Policy Formulation (Miller 1998; Almond
654 1950)

655

656 **(8) The previous research of Taiwanese public's attitude toward Nano**

657 According to the research results of Shin (2013), Nano is not a foreign concept to
658 the Taiwanese public. Shin (2013) points out that, in general, almost 90% of the
659 Taiwanese public claims they have heard about Nano and they tend to present positive
660 attitudes toward Nano (7.41 on an 11-point scale). Comparing the survey results in the
661 US in the same period (Harris Interactive, 2012), only 38% of the American public
662 claims they have heard about Nano. In other words, Nano is more popular in Taiwan
663 than in the US (Shin, 2013).

664 Also, according to other results reported by Shin (2013), the Taiwanese public
665 report relatively low worries (average point is 5.78) and fears (5.49) about the risks
666 that come with the development of Nano, and don't think there are the moral concerns
667 when developing Nano (average point is 5.67). When discussing the most relative
668 benefit of developing Nano, the participants in this research approve of the
669 contributions of Nano toward "detection and treatment of the disease" and "solving
670 environmental pollution". In terms of the risk associated with developing Nano, the
671 Taiwanese public is most concerned that Nano may be applied in the manufacture of
672 micro-surveillance equipment, which will enable individuals to lose privacy. Another
673 worthy result in this research is that, compared to the US and the EU, the Taiwanese
674 public have a relatively lower perception toward the health risk which comes along
675 with developing Nano (Shin, 2013).

676 Shin (2013) claims the Taiwanese public having less health concerns of
677 developing Nano may be due to the fact that they are not familiar with the health
678 problems which are caused by Nano. In Taiwan, media is the main approach for the

679 public to gain scientific information but there are rarely relative scientific reports
680 about the risk of Nano in the media, so public will have less opportunities to obtain
681 the relative information. In the meantime, Nano is not a main target of consumers and
682 the environmental groups yet, which means it is not a controversial scientific issue in
683 Taiwan. All above situations may result in a scenario whereby the potential health
684 risks of Nano are being ignore by Taiwanese public (Shin, 2013).

685

686 **(9) The possible effect variable toward public's attitude toward Nano**

687 The author's previous study results show that the media's attitude toward Nano
688 in Taiwan is overwhelmingly positive (P.-L. Lin et al., 2012b). Since the mass media
689 has become the main source for the public to receive information on science and
690 technology (Scheufele & Lewenstein, 2005; Corley & Scheufele, 2010), and
691 individuals' use of cognitive processing strategies to deal with the scientific
692 information that they gathered from the mass media will be associated with their
693 acceptance of the new technology (Corley & Scheufele, 2010), it is worthy to
694 investigating what is the relationship among public's attitude toward nano, media
695 effect of nano representation in the media , and the individual's cognitive processing
696 strategies toward nano.

697 The framing effect of media has been seen as a shortcut for the public to process
698 new information in a short time, and can influence the public's risks and benefits
699 considerations (Scheufele, 2007). In the US,news reports most frequently use the
700 frame of "innovation" to represent Nano, followed by the use of the frame of ""future
701 technology", and "economic benefits", while the frames which mentions "out of
702 control of science and technology" and "ethics" are the less used(Lewenstein, Radin,

703 & Diels, 2007; Shin, 2010). By examining nine German print media from 2000 to
704 2008, Donk, Metag, Kohring, & Marcinkowski (2012) also show how the use of
705 media framing is specifically focused on the medical and economic benefits of Nano
706 and the lack of critical coverage opposing this one-sided perspective in the German
707 media. In terms of Taiwan, one content analysis points out that newspapers tend to
708 use the frame of “cross-era innovation” (more than 40% news articles), and the frame
709 of "interest" (about 25%)”, and like the trend of the US and Germany, the risk frames
710 are less frequently used to represent Nano in Taiwan media (Shin, 2012). The other
711 study focusing the media representation of Nano in Taiwan analyzed a total of 218
712 news articles from four major prints from 2011 to 2013 in Taiwan, and the results
713 show over half of news articles use the frame of “the convenience of science and
714 technology” to describe Nano and rarely mention the frames of “new scientific
715 finding” (15.8%) and “public understanding and engaging”(6.4%) (Zheng, Lin &
716 Shih, 2013). The authors’ previous study results also find the same pattern of media
717 representation of Nano, the frames which correlated to the business and national
718 interest are significantly used to highlight the benefit of Nano. As in the above
719 studies, the results show media tend to use the positive frames to depict Nano and the
720 coverage of benefits occurs far more frequently than that of risks. Since the framing is
721 the vital factor to influence the public’s attitude toward Nano, the investigation of
722 what is the frame which public tend to use to describe Nano is a worthy way to go.

723 When the public decides to accept a new emerging science or not, they will tend
724 to rely on a host of cognitive shortcuts (Shin, 2015). These shortcuts can include
725 religious belief, the deference to scientific authority, and the sense of trust (Shin,
726 2013). Many researchers highlight the religious belief of public as a likely heuristic
727 cue to effect public’s attitude’s formation toward Nano (Brossard et al. 2009; Ho et

728 al.2008; Nisbet 2005). Nano has been officially defined as part of the Nano-Bio-Info-
729 Cogno (NBIC) technologies giving prominence to the unity of nature at the nanoscale
730 by the FDA (Corley & Scheufele, 2010). Nano can manipulate matter on an atomic,
731 molecular and, supramolecular scale, which challenges the creations of God (Corley
732 & Scheufele, 2010). Given religious guidance in western society is hugely effected by
733 the Christian and Catholic faiths, it is predictable to find the public's opinions against
734 the development of Nano in the western society. However, in term of Taiwan,
735 Christianity is not a major religion, and the traditional Taiwanese religions like
736 Taoism and Buddhism do not emphasize the conflict of science and the creation of
737 Gods, so the effect of religious belief to public attitude toward Nano still needs more
738 investigation and the local cultural factor should be taken into account when
739 discussing the public's perception of Nano (Shin, 2013).

740 The Research Center for Promoting Civic Literacy in National Sun Yat-sen
741 University in Taiwan hosts a longitudinal survey project which aims to trace and
742 investigate Taiwan citizens' technological literacy, and gradually construct a long-
743 term basic data base. According to the survey results in 2012, of 1983 participants,
744 age from 13 -65, around 90% reported "the media" are the main approach to receive
745 the information related to science and technology (Huang, 2012). More than 70% of
746 participants thought "Science and technology have positive impact on well-being of
747 the general public" (Huang, 2012), and the percentage of this positive and supported
748 public attitude toward science and technology raise to more than 80 % in the survey
749 result in 2015 (Huang, 2015). Especially on emerging and transformative science and
750 technology subjects like: "Genetic Engineering Research" and "Nano Technology
751 Research", more than 50% of participants reported they believe the development of
752 these kind of science and technology do "more good than harm" for humans. In

753 general, the Taiwan public holds a promising attitude toward the development of
754 emerging science and technology. However, in terms of the public attitudes toward
755 the daily life products which applied emerging science and technology, Taiwan's
756 public tends to have a different attitude. On the one hand, Shih's research (2013)
757 pointed out the "rush" and "seeking" of new things in the market is a local cultural
758 feature in Taiwan, like the popular selling of Binchō-tan products, which used a
759 traditional Japanese charcoal, and can be used to reduce moisture and dilute fumes,
760 and the popularity of Nano products in the market. Shin's (2013) research points out
761 the feature of Taiwan consumers to "rush" and "seek" the application products of
762 emerging science to the market is driven by the reverence of science and the positive
763 media attitude toward certain emerging science (Scheufele & Lewenstein, 2005; Shin,
764 2013). On the other hand, even the Taiwanese public has a positive and supportive
765 attitude toward "Biotech" and "Genetic Engineering"(Huang, 2012) itself, but most of
766 Taiwan's public had a very negative attitude toward Genetically modified food and
767 its related environmental influence(Chen & Hsieh, 2011; Fu et al. 2013).

768 Since the public supportive of developing of Nano itself is high and Nano
769 products have own a high market share in daily life products market. The inconsistent
770 public attitude toward emerging science and technology between science and
771 technology itself and applicant products based on the case of biotech in Taiwan, raise
772 author's curious and tend to further investigate that: Is Taiwanese public attitude
773 toward Nano has the same pattern of biotech in Taiwan?

774 The World Value Survey study has pointed out the Taiwanese public's degree of
775 worship toward science is much higher than in many Western countries (Shin, 2013).
776 Under this high reverence of science circumstance and not like western societies

777 which are under the impact of religion and precautionary principles, the Taiwanese
778 public tends to accept the development of emerging science more easily (Shin, 2013).
779 It raises the question: following the author's previous findings that the media attitude
780 toward Nano is overwhelming positive, and given that the media has become the main
781 approach for the public to obtain related information toward new science and
782 technology (Corley, 2010), does Taiwanese public really tend to place trust on media
783 perception and further form their attitude and perception toward certain emerging
784 science?

785 That the degree of public trust toward scientists and government will affect their
786 attitude toward certain science has been widely discussed by researchers (Irwin &
787 Wynne, 1996; Brossard & Nisbet, 2007; Lin, 2010). Irwin and Wynne (2007) point
788 out that the public is more concerned about if the actors who are presenting the
789 scientific issue are reliable, than the scientific aspects of an issue itself. The research
790 in Taiwan also shows that the public who trust the ability of government to regulate
791 the development of Nano also tend to see the benefit of Nano development and have
792 lower risk perception toward Nano (Lin, 2010). Since the media play a vital role for
793 the public to receive the related information toward emerging science, and the
794 representation of Nano in Taiwanese media is biased and overwhelmingly positive, it
795 is worthy to investigate if the public's degree of trust of the media impacts their
796 attitude toward Nano. In order to further investigating the impact of public's trust
797 degree of media toward their Nano attitude, this study takes the participant's trust
798 toward media as an important independent factor.

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804 **3. Research Plan**

805 In order to provide a comprehensive and clear investigation of media
806 representation and public attitude toward Nano in Taiwan, this study is divided into
807 three sub-studies:

808 **(1) Study 1:**

809 Study 1 is an exploration of Taiwanese media attitudes and agenda setting and
810 framing effects toward Nano by using news articles from The United Daily News data
811 base from 2002 to 2009. In order to present the unique angles and contexts from
812 Taiwan media toward Nano, instead of using instruments which are based on western
813 media contexts (like US and EU), a new coding instrument which is located on
814 Taiwanese media was developed by the author and her supervisors. By using this
815 Taiwanese Nano media effects instrument, the development and variety of Taiwanese
816 media attitudes and attention toward Nano will be investigated. The goal of study 1 is
817 to investigate the development and variety of media attitudes and attentions toward
818 Nano news in contemporary Taiwan. Cohen's statement (1963) that "The press may
819 not be successful much of the time in telling people what to think, but it is stunningly
820 successful in telling its readers what to think about," accurately describes the push of
821 this study. As Fig. 2 illustrates, the research motivations are investigating agenda
822 setting activities (what topics in the Nano news were chosen as important issues?),
823 and then investigating the framing effects on Nano news (how Taiwanese media

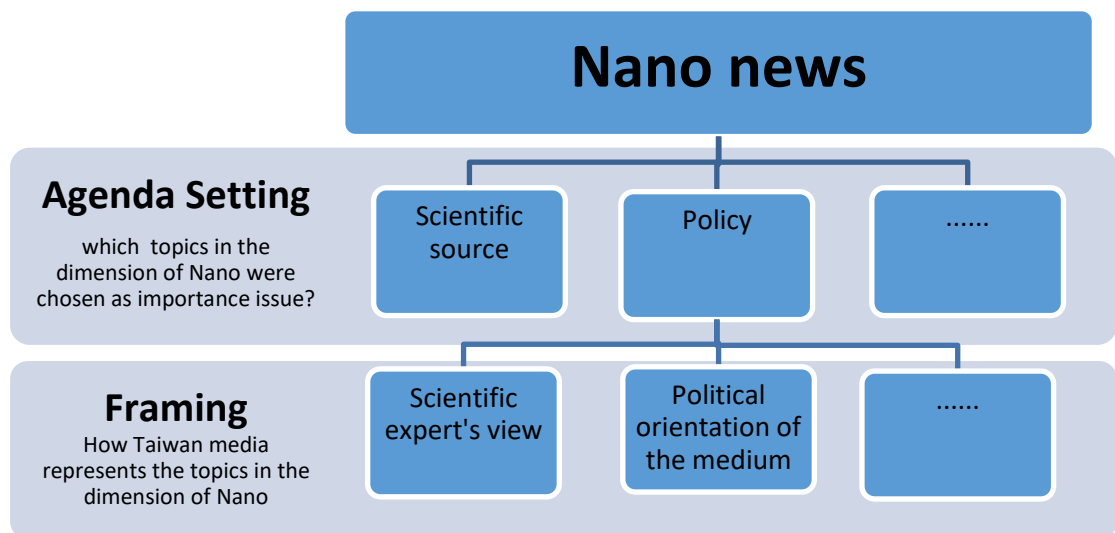
824 represents the topics in different frames?), and since the media plays an important role
825 in public understanding of new science and technology (Dudo, Dunwoody, et al.,
826 2011), it is vital to investigate media attitude toward Nano.

827 Nano is presently a focus for scientific development as well as an underlining
828 concern for economic growth in Taiwan (Y.-P. Lin, Wu, et al., 2010; H.-N. Su & Lee,
829 2008). Thus, in the first stage, the effect of agenda setting is approached to provide an
830 explanation of why Nano is chosen as a concerning scientific issue by Taiwanese
831 media compared to others. The further question I would like to ask is: what are the
832 salient, important topics chosen by media in Nano news? In other words, which topics
833 in Nano news are deemed important and salient by the Taiwanese media?

834 Furthermore, according to Scheufele's (1999) typology, study 1 is located in
835 "media frames as dependent variable" and intends to investigate how the frame of
836 Nano news is built in the process model of framing. In response to Scheufele (1999)'s
837 suggestion mentioned above, with respect to media frames as dependent variable, the
838 researchers should ask: (a) what factors influence the way journalists or other societal
839 groups frame certain issues? (b): How do these processes work and, as a result, what
840 are the frames that journalists use? I propose to use the theory of framing to
841 investigate how the framing has been built under different agenda setting topics of
842 Nano news, and as a result, what are the frames that media use. In other words, what
843 kind of frame would be chosen by the Taiwan media to represent the topics in the
844 dimension of Nano?

845 In short, the research goals of study 1 are investigating the media representation
846 of Nano in Taiwan and the relationship among different nano emphasis themes,
847 frames usage and media attitude in the Taiwan. Thus, in order to achieve the above

848 goals, the following research questions will be asked and answered, Furthermore, I
 849 will provide an inference of what factors may influence the way media frames the
 850 news of Nano. (a.) What are the salient Nano themes and frames in Taiwanese media?
 851 (b.) What is the relationship between the usages of Nano frames and themes? How are
 852 the Nano themes and frames used separately or in combinations within the same
 853 article? (c.) What is the relationship among media attitude, Nano themes, and Nano
 854 frames usage?



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 856

857 Figure 2. The organization chart of Nano news for study 1 and 2

858

859 **(2) Study 2:**

860 According to the results of study 1, in total 1739 news articles related to Nano
 861 from four different newspapers, included Economic Daily News, United Daily News,
 862 United Evening News and Min-Sheng Dailin, the proportion of the news articles
 863 which with positive attitude toward Nano is 89%. The result indicated the general
 864 trend of media evaluation toward Nano in Taiwanese media is overwhelmingly

865 positive. In other words, the multivariate debates and discussions do not exist in
866 Taiwanese media. Considering above circumstances, the following question arise:
867 Why the media attitude toward Nano are so unitarily positive in Taiwanese media?
868 Thus, study 2 is trying to find out who are the most visible actors of Nano in the
869 Taiwanese media discourse and how the relationship among main actors, framing
870 effect and media attitude toward Nano? The research question of study 2 are (1) who
871 are the most visible actors of Nano in the Taiwanese media discourse? Whose
872 particular voice toward Nano can be heard in Taiwanese public debate? (2) From
873 2002 to 2009, do main actors in Taiwanese Nano news have different variety? (3) Do
874 different actors associate with particular frame using toward Nano in Taiwan? (4)
875 How Taiwanese media evaluation be affected by different actors and Nano frames
876 usage?

877 **(3) Study 3:**

878 After the results of study 1 and 2, the culture contexts and characters of
879 Taiwanese media toward Nano has been presented. Thus, the goal of study 3 is
880 exploring the overview of the Taiwanese public attitude toward Nano and how the
881 Taiwanese public attitude toward Nano is influenced by framing effects and public
882 confidence in new source by using the data from “The Risk Perceptions about Nano
883 and policy research, which is fund by Environmental Protection Administration,
884 Taiwan”. Finally, the comparing discussion of media attitude and public attitude
885 toward Nano in Taiwan can be provided in the end and in the hope to contribute to
886 future related Nano policies established for government and the related Nano
887 scientific social issue’s discourse between government, scientists, and laypeople.
888 Thus, the research question of study 3 are (a) What is the overview of the Taiwanese
889 public’s attitude, knowledge and awareness toward Nano? (b) Will the Taiwanese

890 public hold a specific frame to consider Nano, or be affected by certain frames to
891 acknowledge and identify Nano, based on their demographic characters? (c) How is
892 the public attitude toward Nano influenced by the different five framing effect
893 (science, commercial prospect, national interest, communication and risk frame) and
894 the degree of the public confidence in news source?

895 **4. Data**

896 **(1) The Data of Study 1 and 2**

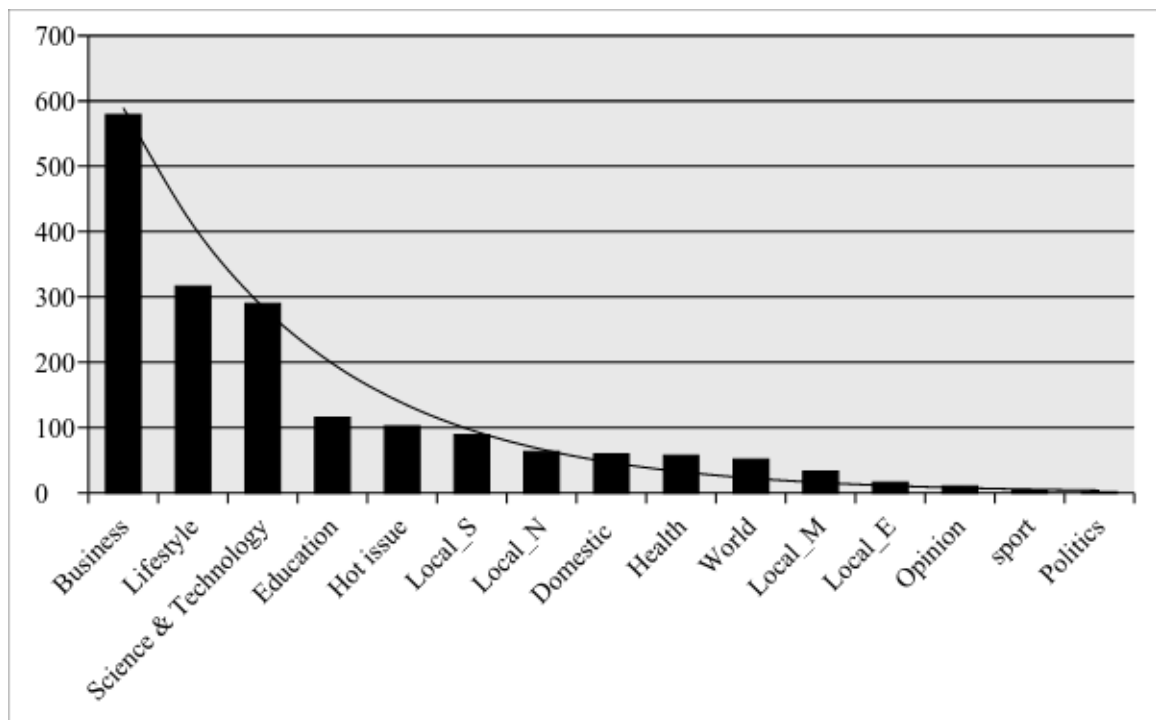
897 Selection of News Articles

898 In study 1 and 2, the author use computer analysis (Tseng, 2010), to identify the
899 article (or the sentence) included the multiple key terms or employ the main key
900 terms: “Nano,” and to extract these reports from approximately two million news
901 reports from United Daily News data (2002 to 2009).

902 The United Daily News data base included four papers: (1) Economic Daily
903 News, which emphasizes local, world economic and financial news. (2) United Daily
904 News, one of three biggest newspaper in Taiwan, with a large readership (3) United
905 Evening News (4) Min-Sheng Daily, which focuses on entertainment, sports, outdoor
906 life, home and consumer news. All four newspapers belong to the United Daily news
907 group. Using “Nano” as a key word, 1739 news articles are collected for my future
908 analysis.

909 The first step is looking through the news sections of whole Nano news articles,
910 and fifteen different news sections are found in the four newspapers. The results are
911 presented in figure 3. The first four sections are Business, Lifestyle, Science &

912 Technology and Education. Accordingly, these four topics will be considered as
913 important categories in the coding instrument.



914

915 Figure 3. The number of Nano news article in different news sections.

916

917 The Developing of Coding Instrument

918 Based on the coding instruments, which were developed and used by Carver,
919 Waldahl and Breivik (2008) and Gaskell, G and Bauer, M. W et al.(2001) and the
920 research results of Nisbet, Brossard, and Kroepsch (2003), which investigate the
921 media attention, media framing, and media sourcing across stages of scientific,
922 political, and policy development toward stem cell controversy in media
923 presentations, the author developed the first version of coding instrument and
924 modified it for my research needs.

925 The first step for developing the coding instrument was sampling news articles.
926 Following the rule of systematic sampling, the data from United Daily News data base

927 was downloaded on March, 2012. The news articles were then sorted by time. Each
928 article was marked with a respective identified number. In order to keep the feature of
929 news article across time period from 2002 to 2008, the news articles are order by day.
930 I took 10% of the news articles from raw news database as a sample. Every ten news
931 articles, one would be chosen as sample. In total, 173 articles were chosen. Of those,
932 173 sample news articles were used to investigate and identify the main terms and
933 concepts relating to Nano by which establish the coding instrument for my further
934 analysis by which establish the coding instrument for my further analysis.

935 A classic content analysis is used to illustrate descriptive and thematic
936 characteristics of media coverage of Nano. The classic content analysis is based on
937 human coder to read and hand-code the texts by pre-defined coding rule (Benoit,
938 2011). By dividing original text into more specific content categories, the classic
939 content analysis provides the systematic, replicable inference and comparison from
940 data to its context to investigate media coverage over time (Krippendorff, 1980;
941 Nisbet et al., 2003; Stemler, 2001).

942 After the first round of inspecting the sample news articles, seventy-four terms
943 and concepts were identified as the emphasis terms and concepts relating to Nano in
944 the news, and were divided into six categories by author: (1) The actors, like
945 government and private organizations: Industrial Technology Research Institute, Hon
946 Hai company, National Taiwan University, China...etc (2) The scientific terminology
947 and applications with regard to Nano: Nano Ceramic, Microfabrication Technology
948 and Nano Photo catalyst...etc (3) The nano commercial products: nano home
949 appliances, nano masks, nano mattress, the beauty products...etc (4) Public and
950 Formal education: new Nano curriculum and academic degree established and Nano

951 workshop and conference are holding for academia and public.(5) The social events:
952 Severe acute respiratory syndrome (SARS) outbreak in Taiwan, National Program of
953 Nano (NPNT) was approved in the 157th meeting of National Science Council
954 (NSC), for a period of 6 years by government...etc. (6) The Policy: Industry and
955 research institutes (or schools) Cooperation for the developing of Nano and the
956 development of Nano can enhance national competitiveness...etc. Those terms and
957 concepts of classification allowed deduction of more clear and specific concepts, and
958 can be used as references for further developing of the items and categories in coding
959 instrument.

960 In order to investigate the agenda setting effect in the nano news, the themes of
961 each Nano new article should be identified in regard to the feature of news headline
962 and content. According to the exposure of each theme in Nano news, the pattern of
963 dominant and salient topics in Nano news can be shown. Thus, the “Theme” item in
964 the draft of coding instrument is revised. Following the results of the preliminary
965 inspection, the “Theme” items fall into five categorical sets: (1) Scientific Source:
966 Scientific background and New research, (2) Policy: Political promotion strategy and
967 Policy regulatory, (3) Nano product, (4) Communication: Public education and
968 Formal education and (5) Social event: Severe acute respiratory syndrome (SARS),
969 National Program of Nano (NPNT) and Science park established. As the table 1
970 shows, the identified themes in data are divided into five categories, and each
971 category is further divided into several sub-categories. Since most articles include
972 several, different themes, maximum of three themes per news article.

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978 Table 1. The item of “Themes” in the coding instrument.

Themes		Code
1. Scientific Source	Scientific background	
	Medical	1
	Chemistry	2
	Physic	3
	Biology	4
	Engineering/Optoelectronics	5
	Environmental	6.1
	New research	
	Medical	7
	Chemistry	8
	Physic	9
	Biology	10
	Engineering/Optoelectronics	11
	Environmental	12.1
2. Policy	Political promotion strategy	
	Future scientific and technology development	13
	New research center build	14
	Transformation of traditional industries	15
	Industry and research institutes (or schools) Cooperation	16
	Enhancing national competitiveness	17
	Policy regulatory	
	Nano Mark identification	18
	Risk	
	The concern or/and potential damage of Nano	19.1
3.Nano product	Finance	20
	Industry device	21.1
	Computer device	21.2
	Beauty	22
	Home appliances	23
	Nano textile (bedding/clothing...)	24
	Ceramics/ clay	25.1
	Rubber	25.2
	Slate	25.3
	Health products	26.1
	Tableware	26.2
	Food	26.3
	Paint	26.4
	4. Education	4.1 Public education
4.2 Formal education		28
5. Social Events	5.1 Severe acute respiratory syndrome (SARS)	29
	5.2 National Program of Nano (NPNT)	30
	5.3 Science park established	31

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981 Meanwhile, the “Frame” items were developed for capturing the different frames
 982 in Nano news. In light of the scope of National Program of Nano (NPNT) in Taiwan,
 983 which includes the “Academia Excellence Project”, the “Nano Industrialization
 984 Project”, the “Establish & Share Core Facilities Project” and the “Human Resource
 985 Development Program” (National Program on Nano Technology, 2002), and the
 986 seventy-four salient terms and concepts from my preliminary inspection, five different
 987 frame styles are defined as table 2: (1)Science frame (2) Commercial prospect frame
 988 (3) Communication frame (4) National interest frame and (5) Risk frame. In this
 989 section, I have focused on the role and the description of Nano in the news. In order to
 990 look for patterns in how the frames were used separately or in combinations within
 991 the same article, each news article will be tagged with a maximum three codes.

992 Table 2.The item of “Frame” in the coding instrument.

Frame	Description	Code
Science frame	Nano as a discrete scientific concept.	1
Commercial prospect frame	Promotes business and personal daily life interest(Industrial device, beauty Cosmetic and living goods)	2
Communication frame	Nano are describe as an educational subject or public science communication issue which is need to communicate the related information to students or public (a)Academic : The programs and degrees toward Nano established and the workshops and conferences held , new nano curriculum in K-12. (b) Science communication toward public: workshops, museum habitations, science	3
National interest frame	The agent for enhancing national interest and competitiveness: government policy support and funding investment, the importance of Nano for national economic growth and science and technology development, comparison of national competitiveness between Taiwan and other countries (China, Japan and Korea...)	4
Risk frame	The concern related to development of Nano: risk, regulation	5

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995 Following the research goals, the media attitude in the Taiwanese Nano news is
996 of concern. Thus, in order to provide quantifiable results of media attitudes, a series of
997 items called Valuation of Nano (from 0 to 10) were developed. In table 3, the
998 “Valuation of Nano” is identified as the media attitude toward Nano. According to the
999 prominence of the advantages or disadvantages, if the news content mentions the
1000 promotion /benefits or concerns/damages of Nano in regard to the national interest or
1001 the influence over the public, the news will be coded as a “extremely positive or
1002 negative”. Also, the frequency of the positive or negative effect of Nano in each news
1003 article will be considered as an index. If a news article includes one of the advantages
1004 or disadvantages, it will be coded as slightly positive/ critical; those including two
1005 will be coded as somewhat positive/ critical and so on. If a news article is not directly
1006 related to Nano, it will be coded as “none related” (coded as 0).

1007 The draft of the coding instrument was revised by using UK news articles from
1008 the Guardian as samples; the draft of the coding instrument was used to code the
1009 articles item by item. The coding rule, the lack of coding items or ambiguous
1010 descriptions in the coding instrument was discussed and revised until results and
1011 opinions are consistent. After the discussion, the final coding instrument was applied
1012 to code one hundred Taiwanese Nano news articles by the author, in order to make
1013 sure the applicability of the coding instrument and revised again according to the
1014 features of Taiwanese Nano news articles. All 1739 news articles were coded by
1015 following the coding instrument.

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1019 Table 3.The item of “Valuation of Nano” in the coding instrument.

Valuation of Nano	Code
Not applicable	0
Extremely critical: discourse of great concern, of doom	1
Very critical	2
Quite critical	3
Somewhat critical	4
Slightly critical, some discourse of concern	5
Slightly positive; discourse of promise	6
Somewhat positive	7
Quite positive	8
Very positive	9
Extremely positive; discourse of great promise, of Progress	10

1020

1021 **(2) The Data of study 3**

1022 The data of study 3 were collected based on the 2013 project “The Risk
1023 Perceptions about Nano and Policy Research”, which is funded by Environmental
1024 Protection Administration, Taiwan.

1025 The data sample as collected in 2013, including a total of 1,077 telephone
1026 survey interviews (participants’ age are all older than 18 years old). A total of 45
1027 items in the original questionnaire and included seven categories:(1) The situation of
1028 public access scientific information in the media; (2) scientific values and attitude (3)
1029 the public attitude toward the development of Nano; (4) public's interests and risk
1030 perception toward Nano; (5) nano-knowledge; (6) public's attitude toward nano
1031 regulation / control; (7) the degree of confidence in Nano news sources.

1032

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1035 **5. Study 1- Taiwanese media attitude and agenda setting and**
1036 **framing effects toward Nano.**

1037

1038 **(1) Methodology**

1039 To answer Research Question 1, descriptive statistic was utilized to investigate
1040 what the salient Nano themes and frames in Taiwanese media during the years under
1041 study.

1042 In order to investigate whether the different frame's usage is different among the
1043 news articles in different themes and how the Nano themes and frames are used
1044 separately or in combinations within the news, Chi-square tests and correspondence
1045 analysis were used for Research Question 2.

1046 For valuing the different contributions of the main theme/ frame, secondary
1047 theme/frame and tertiary theme /frame, the news articles were separated as parts and
1048 weighted. In order to cluster the news articles by news, the Complex Samples General
1049 Linear Model was used to answer Research Question 3: What is the relationship
1050 among media attitude, Nano themes and Nano frames usage. SPSS 16.0 was utilized
1051 for all above analyses

1052 **Data weighted**

1053 Following the analysis strategy of Carver, Rodland and Breivik (2012), the
1054 assumption is the dominant frame will provide more considerable influence over
1055 audiences than the secondary and tertiary frame. Thus, each frame will be weighted
1056 based on their salience in news. If only one frame is used in a news article, this frame

1057 will be weighted by 1. If two frame are used in a news, the main frame will be
1058 weighted by $\frac{2}{3}$ (approximately 0.67) and the secondary by $\frac{1}{3}$ (approximately 0.33).
1059 If a news article includes three frames, the main frame will be weighted by $\frac{4}{7}$
1060 (approximately 0.57), the secondary by $\frac{2}{7}$ (approximately 0.29) and thirdly by $\frac{1}{7}$
1061 (approximately 0.14) (R. B. Carver et al., 2012). Thus, each theme/frame will
1062 be weighted based on their salience in news.

1063 Since an article can include 9 codes (3 themes and 3 frames) at most, the
1064 combination of theme and frame are 9 styles at most. In order to calculate the usage of
1065 theme and frame, each article can be seen as 9 parts and each part will be weighted by
1066 the combination weight which is contributed both by the frame and theme.

1067 For example, if an article is coded as theme 1(main), theme 2(2nd), theme 3(3th)
1068 and frame 1(main), frame 2 (2nd), frame 3 (3th), the usage of frame and theme in this
1069 article can be seen as Table4. According to the Table 4, A part will be weighted by
1070 $\frac{16}{49}$, B part by $\frac{8}{49}$, C part by $\frac{4}{49}$, D part by $\frac{8}{49}$, E part by $\frac{4}{49}$, F part by $\frac{2}{49}$,
1071 G part by $\frac{4}{49}$, H part by $\frac{2}{49}$ and I part by $\frac{1}{49}$.

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1080 Table 4. The example of data weighted.

Example	Part	Frame(F) and Theme(T)	Style	Weight
One article coded by three themes code and three frame code	A	T1 with F1	Main theme with Main frame	$4/7 * 4/7 = 16/49$
	B	T1 with F2	Main theme with 2 nd frame	$4/7 * 2/7 = 8/49$
	C	T1 with F3	Main theme with 3th frame	$4/7 * 1/7 = 4/49$
	D	T2 with F1	2 nd theme with Main frame	$2/7 * 4/7 = 8/49$
	E	T2 with F2	2 nd theme with 2 nd frame	$2/7 * 2/7 = 4/49$
	F	T2 with F3	2 nd theme with 3th frame	$2/7 * 1/7 = 2/49$
	G	T3 with F1	3th theme with Main frame	$1/7 * 4/7 = 4/49$
	I	T3 with F2	3th theme with 2 nd frame	$1/7 * 2/7 = 2/49$
	J	T3 with F3	3th theme with 3th frame	$1/7 * 1/7 = 1/49$
Total				1

1081

1082 **(2) Result**

1083 **Descriptive statistic**

1084 Table 5. The description of news articles in Taiwanese media from 2002 to 2009

Year	N	Percent	Cumulative Percent	Mean of media attitude	SD
2002	298.00	17.10	17.10	9.15	1.91
2003	426.00	24.50	41.60	9.01	1.71
2004	304.00	17.50	59.10	8.95	1.87
2005	225.00	12.90	72.10	8.95	1.80
2006	175.00	10.10	82.10	8.74	1.72
2007	113.00	6.50	88.60	9.04	1.63
2008	103.00	5.90	94.50	8.94	1.80
2009	95.00	5.50	100.00	8.60	1.88
Total	1739.00	100.00		8.96	1.80

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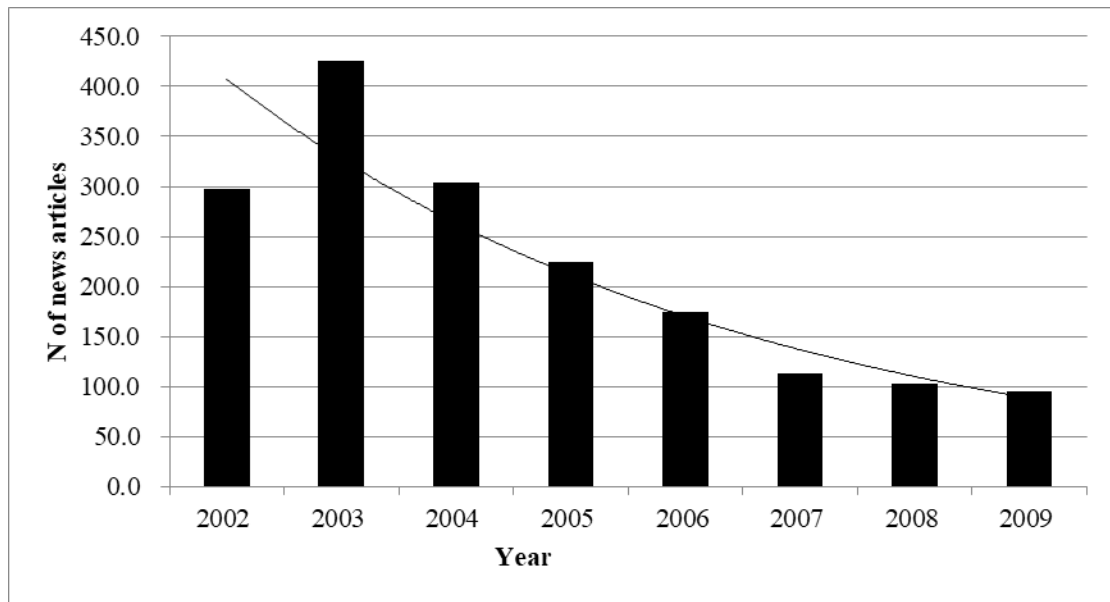


Figure 4. The coverage intensity of Nano news from 2002 to 2009

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Table 6. The description of Nano themes in Taiwanese media.

Theme	N	Percent	Cumulative Percent	Mean of media attitude	SD
Scientific Source	109	6.3	6.3	9.74	1.62
Policy	555	31.9	38.2	8.94	1.99
Nano product	766	44.0	82.2	9.10	1.59
Education	244	14.0	96.3	8.13	1.77
Social Event	65	3.7	100.0	9.38	1.72
Total	1739	100.0		8.96	1.80

1090

Table 7. The description of Nano frames in Taiwanese media.

Frame	N	Percent	Cumulative Percent	Mean of media attitude	SD
Science	380	21.8	21.8	8.86	1.85
Commercial prospect	932	53.6	75.4	9.05	1.63
Communication	133	7.6	83.0	8.05	1.64
National interest	247	14.2	97.2	9.62	1.76
Risk	45	2.6	99.8	7.30	2.83
None	3	.2	100.0	6.00	0.00
Total	1739	100.0		8.96	1.80

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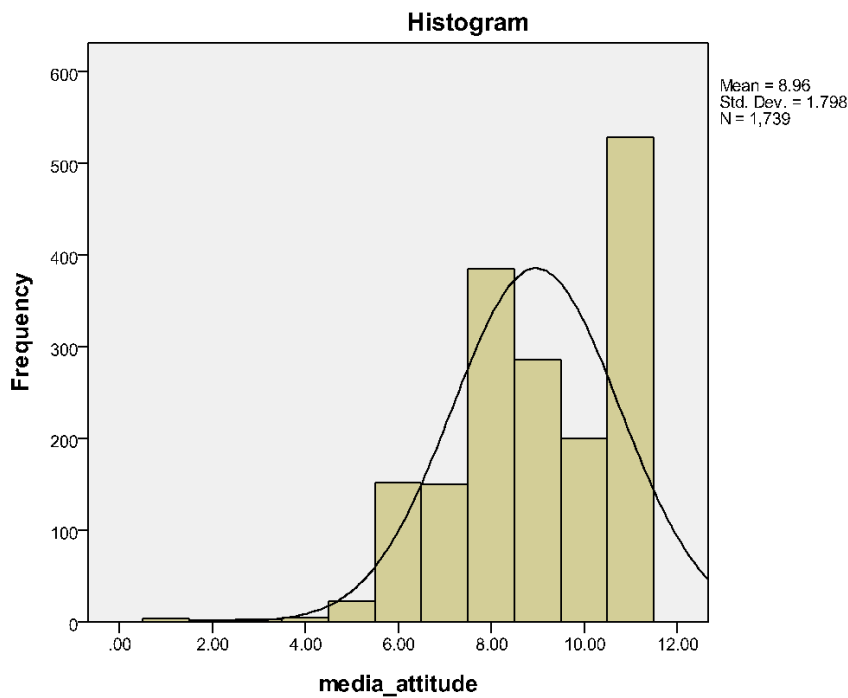
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Table 8. The description of media attitude toward Nano in Taiwanese media.

Media Attitude		Code	N	Percent	Cumulative Percent
Negative	Extremely critical: discourse of great concern, of doom	1	4	0.2	0.2
	Very critical	2	2	0.1	0.3
	Quite critical	3	3	0.2	0.5
	Somewhat critical	4	5	0.3	0.8
	Slightly critical, some discourse of concern	5	23	1.3	2.1
Neutral		6	152	8.7	10.9
Positive	Slightly positive; discourse of promise	7	150	8.6	19.5
	Somewhat positive	8	385	22.1	41.6
	Quite positive	9	286	16.4	58.1
	Very positive	10	200	11.5	69.6
	Extremely positive; discourse of great promise, of Progress	11	529	30.4	100.0
Total			1739	100.0	



Cases weighted by Weight

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Figure 5. The description of media attitude toward Nano in Taiwanese media from 2002 to 2009.

1103 The coverage intensity of Nano news from 2002 to 2009 is shown in the Table 5
1104 and figure 4. In 2003(24.5%), the number of news articles in regard to Nano was the
1105 highest, and decreased year by year since then.

1106 Table 6 indicates the most exposed Nano themes in Taiwanese media were Nano
1107 product (44%), followed by Policy themes (31.9%), and Education themes (14%). In
1108 terms of framing (Table 7), Commercial frame was most popular, which was applied
1109 in more than half of news articles (53%), followed by Science frame (21.8%), and
1110 National interest frame (14.2%).

1111 According to Table 8 and Fig. 5, in addition to the effect of no use of framing,
1112 the media attitudes in different themes or in different frames were positive. The
1113 proportion of the news articles which were positive in attitude toward Nano was 89%,
1114 with negative attitude representing only 1.3% of total news articles (Table 8). The
1115 result indicated the general trend of attitudes toward Nano in Taiwanese media were
1116 overwhelmingly positive.

1117 **Chi-square test and correspondence analysis**

1118 According to Table 9, the different frames' usage was statistically significantly
1119 different among news articles in different themes($X^2= 828.260$, $df=20$,
1120 $p=0.000<0.05$). In order to investigate the association in the Table, the value of
1121 adjusted residual (ar) is used to test whether the observed value is greater or smaller
1122 than the expected value. With a statistical significance level of .05, if the adjusted
1123 residual is more than 1.96 then the number of cases in that cell is significantly larger,
1124 if the adjusted residual is less than -1.96 then the number of cases in that cell is
1125 significantly smaller than would be expected in a population where no relationship
1126 exists.

1127 As seen in Table 9, the usage of Science frames were significantly higher in the
1128 news articles in Scientific Source ($ar=8.8>1.96$), Policy ($ar=2.28.8>1.96$), and
1129 Education Themes ($ar=5.1>1.96$), but significantly lower in Nano product theme ($ar=-$
1130 $9.9<-1.96$). The Commercial prospect frame has most exposure in the news articles
1131 ($ar=20.3>1.96$) in Nano product theme but less exposure in Scientific Source ($ar=-$
1132 $3.7<-1.96$), Policy ($ar=-10.4<-1.96$) and Education themes ($ar=-12.2<-1.96$). In
1133 Figure 5, the plot shows that, compared to each frame, the Nano product themes are
1134 most associated with Commercial prospect frame but especially not associated with
1135 Science, Communication, and Risk frame.

1136 Affected by the promotion of National Program of Nano (NPNT),
1137 unsurprisingly, the National interest frame is used most in the Policy and Social Event
1138 themes, but uses less in Scientific Source, Commercial prospect and Education
1139 themes which are not the main focus categories in NPNT.

1140 The usage of the Communication frame is only statistically higher in the news
1141 articles in the Education theme, but lower in the Scientific Source, Policy and Nano
1142 product themes. In contrast, the Risk frame has significantly higher exposure only in
1143 Policy themes, because one of the main policies of NPNT is Nano Mark identification
1144 which tends to regulate “fake” Nano products. However Risk frame is not emphasized
1145 in Nano product and Education themes. In figure 5, the plot also points out that the
1146 Risk frames were weakly associated with scientific source, Nano product and
1147 Education themes.

1148

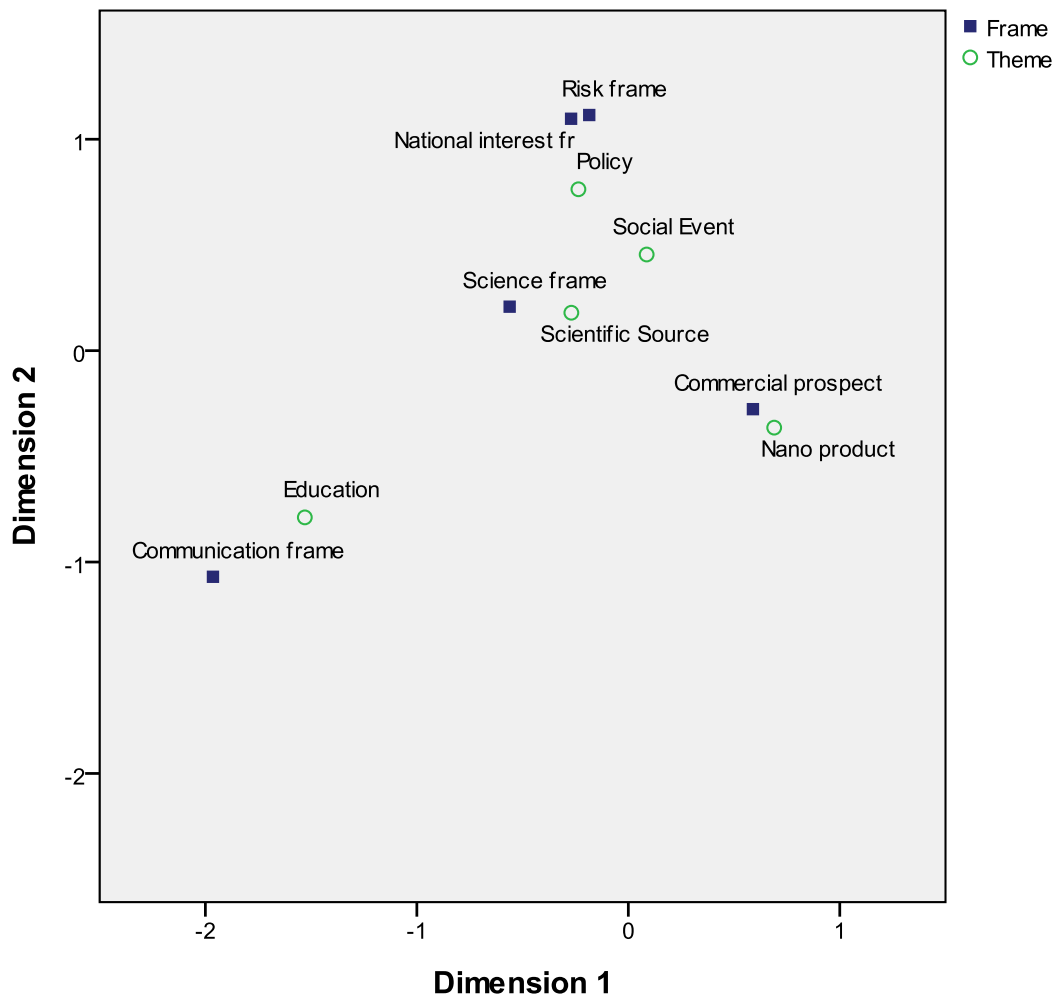
1149

1150 Table 9. The chi-square test of frame's usage between different themes. (ar=adjusted residual)

Frame		Theme					Total
		Scientific Source	Policy	Nano product	Education	Social Event	
Science frame	Count	60.367	139.159	82.463	84.098	13.819	379.905
	% within Frame	15.9%	36.6%	21.7%	22.1%	3.6%	100.0%
	ar	8.8	2.2	-9.9	5.1	-.1	
Commercial prospect frame	Count	39.649	196.302	620.322	42.850	32.449	931.571
	% within Frame	4.3%	21.1%	66.6%	4.6%	3.5%	100.0%
	ar	-3.7	-10.4	20.3	-12.2	-.6	
Communication frame	Count	2.188	32.181	4.125	92.288	1.932	132.714
	% within Frame	1.6%	24.2%	3.1%	69.5%	1.5%	100.0%
	ar	-2.3	-2.0	-9.9	19.1	-1.4	
National interest frame	Count	4.984	156.220	47.932	22.050	15.719	246.905
	% within Frame	2.0%	63.3%	19.4%	8.9%	6.4%	100.0%
	ar	-3.0	11.4	-8.4	-2.5	2.4	
Risk frame	Count	1.764	29.234	10.159	2.857	.891	44.905
	% within Frame	3.9%	65.1%	22.6%	6.4%	2.0%	100.0%
	ar	-.7	4.8	-2.9	-1.5	-.6	
	Count	1.764	29.234	10.159	2.857	.891	44.905
None	Count	.000	2.000	1.000	.000	.000	3.000
	% within Frame	.0%	66.7%	33.3%	.0%	.0%	100.0%
	ar	-.4	1.3	-.4	-.7	-.3	
Total	Count	108.952	555.095	766.000	244.143	64.810	1739.000
	% within Frame	6.3%	31.9%	44.0%	14.0%	3.7%	100.0%

1151 $X^2 = 826.371$, $df = 20$, $p = 0.000 < 0.05$

1152



1153 Figure 6. Correspondence analysis of frames and themes.

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Dimension	Eigenvalue	% Inertia	% Cumulative
-----------	------------	-----------	--------------

1	.561	66.3	66.3
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2	.341	24.5	90.8
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1160 **General Linear Model for complex sample**

1161 Considering that secular trends over time and newspaper types will result in
1162 certain reporting tendencies to shape media attitudes, the news sources and year were
1163 used as control variables to fit the regression models. Also, since the media attitude in
1164 the most news articles are positive, which shows in a right skew in the figure 5, the
1165 values of media attitudes were square-root transformed. This allowed the outcome to
1166 more likely meet regression assumptions.

1167 According to the previous content analysis results involving 1739 Nano news
1168 articles by the author, the majority of news articles were commercial advertisements
1169 (more than 50%). In Taiwan, the research focus on framing effects to investigate
1170 media context itself are not new. The frames which value the “future trends of
1171 emerging science”, the “convenience of technology” and “public accountability” are
1172 used popularly to represent emerging science and technology in Taiwan media
1173 (Cheng et al. 2013; Chen & Lee, 2017). However, most of the previous research
1174 focused on framing effect excluded the commercial advertising articles which were
1175 seen as not a qualified sample to present media presentation toward certain issues
1176 (Cheng et al. 2013; Chen & Lee, 2017). In term of these three studies, for this authors
1177 opinions, exclusion of the commercial advertising news articles for framing effect
1178 research in Taiwan media research is inappropriate, since the content analysis results
1179 indicated more than half of Nano news articles are commercial, the views and
1180 prostrating of Nano in commercial by business companies has become a strong voice
1181 to cause the media representation toward Nano, and thus, the research design and

1182 resulted should face and reflect the real media context's representation. The salient
1183 exposure of commercial advertising in Taiwan Nano news should be taken into
1184 account for further analysis to present the comprehensive view of media
1185 representation toward Nano.

1186 Commercial news comprised the most news articles in the Nano product theme
1187 and use commercial prospect frame. Accordingly, the attitude of commercial
1188 advertising could be the dominate voice to lead the media representation toward Nano
1189 in Taiwan. Media attitudes in those news articles are obviously optimistically bias and
1190 affected by commercial sponsorship. It would be of concern if the media attitude of
1191 news is higher than the news in Nano product theme or using commercial frame.
1192 Thus, the media attitude in Nano product theme and Commercial prospect frame are
1193 set as a reference groups for regression analysis to investigate the relationship among
1194 media attitude and the usage of theme and frame, by controlling for news source and
1195 secular trends over time.

1196 First, the author was concerned that the media attitude in the news articles in
1197 theme or using different frame are statistically significantly affected by secular trends
1198 over time, so the interaction between year and themes and year and frame were tested
1199 during the model fitting process. However, all the interaction variables are not
1200 statically significant, so the interaction of year and theme and year and frame are
1201 dropped to fit the model.

1202 Thus, the research questions toward the relationship among media attitude, usage
1203 of theme and frame are separated in to more specific questions: (3-1) Do Themes have
1204 a joint effect on media attitude, controlling for news sources and secular trends over
1205 time? (3-2) Do Frames have a joint effect on media attitude, controlling for news

1206 sources and secular trends over time? (3-3) Do Frames and Themes have a joint effect
1207 on media attitude, controlling for news sources and secular trends over time? (3-4)
1208 What is the effect of media Theme on media attitude, controlling for Frames, new
1209 sources and secular trends over time? (3-5)What is the effect of media framing on
1210 media attitude, controlling for Themes, new sources and secular trends over time? The
1211 population-level regression models are describe as follows:

1212 Model 1: $Attitude_i = \alpha + \beta_1(Year_i) + \beta_2(Paper_i) + \varepsilon_i$

1213 Model 2: $Attitude_i = \alpha + \beta_1(Year_i) + \beta_2(Paper_i) + \delta T_i + \varepsilon_i$

1214 Model 3: $Attitude_i = \alpha + \beta_1(Year_i) + \beta_2(Paper_i) + \pi F_i + \varepsilon_i$

1215 Model 4: $Attitude_i = \alpha + \beta_1(Year_i) + \beta_2(Paper_i) + \delta T_i + \pi F_i + \varepsilon_i$

1216 α is the population level Attitude of media item "i" for the reference groups in all
1217 vectors and interactions (Commercial prospect Theme , Nano Product Frame, Year
1218 2002 (the variable Year is coded as 0-7)

1219 β_1 is the estimated effect of year (2002-2009, coded as 0-7) on the Attitude of
1220 media item "i".

1221 β_2 is the estimated effect of news source (Min-Sheng Daily, Economic Daily
1222 News, United Daily News and United Evening News, coded as 0-3) on the Attitude of
1223 media item "i".

1224 δ is the estimated effect of a vector of Theme dummy variables on the Attitude of
1225 media item "i".

1226 π is the estimated effect of a vector of Frame dummy variables on the Attitude of
1227 media item "i".

1228 ε_i is the residual (unexplained) variance of Attitude of media item "i".

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Table 10. The results of linear regression model for complex sample among years, news source, theme and frame

		Model 1		Model 2		Model 3		Model 4	
		B	SE	B	SE	B	SE	B	SE
Interception		2.917 ***	.025	2.934 ***	.025	2.934 ***	.024	2.939 ***	.024
Year		-.010	.004	- .011*	.004	-.006	.004	- .007*	.004
News sources	Economic Daily News	.138* **	.026	.142* **	.026	.110* **	.025	.118* **	.024
	United Daily News	-.028	.031	-.009	.030	-.024	.029	-.014	.028
	United Evening News	.035	.048	.020	.048	.009	.046	-.004	.046
Theme	Scientific source			.135* **	.024			.132* **	.022
	Policy			- .041* *	.014			- .048*	.014
	Education			- .131* **	.019			- .128* **	.018
	Social event			.050	.028			.034	.027
Frame	Science					-.011	.013	.003	.012
	Communication					- .121* **	.022	-.033	.022
	National interest					.076* **	.015	.103* **	.015
	Risk					- .325* **	.062	- .299* **	.061
	Non					- .506* **	.040	- .488* **	.036
		R ² = 0.056 ΔR ² =0.056** *		R ² = .092 ΔR ² =0.036** *		R ² = .103 ΔR ² =0.047** *		R ² = .132 ΔR ² =0.076** *	

1246 *p<.05; **p<.01; ***p<.001. Cells contain regression coefficients and robust standard
1247 errors (clustered by article)

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1250 In order to answer research question 3-1, 3-2 and 3-3, the factor of theme and
1251 frame are tested. According to the Table 10, controlling for news sources and secular
1252 trends over time, by comparing model 1 and 2, the joint effect of theme on media
1253 attitude is statistically significant ($F= 17.061$, $P=0.000<.05$), by comparing model 1
1254 and 3, the results show the joint effect of frame also significantly affects media
1255 attitude ($F= 17.937$, $p=0.000<0.05$) and by comparing model 1 and 4, the theme and
1256 frame have joint effect on media attitude ($F= 16.762$, $p=0.000<0.05$). Per the above
1257 result, by controlling for new sources and secular trends over time, the media theme
1258 and framing both effect media attitude. And the joint effect of framing (R^2 change=
1259 0.047 , $p=0.000<0.05$) is stronger than theme (R^2 change= 0.036 , $p=0.000<0.05$)
1260 toward media attitude. Thus, the next step is investigating what is the effect between
1261 different themes and frames toward media attitude.

1262 The results of model 4 (Table 10) shows that, by controlling the effect of secular
1263 trends over time, new sources and frame, comparing to Nano product theme, the
1264 media attitude in Scientific themes is significantly more positive ($B=.132$,
1265 $p=0.000<0.05$) and the media attitude in policy ($B=-.048$, $p=0.000<0.05$) and
1266 education ($B=-.128$, $p=0.000<0.05$) theme are both statically less positive than Nano
1267 product theme. The media attitude in Social event theme and in Nano product theme
1268 are not significantly different than the reference (Research question 3-4).

1269 By controlling for the effect of secular trends over time, the effects of different
1270 framing toward media attitude are also presented in the model 4(Table 10). Compared
1271 to the effect of Commercial prospect framing, new sources and theme, the effect of
1272 National interest framing can shape media attitude more positively ($B=.103$,
1273 $p=0.000<0.05$) and the effect of Risk framing ($B=.103$, $p=0.000<0.05$) and no use of

1274 framing bring about less positive media attitudes. The framing effect of science and
1275 communication are not significantly different between commercial prospects, in the
1276 sample (Research question 3-5).

1277 **(3) Discussion**

1278 In general, the agenda setting and framing of Nano in Taiwanese media are
1279 derived by commercial sponsorship and the National Program of Nano (NPNT),
1280 which can be seen from the numerous news articles that are related to Nano product
1281 and policy themes and the high exposure of the commercial prospect and National
1282 interest framings. The impression and role of Nano in the media has been shaped as
1283 an emerging scientific “idol” which not only benefits the public’s daily life but also
1284 increases the national interest and competitiveness of Taiwan. This situation can also
1285 be seen in our research results: Nano scientific knowledge and application are
1286 disconnected. What’s more, there seems to be less risk assessment and an over
1287 optimistic attitude toward Nano.

1288 According to the results (Table 9) of investigating the relationship between usage
1289 of themes and frame, Taiwanese media raises the importance of the scientific features
1290 of Nano in the news articles of scientific source, policy, and education themes, but
1291 mentions less the articles related to Nano products. Meanwhile, the application of
1292 Nano in our daylily lives is mostly discussed in the commercial news articles but
1293 barely in the news articles in scientific sources, policy, and education. This disconnect
1294 between the scientific and lay media may lead to the situation in which public may
1295 know Nano as the science knowledge but have a vague image of how/what the
1296 interactions between the developing of nano and individuals’ life might be. The same
1297 research results of Research Question 2 in Table 9, also indicates that science

1298 communication and education toward Nano are only most valued in the news related
1299 to education themes, but do not take into account in the discussion of nano policies,
1300 nano science and nano products. In other words, nano is not valued as a popular
1301 science communication issue in the Taiwanese media.

1302 In Tables 9 and figure 5, the discussion of Nano risk is weakly associated with
1303 scientific source, Nano product, and Education themes. The above disconnection of
1304 information also shows that media barely discuss the risk of Nano science and
1305 products in the commercial and even not in science communication framed articles.
1306 Since Nano is a newly emerging scientific issue, the related knowledge, possible
1307 benefit, and damage are all also developing and uncertain. The lack of media attention
1308 is an obstacle for members of the lay public to form opinions and understandings
1309 toward Nano, and even less awareness or ignorance of the related risks and dangers
1310 which are already present.

1311 According to the news sources analyzed, “nano commercial products” articles
1312 emphasize the benefits to human health and beauty (e.g., clothing, home appliances,
1313 and skin care product) or the industrial equipment which can help foster business
1314 growth (e.g., nano grinding instruments) mostly mention the benefit of the products
1315 but barely address the science background and the risk of how nano can be applied or
1316 science sources. In other words, the role of Nano is more like a “sales pitch” for
1317 promoting products. Affected by commercial sponsorship, the news articles in the
1318 Nano product theme shape Nano into a relatively simple and flat concept but ignore
1319 the scientific evidence and also did not bring enough information toward the possible
1320 damage for using Nano products. Nano became merely an adjective which implies the
1321 authority of science. The authority of science can sometimes mislead the public’s

1322 implicit beliefs and trust toward scientific contexts (Martin, 1991). Especially, in the
1323 case of the heavy promotion of the Taiwanese government toward Nano, this
1324 “adjective-like” representation and commercial frame should cause more concerned
1325 about its overly optimistic and unitary description toward Nano, as it may the lead
1326 audience to an overly positive perception toward this emerging science.

1327 The media attitude toward Nano is also affected by agenda setting and framing in
1328 Taiwanese media. As the results of Research Question 3 show, the media attitude
1329 from scientific sources is more positive than from Nano product sellers. The effect of
1330 National interest framing can shape media attitudes to become even more optimistic.
1331 The above result indicates that although the “Academia Excellence Project” is one of
1332 the main scopes of National Program of Nano (NPNT) in Taiwan, the risk and
1333 possible damage of Nano still needs to be more rigorously investigated in order to
1334 provide a more comprehensive understanding the cost behind the prosperity the media
1335 describes.

1336 However, there are a variety of media attitudes among different themes and
1337 frames. In general, the media presents a consistently positive attitude towards Nano in
1338 news articles, which may lead and imply public opinions about Nano, which is in turn
1339 likely to influence national policy, as well as future Nano development and
1340 underestimate related risk and danger. In addition, the results in Table 10 (model 4)
1341 indicated that media attitudes slightly decrease with year ($B = -.007, p < 0.05$).
1342 According to the contents of news articles, we find that in the later period of NPNT
1343 (2006 to 2009), the Taiwanese government started to focus on the regulation policy
1344 toward the fake Nano products, and the media presents many concerns on the Nano
1345 counterfeits. However, although the media attitude in the news slightly decreased, the

1346 negative evaluation is toward the counterfeits which were claiming to be related to
1347 Nano. The evaluation toward Nano itself is still consistently positive. The above
1348 findings can also provide the explanation why the media attitude in the Policy theme
1349 in Table 10 ($B=-.041$, $p<0.01$) is less positive than the media attitude in Nano product
1350 theme and the media attitude in the news articles using risk frame is still positive in
1351 Table 7 (Mean of media attitude=7.3). In other word, the regulation policy may raise
1352 the media and public's awareness toward the Nano counterfeits, but the discussion
1353 toward the possible damage caused by developing Nano itself is still lacking in the
1354 media.

1355 The news articles using risk frame accounts for a small percentage of Taiwanese
1356 media ($n=45$, $\%=2.6$). According to the news content, unlike the numerous critical
1357 discussions toward Nano itself by the US and Europe local media, the news articles
1358 discussing the concerns toward Nano itself are reports from foreign news, not reports
1359 by Taiwanese local media. Thus, the Taiwanese media acts as a mediator between
1360 information and audience. The diversity and objectivity of reporting should be
1361 supervised, especially on the scientific issues which people are not familiar.
1362 Otherwise, danger possible danger arises: the society views and values will be led to
1363 the only "one way", the way only guides to one direction: blind.

1364 Following the point of the Sociology of Scientific Knowledge, science should be
1365 considered as an enterprise conducted by social construction and interest(Tai, 2012).
1366 Affected by the government policy promotion of NTNP and commercial sponsorship,
1367 the overwhelmingly positive expectation and attitude toward Nano in Taiwanese
1368 media can be seen as an example of how agenda setting and framing work together to
1369 shape the image of emerging science. However, we can't underestimate the reflexivity

1370 of the audience's thinking. The investigation of public attitude toward Nano will be
1371 the last puzzle to picture the process and results of the representation of Nano in
1372 Taiwanese News Media.

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1389 **6. Study 2- media evaluation, Actor, Framing usage**

1390 **(1) Methodology**

1391 Classic content analysis and quantitative analysis are both utilized in this study.
1392 A total of 1739 news articles were coded by following the coding instrument which
1393 developed from the author's previous study in November, 2013. Based on the coding
1394 results, quantitative analyses were used to analyze the relationship between actors,
1395 frame usage, and media evaluation.

1396 Based on the instrument developed by Bauer et al.(1996) and in order to provide
1397 detail information on the main actor, the first round of inspecting the sample news
1398 articles, "main actor" in the Nano news in coding instrument are divided into 30
1399 options. In order to facilitate following analyses, according to the similarity of
1400 characters, 30 options are recoded into 9 groups(as Table 11) which included (0) Not
1401 applicable, unknown (1) Government agencies (2) Government research institutions
1402 (3) Research institution of University (4)Education (5) Public (hospitals, The public,
1403 public opinion...) (6)Business company (7) Scientists (8)International. According to
1404 the results of content analysis by the author, the "government agencies" represents the
1405 government's tone for general policy toward present and future Nano development
1406 and "government research institutions" are more focus on the research, innovation,
1407 and application of Nano, thus they are divided into two different groups.

1408 Most of the news' content of K-12 school and museum intend to communicate
1409 and promote the knowledge and application of Nano toward student and public, so
1410 these two options are seen as the same group in this research. The "hospital" is a

1411 difficult option to classify. The news with hospitals as the main actors are related to
1412 claims using Nano mask and air cleaning devices to help the public health or not
1413 during the outbreak of SARS (Severe Acute Respiratory Syndrome). Accordingly, the
1414 hospitals play the role of public Nano products assessment agency in the Nano news,
1415 which is the reason ‘hospital’ are classified as the ‘Public’ group in this research. The
1416 total number of actor coded 0 (Not applicable, unknown) are 6 which are dropped in
1417 following analysis.

1418 The “Frame” items in the coding instrument are developed for capturing the
1419 different frames in Nano news, and focus on the role and the description of Nano in
1420 the news. The five different frame styles are defined as Table.12 : (1)Science frame.
1421 (2) Commercial prospect frame (3) Communication frame (4) National interest frame
1422 and (5) Risk frame. In order to look for patterns in how the frames were used
1423 separately or in combinations within the same article, each news article will be tagged
1424 with a maximum of three codes.

1425 The media evaluation in the Taiwanese Nano news is seen as the dependent
1426 variables in this study(Table 13). In order to provide quantifiable results of media
1427 evaluations, the media evaluation of Nano news is coded base on the prominence of
1428 the advantages or disadvantages (from 0 to 10), if the news content mentions the
1429 promotion /benefits or concerns/damages of Nano in regard to the national interest or
1430 the influence over the public, the news will be coded as a “extremely positive or
1431 negative”. Also, the frequency of the positive or negative effect of Nano in each news
1432 article will be considered as an index. If a news article includes one of the advantages
1433 or disadvantages, it will be coded as slightly positive/ critical; those including two

1434 will be coded as somewhat positive/ critical and so on. If a news article is not directly

1435 related to Nano, it will be coded as “Not applicable” (coded as 0).

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1437 Table 11. The item of “Main actor” in the coding instrument.

Recode	Main actor	Description of actors	Original code
0	Not applicable, unknown	Not applicable, unknown	0
1	Government agencies	Government (general)	1
		Executive Yuan (the executive branch of Taiwan government)	2
		Ministry of Economic Affairs	3
		Ministry of Education	4
		Environmental Protection Administration	5
		Ministry of Health and Welfare	6
		The Council for Economic Planning and Development (CEPD)	7
2	Government research institutions	Industrial Technology Research Institute	8
		National Science Council	9
3	Research institution of University	University/scientists	10
4	Education	K-12	11
		Museum	11.1
5	Public	Hospitals	12
		The public, public opinion (also: ‘we’, ‘one’)	13
		The media, published opinion	14
		Consumer groups	15
		Environmental organizations	16
6	Business company	Business company	17
7	Scientists	Scientist	18
8	International	China	19.1
		Japan	19.2
		The United States of America	19.3
		French	19.4
		Russia	19.5
		UK	19.6
		Canada	19.7
		Swiss	19.8
		Korea	19.9
Other centuries	20		

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1441 Table 12. The item of “Frame” in the coding instrument.

Frame	Description	Code
Science frame	Nano as a discrete scientific concept.	1
Commercial prospect frame	Promotes business and personal daily life interest(Industrial device, beauty Cosmetic and living goods)	2
Communication frame	Nano are describe as a educational subject or public science communication issue which is need to communicate the related information to students or public (a)Academic : The programs and degrees toward Nano established and the workshops and conferences held , new nano curriculum in K-12. (b) Science communication toward public: workshops, museum habitations, science	3
National interest frame	The agent for enhancing national interest and competitiveness: government policy support and funding investment, the importance of Nano for national economic growth and science and technology development, comparison of national competitiveness between Taiwan and other countries (China, Japan and Korea...)	4
Risk frame	The concern related to development of Nano: risk, regulation	5

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1443 Table 13. The item of “Valuation of Nano” in the coding instrument.

Valuation of Nano	Code
Not applicable	0
Extremely critical: discourse of great concern, of doom	1
Very critical	2
Quite critical	3
Somewhat critical	4
Slightly critical, some discourse of concern	5
Slightly positive; discourse of promise	6
Somewhat positive	7
Quite positive	8
Very positive	9
Extremely positive; discourse of great promise, of Progress	10

1444 **Data weighted**

1445 Following the analysis strategy of Carver, Rodland, and Breivik (2012), the
 1446 assumption is the dominate frame will provide more considerable influence over
 1447 audiences than the secondary and third frame. Thus, each frame will be weighted
 1448 based on their salience in news. If only one frame is used in a news article, this frame

1449 will be weighted by 1. If two frame are used in a news, the main frame will be
 1450 weighted by $2/3$ (approximately 0.67) and the secondary by $1/3$ (approximately 0.33).
 1451 If a news article includes three frames, the main frame will be weighted by $4/7$
 1452 (approximately 0.57), the secondary by $2/7$ (approximately 0.29) and thirdly by $1/7$
 1453 (approximately 0.14). The assumption is the dominate frame will provide more
 1454 considerable influence over audiences than the secondary and third frame. Thus, each
 1455 theme/frame will be weighted based on their salience in news.

1456 Since an article can include 3 codes (3 frames) at most, the combination of theme
 1457 and frame are 3 styles at most. In order to calculate the usage of theme and frame,
 1458 each article can be seen as 3 parts and each part will be weighted by the combination
 1459 weight which is contributed by the frame.

1460 For example, if an article is coded frame1 (main), frame 2 (2nd), frames 3(3th),
 1461 the usage of frame in this article can be seen as Table 14. According to the Table 4, A
 1462 part will be weighted by $4/7$, B part by $2/7$, C part by $1/7$.

1463 Table 14. The example of data weighted.

Example	Part	Frame(F)	Style	Weight
One article coded by three frame code	A	F1	Main frame	$4/7$
	B	F2	2nd frame	$2/7$
	C	F3	3th frame	$1/7$
Total				1

1464 **Analysis**

1465 Descriptive statistics were utilized to investigate who are the influential actors of
 1466 Nano in the Taiwanese media discourse for Research Questions 1 and 2, the media
 1467 exposure of different actors in the Nano news were presented by frequency.

1468 In order to investigate if different actors have their preference of frame toward
1469 Nano in Taiwan, Chi-square tests are used to show the relationship between media
1470 exposure of main actors and frame usage for Research Question 3.

1471 For valuing the different contribution of main frame, secondary frame and
1472 tertiary frame, the news articles are separated as three parts and weighted.

1473 In order to cluster the news articles by news, the Multivariate Multiple
1474 Regression Model is used to answer Research Question: How is Taiwanese media
1475 evaluation affected by different actors and Nano frames usage?

1476 **(2) Results**

1477 **Descriptive statistic- Research question (1) and (2), the media exposure of** 1478 **different actors in the Nano news are be presented by frequency**

1479 According to the result of descriptive statistic analyses, in Table 15, the most
1480 dominate main actor in the Taiwanese Nano news was “Business Company” who
1481 covered over 50% Nano news articles, followed by “Research institution of
1482 university” (13.9%), Government agencies (12.2%), Government research institutions
1483 (7.6%) and Scientists (7.4%). The voices of Education, Public and International had
1484 less than 3% coverage in Nano news articles.

1485 Since the coverage of Education, Public, and International were too small to
1486 provide a valid variety of main actors in different years, the author focused on only
1487 the top 5 main actors for the following discussion. However, the possible influence
1488 and concerns of the missing voices from “Education”, “Public” and “International”
1489 will be considered in the discussion section.

1490 As shown in Table 16 and Figure 7, “Business Company” was always the
1491 leading actor toward Nano in the Taiwanese media from 2002 to 2009. The voices of
1492 “Business Company” hugely increased from 2002 to 2003(from 32.2% to 60.6%) and
1493 maintained around 50 to 60% coverage and slightly decreased in 2008(45%) but
1494 rapidly increased to 51.6% in 2009. Even though the coverage varied from 2002 to
1495 2009, the voices of “Business Company” were still far ahead of other actors.
1496 Interestingly, expect the” business company” the voices of actors all decreased from
1497 2002 to 2003.

1498 The voices of “Research institution of university” maintain a slight decreasing
1499 trend from 2002 to 2005, and only are active on 2006 and 2008 again.

1500 The varieties of the voices of “Government agencies” and “Government
1501 research institutions” is similar, withhich both showing most activty in 2002 and a
1502 decrease from 2003 until 2007, past which the voices from”Government agencies”
1503 and “Government research institutions” toward Nano were both active again.

1504 The voice of “Scientist” was relatively stable from 2002 to 2009, which only
1505 showed actively on 2008 which is the end of the national Nano project and the
1506 application time for phase II of national nano project.

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1511 Table 15. The description of main actor in Taiwanese Nano news.

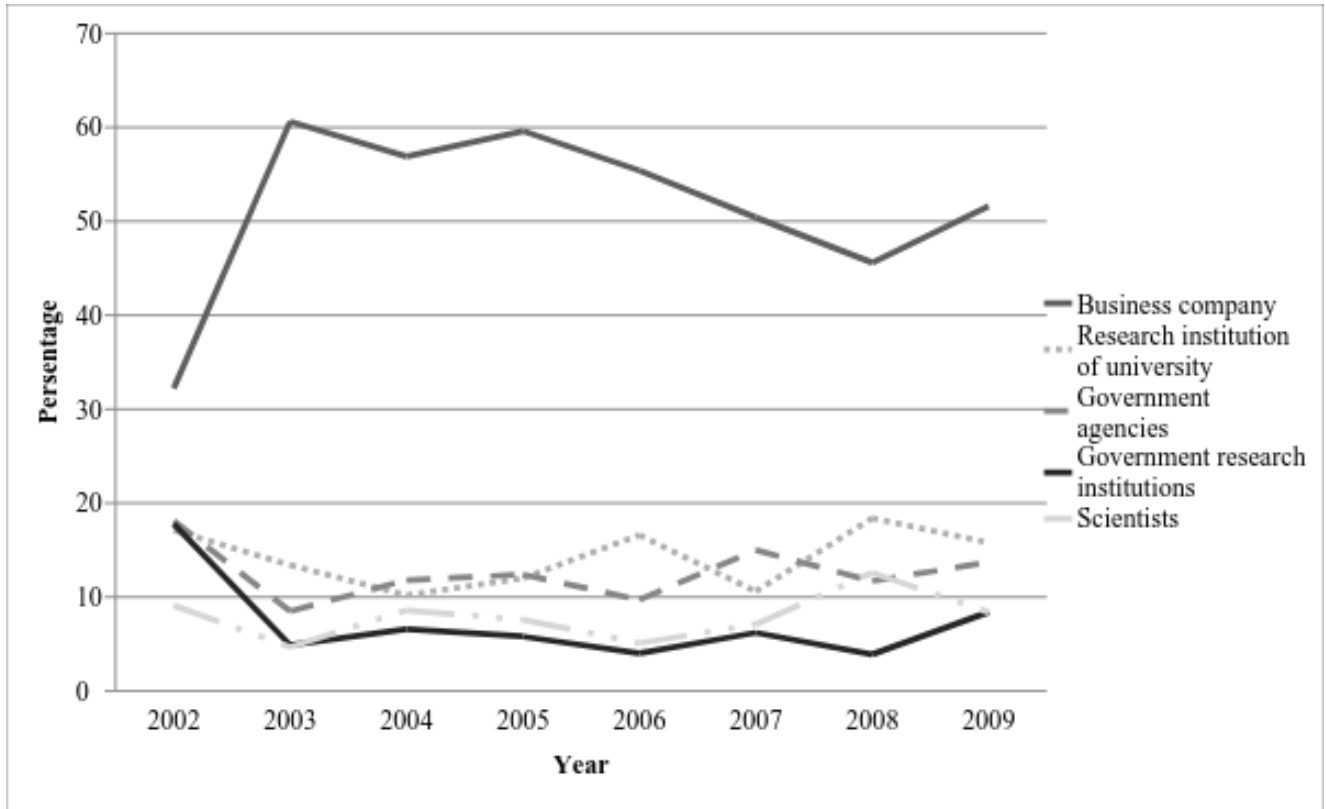
Main actor	N	Percent	Cumulative Percent
not applicable, unknown	6	.3	.3
Government agencies	213	12.2	12.6
Government research institutions	133	7.6	20.2
Research institution of university	241	13.9	34.1
K-12 School and museums	40	2.3	36.4
Public	20	1.2	37.6
Business company	911	52.4	89.9
Scientists	128	7.4	97.3
International	47	2.7	100.0
Total	1739	100.0	

1512

1513 Table 16. The description of frame usage in Taiwanese Nano news

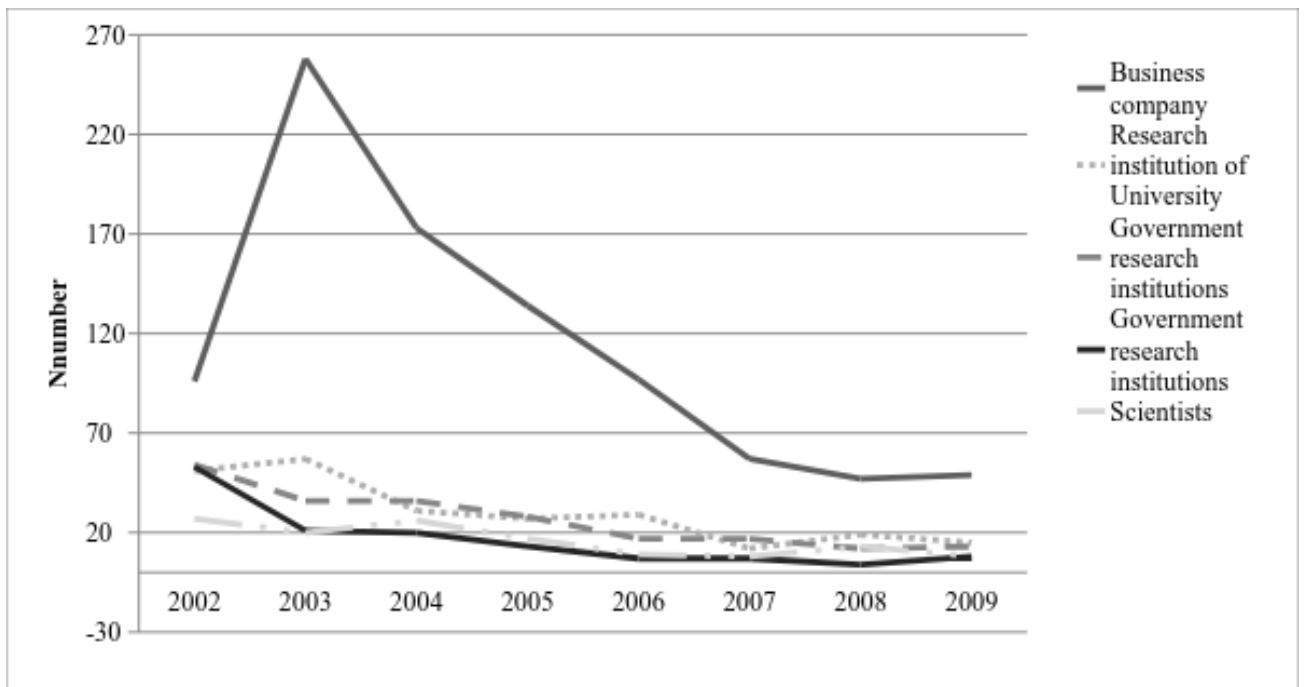
Frame	M of media evaluation	Number	S.D
Science frame	8.8849	377	1.82653
Commercial prospect frame	9.0589	930	1.62688
Communication frame	8.0477	133	1.64035
National interest frame	9.6284	246	1.75574
Risk frame	7.2969	45	2.83128
Non	6.0000	3	.00000
Total	8.9735	1733	1.79085

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Figure 7. The variety of the top five main actors in Nano news from 2002 to 2009 (by percentage of each year)



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 1523

Figure 8. The variety of the top five main actors in Nano news from 2002 to 2009 (by numbers of each year)

1525 Table 17. The chi-square test of frame's usage between different actors. (ar=adjusted residual)

Frame		Actor								Total
		Government agencies	Government research institutions	Research institution of University	Education	Public	Business company	Scientists	International	
Science	Count	36	36	100	16	8	94	73	14	377
	% within Frame	9.5%	9.5%	26.5%	4.2%	2.1%	24.9%	19.4%	3.7%	100.0%
	ar	-1.8	1.5	8.0	2.8	2.0		10.0	1.4	
Commercial prospect	Count	78	45	47	4	9	705	27	15	930
	% within Frame	8.4%	4.8%	5.1%	0.4%	1.0%	75.8%	2.9%	1.6%	100.0%
	ar					-.8	20.8			
Communication	Count	9	8	68	19	2	15	11	0	132
	% within Frame	6.8%	6.1%	51.5%	14.4%	1.5%	11.4%	8.3%	0.0%	100.0%
	ar		-.7	13.0	9.6	.4		.4		
National interest	Count	74	39	24	1	0	80	11	16	245
	% within Frame	30.2%	15.9%	9.8%	0.4%	0.0%	32.7%	4.5%	6.5%	100.0%
	ar	9.3	5.2			-1.8		-1.9	4.0	
Risk	Count	14	5	2	0	1	16	6	1	45
	% within Frame	31.1%	11.1%	4.4%	0.0%	2.2%	35.6%	13.3%	2.2%	100.0%
	ar	3.9	.9	-1.9	-1.0	.7		1.5	-.2	
Non	Count	1	0	0	0	0	1	0	1	3
	% within Frame	33.3%	0.0%	0.0%	0.0%	0.0%	33.3%	0.0%	33.3%	100.0%
	ar	1.1	-.5	-.7	-.3	-.2	-.7	-.5	3.3	
Total	Count	212	133	241	40	20	911	128	47	1732
	% within Frame	12.2%	7.7%	13.9%	2.3%	1.2%	52.6%	7.4%	2.7%	100.0%

1526 $X^2 = 831.952$, $df = 35$, $p = 0.000 < 0.05$

1527

1528

1529 **RQ3: Do different actors associate with particular frame using toward Nano in**
1530 **Taiwan?**

1531 According to Table 17, the different frame's usage is statistically significantly
1532 different among news articles in different actors ($X^2= 831.952$, $df=35$,
1533 $p=0.000<0.05$). In order to investigate the association in the Table, the value of
1534 adjusted residual (ar) is used to test whether the observed value is greater or smaller
1535 than the expected value. With a statistical significance level of .05, if the adjusted
1536 residual is more than 1.96 then the number of cases in that cell is significantly larger,
1537 if the adjusted residual is less than -1.96 then the number of cases in that cell is
1538 significantly smaller than would be expected in a population where no relationship
1539 exists.

1540 Table 17 points out, the usage of Science frame are significantly higher in the
1541 news articles in the main actors Research institution of University ($ar=8>1.96$),
1542 Education($ar=2.8>1.96$), Public($ar=2.0>1.96$), and Scientists($ar=10.0>1.96$), but
1543 significantly lower in Business company($ar=-12.2<-1.96$).

1544 Affected by the promotion of National Program of Nano (NPNT),
1545 unsurprisingly, the National interest frame is used most in the news articles that
1546 main actor are the Government agencies($ar=9.3>1.96$), Government research
1547 institutions($ar=5.2>1.96$), International($ar=4.0>1.96$), but uses less in Research
1548 institution of University($ar=-2.0<-1.96$), Education($ar=-2.1<-1.96$), Business
1549 company($ar=-6.7<-1.96$)

1550 The Commercial prospect frame has most exposure in the news articles that the
1551 main actor is Business company ($ar=20.8>1.96$) but less exposure in Government

1552 agencies(ar=-5.3<-1.96), Government research institutions(ar=-4.8<-1.96), Research
1553 institution of University(ar=-11.5<-1.96), Education(ar=-5.6<-1.96), Scientists(ar=-
1554 7.7<-1.96), International(ar=-3.0<-1.96).

1555 The usage of the Communication frame is statistically higher in the news
1556 articles that main actor are Research institution of University(ar=13.0>1.96) or
1557 Education(ar=9.6>1.96), but lower in the Government agencies(ar=-2.0<-1.96),
1558 Business company(ar=-9.9<-1.96), International(ar=-2.0<-1.96)

1559 In the meantime, the Risk frame has significantly higher exposure only in the
1560 news articles that main actor is Government agencies(ar=3.9>1.96). However, Risk
1561 frame is only lower in the news articles that main actors is Business company (ar=-
1562 2.3<-1.96).

1563 **RQ4: How Taiwanese media evaluation be affected by different actors and Nano**
1564 **frames usage?**

1565 Considering that secular trends over time and newspaper types will contribute
1566 to certain reporting tendency that shape the media evaluation, the news sources and
1567 years are be used as control variables to fit the regression models. Also, since the
1568 media evaluation in the most news articles are positive, the value of media
1569 evaluation are taken square, allowing the outcome to more fit to normal distribution
1570 for further regression analysis.

1571 The commercial prospect frame is most frequently used by commercial news
1572 articles, and the media evaluation in those news articles is obviously optimistically
1573 biased and affected by commercial sponsorship. It would therefore be of interest if
1574 the media evaluation of news is more positive than the news using commercial

1575 frame. Thus, the media evaluation using Commercial prospect frame and whose
 1576 main actor is Business Company are set as a reference groups for regression analysis
 1577 to investigate the relationship among media evaluation, the usage of theme and
 1578 frame, by controlling news source and secular trends over time.

1579 Thus, the research questions toward the relationship among media evaluation,
 1580 usage of theme and frame are separated in to more specific questions: (4-1) Do Main
 1581 actors in the Nano news have a joint effect on media evaluation, controlling for
 1582 news sources and secular trends over time? (4-2) Do Frames usages have a joint
 1583 effect on media evaluation, controlling for news sources and secular trends over
 1584 time? (4-3) Do main actors and frame usage have a joint effect on media evaluation,
 1585 controlling for news sources and secular trends over time? (4-4) What is the effect
 1586 of main actors in the nano news on media evaluation, controlling for Frames, new
 1587 sources and secular trends over time? (4-5) What is the effect of media framing on
 1588 media evaluation, controlling for main actors, new sources and secular trends over
 1589 time? The equation of regression models are describe as following:

1590 Model 1: $Evaluation_i = \alpha + \beta_1(Year_i) + \varepsilon_i$

1591 Model 2: $Evaluation_i = \alpha + \beta_1(Year_i) + \beta_2(Paper_i) + \varepsilon_i$

1592 Model 3: $Evaluation_i = \alpha + \beta_1(Year_i) + \beta_2(Paper_i) + \delta A_i + \varepsilon_i$

1593 Model 4: $Evaluation_i = \alpha + \beta_1(Year_i) + \beta_2(Paper_i) + \pi F_i + \varepsilon_i$

1594 Model 5: $Evaluation_i = \alpha + \beta_1(Year_i) + \beta_2(Paper_i) + \delta A_i + \pi F_i + \varepsilon_i$

1595 Model 6: $Evaluation_i = \alpha + \beta_1(Year_i) + \beta_2(Pape_i) + \delta A_i + \pi F_i + \mu_1 interaction Risk^*$

1596 Government agencies $+ \mu_2 interaction Risk^*$ Government research

1597 institutions+ μ_3 interaction Risk* Research institution of university+ μ_4 interaction

1598 Risk* Education+ μ_5 interaction Risk* Public+ μ_6 interaction Risk*

1599 Scientists+ μ_7 interaction Risk* Business company + μ_8 interaction Risk*

1600 International + ϵ_i

1601 α is the population level evaluation of media item "i" for the reference groups
1602 in all vectors and interactions (Commercial prospect Theme, Nano Product Frame,
1603 Year 2002 (the variable Year is coded as 0-7)

1604 β_1 is the estimated effect of year (2002-2009, coded as 0-7) on the evaluation
1605 of media item "i".

1606 β_2 is the estimated effect of news source (Min-Sheng Daily, Economic Daily
1607 News, United Daily News and United Evening News, coded as 0-3) on the
1608 evaluation of media item "i".

1609 δ is the estimated effect of a vector of Main actor's dummy variables on the
1610 evaluation of media item "i".

1611 μ is the estimated effect of a vector of interaction variables on the evaluation of
1612 media item "i".

1613 π is the estimated effect of a vector of Frame dummy variables on the
1614 evaluation of media item "i".

1615 ϵ_i is the residual (unexplained) variance of evaluation of media item "i".

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1621 Table 18. The results of linear regression model for Multivariate Multiple Regression Model among years, news source, Main actor and frame

		Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
		B	SE	B	SE	B	SE	B	SE	B	SE	B	SE
Interception		22.058**	7.497	2.918***	.024	2.917***	.025	2.934**	.024	2.929**	.025	16.607**	7.296
Year		-.010*	.004	-.011*	.004	-.010	.004	-.007	.004	-.006	.004	-.007	.004
News sources	Economic Daily News			.140**	.025	.134**	.025	.112**	.025	.111**	.025	.107**	.025
	United Daily News			-.021	.028	-.022	.028	-.016	.028	-.020	.028	-.019	.028
	United Evening News			.035	.055	.035	.055	.009	.054	.011	.053	.007	.053
Main Actor	Government agencies					.023	.024			.030	.024	.094**	.029
	Government research institutions					.088*	.029			.093*	.029	.014	.025
	Research institution of university					-.016	.023			.016	.025	.071	.053
	Education					.024	.052			.072	.053	-.022	.071
	Public					-.090	.071			-.063	.069	.026	.031
	Scientists					-.008	.030			.011	.031	-.070	.046
	International					-.093*	.046			-.094*	.046	.094	.029

1622			$\Delta R^2 = 0.051^{***}$	$\Delta R^2 = 0.009^{***}$	$\Delta R^2 = 0.047^{***}$	$\Delta R^2 = 0.055^{***}$	$\Delta R^2 = 0.017^{***}$
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*p<.05; **p<.01; ***p<.001. Cells contain regression coefficients and robust standard errors (clustered by article)

1623
1624

Table 19. The predict value of linear regression model 6 for Multivariate Multiple Regression Model among years, news source, Main actor and frame

Actor	Frame	Mean	Number	SD
Government agencies	Science	3.00	36	.0643
	Commercial prospect	3.02	78	.0580
	Communication	2.97	9	.0726
	National interest	3.03	74	.0518
	Risk	2.86	14	.0463
	None	2.93	1	.0000
	Total	3.01	213	.0713
Government research institutions	Science	3.08	36	.0715
	Commercial prospect	3.09	45	.0680
	Communication	3.05	8	.0815
	National interest	3.11	39	.0547
	Risk	2.70	5	.0712
	Total	3.08	133	.101
Research institution of University	Science	2.92	100	.071
	Commercial prospect	2.96	47	.068
	Communication	2.92	68	.072
	National interest	2.98	24	.055
	Risk	3.11	2	.080
	Total	2.93	241	.073
Education	Science	2.89	16	.035
	Commercial prospect	2.91	4	.021
	Communication	2.89	19	.039
	National interest	2.89	1	.033
	Total	2.89	40	.035
	Public	Science	2.88	8
Commercial prospect		2.89	9	.048
Communication		2.85	2	.060
Risk		1.83	1	.050
Total		2.82	20	.256
Business company		Science	2.99	94
	Commercial prospect	2.99	705	.060
	Communication	2.96	15	.079
	National interest	3.00	80	.050
	Risk	2.95	16	.069
	None	3.04	1	.
	Total	2.98	911	.060
Scientists	Science	2.95	73	.070
	Commercial prospect	2.97	27	.080
	Communication	2.92	11	.065
	National interest	3.01	11	.073
	Risk	2.30	6	.060
	Total	2.93	128	.157
International	Science	2.92	14	.077
	Commercial prospect	2.94	15	.057
	National interest	2.94	16	.060
	Risk	1.57	1	.050
	None	2.83	1	.

	Total	2.90	47	.230
Total	Science	2.97	377	.083
	Commercial prospect	2.99	930	.068
	Communication	2.93	133	.079
	National interest	3.02	246	.070
	Risk	2.75	45	.339
	None	2.94	3	.105
	Total	2.98	1733	.100

1625

1626 In model 1(Table 18), the result shows the media evaluation decreases with year
1627 (F=-.010, P=0.010<.05)

1628

1629 In order to answer research question 4-1, 4-2 and 4-3, the factor of main actor
1630 and frame are tested. According to the Table 18, controlling for news sources and
1631 secular trends over time, by comparing model 2 and 3, the joint effect of main actor
1632 on media evaluation is statistically significant (F= 10.832, P=0.000<.05), by
1633 comparing model 2 and 4, the results show the joint effect of frame also
1634 significantly affects media evaluation (F= 21.920, p=0.000<0.05) and by comparing
1635 model 2 and 5, the main actors and frame have joint effect on media evaluation (F=
1636 13.638, p=0.000<0.05). As above result, by controlling for new sources and secular
1637 trends over time, the main actor and framing both effect on media evaluation. And
1638 the joint effect of framing (R2 change=0.047, p=0.000<0.05) is stronger than main
1639 actor (R2 change=0.009, p=0.000<0.05) toward media evaluation. Thus, the next
1640 step is investigating what is the effect between different main actor and frame
toward media evaluation.

1641

1642 The results of model 5 (Table 18) shows that, by controlling the effect of
1643 secular trends over time, new sources and frame, comparing to main actor that is
1644 Business Company, the media evaluation in the news that main actor is Government
1645 research institutions is significantly more positive (B=.093, p=0.01<0.05) and the
1646 main actor is International (B=-.094, p=0.040<0.05) is statically less positive than
1647 Business Company. The media evaluation in the news that main actor are
1648 Government agencies, Research institution of university, Education, Public,
1649 Scientists and Business Company not significantly indifference (Research question
4-4)

1650

1651 By controlling the effect of secular trends over time, the effects of different
framing toward media evaluation are also presented in the model 5(Table 18).

1652 Comparing to the effect of media evaluation Commercial prospect framing, new
1653 sources and main actor, the effect of Communication ($B=-.143$, $p=0.000<0.05$), Risk
1654 framing ($B=-.337$, $p=0.000<0.05$) and bring about less positive on media evaluation.
1655 The framing effect of Science, National interest and Non framing is not significantly
1656 difference between commercial prospects (Research question 4-5).

1657 In order to investigate the further effect of risk frame, the interaction of risk and
1658 different actors are added in model 6 to show what is the effect of risk frame is
1659 different among different actors toward media evaluation. The interaction of risk
1660 frame with public, scientist and international actor show the significantly negative
1661 affect in model 6, which means there are different in slope of risk frame on media
1662 evaluation for actor of public, scientist and international compared to other actors.

1663 There is a negative interaction between risk frame and public actor, as shown
1664 by the significant coefficient of $-.757$. As Table 19, so for instance (Table 19), if we
1665 hold all other variables at their mean and look at the predicted attitude for the risk
1666 frame across all actors it is 2.7, whereas the predicted attitude combining risk frame
1667 with public actor is 1.8 and with international actor is only 1.6. That said there is
1668 only one observation in the cells of public and international, so although this result
1669 is suggestive, it should be treated with caution. The predicted attitude combining
1670 risk frame with Scientist actor is 2.3

1671

1672 (3) Discussion

1673 The relationships among different actors can be briefly seen from the results
1674 of descriptive analysis (Table 15) and Chi-square test (Table 17). As showed in
1675 table 15 and 17, the most dominate actor in Nano news in Taiwan media is
1676 “Business Company” (50% of news articles), whose aim is promoting and selling
1677 Nano products. This results is consistent with the results of study 1: the majority of
1678 Nano news is commercial advertisings. The effect of NPNT project, in around 20 %
1679 Taiwanese Nano news “, Government (including Government agencies,
1680 Government research institutions)” play an important actor to only promote Nano

1681 developing for our National interest. In the other words, the over optimistic media
1682 attitude toward Nano in Taiwan which find in study 1, could be caused by the
1683 commercial sponsorships and further fostered by our government's policies. There is
1684 no surprise, business company hold the only positive attitude in media toward Nano.
1685 However, the results in table 15 and 17 are disappointingly showing out Taiwan
1686 government not only had enough risk awareness for developing the emerging
1687 science like Nano, but also lacked the sense for regulating the related process of
1688 research, development and released of the daily life Nano products by business
1689 companies. According to the results, Taiwan government neglected its duty to be a
1690 qualified gate keeper to supervise the uncertainties and damages of Nano developing
1691 in Taiwan.

1692 In the meantime, the absence of scientists and education actors (k-12 school
1693 and museum) in Taiwan Nano news articles has been pointed out in tables 15 and
1694 17. Since the related knowledge and influence of Nano are relatively obstacle and
1695 unfamiliar to public, how to communicate the related possible risks and influence of
1696 Nano developing with public by media, should be an important task for scientists
1697 and educational actors as a remedy. However, the results of table 15 and 17 showed
1698 there is still a lot of room for improvement for our formal and informal educational
1699 system. Also, we need to encourage scientists to be more positive participants in
1700 media discourse. This should positively impact future public understanding of
1701 science, and enhance science-related policies developed in Taiwan.

1702 The result of Chi-square test (Table 17) is provided to answer research question
1703 2: Do different actors have their preference of frame using toward Nano in Taiwan?
1704 In Table 17, the result pointed out, affected by the promotion of National Program
1705 of Nano (NPNT), the government (the government agencies and government
1706 research institutions) tends to use the National interest frame to portray the Nano,
1707 while simultaneously demonstrating lower usage of the commercial prospect frame.
1708 However, the science frame is not significantly emphasized by the government. The
1709 description of Nano by the government is quite abstract, and is mostly focused on
1710 the potential benefit toward nation but does not mention the use of Nano of our daily
1711 life (commercial prospect frame) and the core nature of science of Nano (science
1712 frame). In other words, the government only pointed out that Nano will benefit the

1713 nation but did not tell the public how it will affect our life and, more importantly,
1714 what Nano is. Nano is an emerging science, within which the related knowledge of
1715 impacts are still developing. Failing to provide comprehensive information about
1716 Nano in combination with strong promotion of Nano by the government is
1717 dangerous and irresponsible. That is, the Taiwanese government has led the nation
1718 into a situation which focuses on development of a technology that the public does
1719 not fully understand.

1720 In contrast, the actors in research institutions such as universities and other
1721 educational institutions frequently use the nature of science of Nano (science frame)
1722 and tend toward communication with the public (communication frame). In the
1723 meantime, the commercial prospect and national interest frames are less used to
1724 portray Nano by education institutions. However, even though education institutions
1725 make the effort to communicate science, the lack of knowledge of our daily life using
1726 regarding Nano (commercial prospect frame) still exists. The actors of Scientists and
1727 public have the same problem. The scientists and educational institutions have the
1728 bias of only focusing on scientific research results but ignore the practical applications
1729 of Nano. The knowledge and information which connect scientific researches and
1730 practical applications of neonatology should become the vital goal for future science
1731 communication to help the public form their own opinions and evaluations, allowing
1732 for better critical decision making regarding government policies toward Nano.

1733 Business companies show the most interest in the commercial prospect frame
1734 in our Nano news and less focus on other frames. This results points out that the
1735 commercial articles in our Nano news are affected by commercial sponsorship. The
1736 business company is only focused on the promotion of Nano products but ignores the
1737 scientific mechanism behind the products and also lacking the warning of potential

1738 damage of Nano by our daily use. Product usage warning and labeling should be an
1739 important policy to be implemented by the Taiwanese government.

1740 The international actor in our Nano news is mainly a discussion about
1741 national interest but not like the results of research from countries like the USA, EU
1742 and Canada which openly discuss the benefits and damages of Nano. The reason for
1743 this situation is that the international articles in our Nano news are more focused on
1744 the positive results of Nano on the development and economies of different countries
1745 for the evidence to support the policy of National Program of Nano (NPNT). We
1746 should be concerned by the lack of comprehensive views toward Nano when our
1747 media report the news from foreign countries. The effect of agenda setting seems to
1748 be that the media tends to report the views consistent with the government.
1749 Considering that Nano is still a developing emerging science, enriching our media
1750 reporting to adopt more multivariate views, research results, and opinions should be
1751 the next goal for Taiwanese media in order to help the public to form more
1752 comprehensive evaluations.

1753 The risk frame is only being significantly used by Government agencies.
1754 However, upon further review, the reason the risk frame is often used is because the
1755 Taiwanese government has policy to regulate “fake Nano products” but not focus on
1756 the potential damage of Nano development. The awareness of potential damage of
1757 Nano is uniformly ignored in the media discourses by government, educational
1758 institutions, public, business companies, international and even scientists in Taiwan.
1759 In other words, Taiwan media seems to be too excessively optimistic toward Nano,
1760 which may the lead public’s awareness to be biased. This bias should be of concern

1761 given that the media are a main source of information for citizens regarding this topic,
1762 and are therefore on the front line of helping the public to make better decisions.

1763

1764

1765 **7. Study 3- Public attitude toward Nano in Taiwan**

1766 **(1) Methodology**

1767 In order to explore the relationships between the different frames of how
1768 participants view Nano and the degree of the public's confidence in news sources
1769 toward the public attitude toward Nano, the following 17 items (translated from the
1770 original Chinese) were selected from the original survey instrument by the author for
1771 further analysis for study 3.

1772 Item 15: "Generally speaking, in near twenty years, would you think Nano will
1773 bring the good or bad effect?" This items will provide a general opinions of how
1774 public think of Nano.

1775 Item 19: "Someone said 'Nano can make better products which can make life more
1776 comfortable' However, someone said 'developing Nano will threat environment and
1777 health'. There are both side stories. Would you support to developing Nano?" This
1778 item's wording includes the opinions from supported and unsupported sides as a
1779 reference for participants. The public's considerations and choices between benefits
1780 and risks of Nano can be show as results.

1781 Item 20: "Someone said' generally speaking, Nano brings more benefits than risk to
1782 human'. Would you agree or not?" This item reflects the public opinion about the
1783 relative risk of Nano.

1784 Science Items 15, 19, 20 directly ask the participant's attitude toward the
1785 development of Nano, and thus the rescaled sum scores of items 15, 19, and 20
1786 represent the public attitude toward Nano (Cronbach's Alpha=0.605).

1787 Table 20. Distribution of responses for dependent variables

Dependent variables	Question wording	Response scale	%
The public attitude toward Nano	Item 15. Generally speaking, in near twenty years, would you think Nano will bring the good or bad effect?	Good effect	68.6
		No effect	8.7
		Bad effect	5.2
	Item 19. Someone said “Nano can make better products which can make life more comfortable” However, someone said” developing Nano will threat environment and health”. There are both side stories. Would you support to developing Nano?	I don’t know/didn’t answer	17.4
		Very supported	14.2
		Supported	52.7
		It depends	7.4
		Less supported	8.6
		Very not supported	4.0
	Item 20. Someone said” generally speaking, Nano brings more benefits than risk to human”. Would you agree or not?	I don’t know/didn’t answer.	13.1
		Very agree	14.0
		Agree	43.6
		It depends	3.8
		Disagree	16.9
		Very disagree	5.9
	I don’t know/didn’t answer.	15.7	

1788

1789 In the literature review, the definition of framing is classified into two different
 1790 meaning, each based on psychological and sociological theories. In study 1 and 2,
 1791 based on the psychologically rooted definition, framing approaches the question of
 1792 how the media guides the public to think about Nano (Kahneman et al. 1979;
 1793 Kahneman 1983). In the present study, the definition of frames is based on
 1794 sociological theories, in which frame is defined as a tool and schema for individual to
 1795 construct and interpret the Nano by they view. In other words, the framing effect of
 1796 this study will be described as how individuals view and emphasize the role of Nano
 1797 plays.

1798 Thus, the descriptions of different frames follow the coding instrument which
1799 was developed by the author in studies 1 and 2. The items which correspond with
1800 each frame depend on the role that Nano plays in the item description in the original
1801 questionnaire. Based on the coding instrument of framing in the author’s last two
1802 studies, if the items of the original survey questionnaires use Nano as a discrete
1803 scientific concept, those items will be chosen to represent the effect of the science
1804 frame. The idea is: If a participant gives a more positive answer or higher scores to
1805 the item’s context which value the “science” character of Nano, it reflects that he/she
1806 recognizes the role of Nano as “science” and has thus been effected by the science
1807 frame when he/she touches upon Nano. Items 22, 23 and 31 ask questions focused on
1808 the scientific role of Nano, so the rescaled sum scores of Items 22, 23, 31 are used to
1809 describe the effect of the science frame (Cronbach’s Alpha=0.634).

1810 Following the above idea, Item 24 is a question related to the character of
1811 Nano to promote business and interest in daily life (e.g., industrial devices, beauty,
1812 cosmetic, and living goods), so the score of items 24 is used to describe the effect of
1813 the commercial prospect frame.

1814 The descriptions of Nano in items 35, 36, 37 are as an educational subject or
1815 public science communication issue. These cover topics such as Nano-related
1816 programs and degrees, K-12 curricula, and public workshops. Thus, the average score
1817 of items 35, 36 and 37 is used to describe the effect of the communication frame
1818 (Cronbach’s Alpha=0.602). The original results of item 35, 36 and 37 are true or false
1819 questions. Thus, if the respondent answers in the affirmative, he/she will have a score
1820 of “1” on each question. Negative or uncertain responses were coded as “0”.

1821 Item 21 asks about how Nano can be an agent for enhancing national interest
1822 and competitiveness via government policy support and funding investment, the
1823 importance of Nano for national economic growth and science and technology
1824 development, comparison of national competitiveness between Taiwan and other
1825 countries. Accordingly, the score of item 21 is used to describe the effect of the
1826 National interest frame.

1827 Concerns of the development of Nano and the related risks and regulations are
1828 the emphasis in items 25, 26, 27, 28 and 30. The rescaled average scores of those
1829 items is used to describe the effect of the risk frame (Cronbach's Alpha=0.751).

1830 Also, the degree of confidence in Nano news sources is also taken account via
1831 item 14, with lower scores meaning less trust toward media reports.

1832 Item 11 asks, "Have you ever heard about Nano?" and is used to distinguish the
1833 people who did or didn't hear about Nano. Of the 1077 respondents, there are 101
1834 respondents (9.4%) which claimed he/she had not ever heard about Nano. Because
1835 study 3 is focusing on the public attitude toward Nano, the respondents who hadn't
1836 heard about Nano will be excluded for further analysis. The distribution of responses
1837 for each variable are presented as table 20 and 21.

1838 According to the author's study 1, since the majority of Nano news articles is
1839 commercial advertisings, and mostly focus on cosmetic products and home
1840 supplements, it is reasonable to consider young female has been taken as the target
1841 audience for Nano commercial new articles in Taiwan media. Thus, the author is
1842 curious about does the difference of gender and age will impact public's attitude
1843 toward Nano in study 3.

1844 In the meantime, the results of study 1 and 2 pointed out that education frame and
1845 actors has lower exposures in Taiwanese media and thus further investigating the

1846 relationship between public's educational level and their attitude toward Nano will be
1847 a worthy question to ask in study 3. Thus, in study 3, gender, age and educational
1848 level has been take into account as the independent variables.

1849

Table 21. Distribution of responses for public attitude toward Nano

Independent variables	Question wording	Response scale	%
The effect of National Interest frame	Item 21: Someone said” developing Nano can increase our national economical and industry competitiveness”. Would you think this statement is right or not?	Very Right	21.5
		Right	44.5
		It depends	3.3
		Less right	12.9
		Wrong	4.6
		I don't know/didn't answer.	13.2
The effect of commercial prospect frame	Item 24: Someone said “the applications of Nano can help to make relatively cheaper and durable products” Would you think this statement is right or not?	Very Right	9.8
		Right	27.2
		It depends	4.4
		Less right	30.3
		Wrong	11.7
		I don't know/didn't answer.	16.6
The effect of science frame	Item 22: Someone said “the application of Nano can improve the medical technical and help to improve the treatment of diseases” Would you think this statement is right or not?	Very Right	24.2
		Right	46.0
		It depends	1.9
		Less right	8.0
		Wrong	2.2
		I don't know/didn't answer.	17.7
	Item 23: Someone said “the applications of Nano can filter the air and water pollution, and improve the ecological environment”. Would you think this statement is right or not?	Very Right	12.2
		Right	38.4
		It depends	3.3
		Less right	15.8
		Wrong	6.7
		I don't know/didn't answer.	23.7
	Item 31: Someone said” if we want to control the use of Nano, it is likely to affect the developing of scientific research”. Would you agree or not?	Very agree	21.1
		Agree	39.0
		It depends	0.9
Disagree		17.2	
Very disagree		10.5	
I don't know		11.3	
The effect of communication frame	Item 35. Someone said” Nano can process material into the size which human eyes can't see? ” Would you think this stamen is right or not?	Wrong	34.0
		Correct	66.0
	Item 36: Someone said” Nano will bring us the next industry revolution”. Would you think this stamen is right or not?	Wrong	32.6
		Correct	67.4
	Item 37: Someone said “Nano can produce atomic and molecular structure which cannot naturally aligned.”	Wrong	53.8
		Correct	46.2
The effect of	Item 25: Someone said “even the scientists	Very agree	36.5

risk frame	can't make sure some risk of developing Nano" Would you agree or not?	Agree	44.4
		It depends	0.6
		Disagree	5.7
		Very disagree	1.6
		I don't know/ didn't answer	11.2
	Item 26: In the future, Nano can be used in humans or genetic research, so some people say that this technology will lead to the moral conflicts of development of science and. Would you think it will happen or not?	Must will	28.9
		Likely	43.0
		It depends	1.5
		Maybe not	13.1
		Must not	3.0
		I don't know/ didn't answer	10.5
	Item 27: Would you think the products of Nano will affect human healthy or not? And, will you concern about it?	Will affect, very concern	30.0
		Will affect, concern	19.3
		Will affect, medium concern	2.0
		Will affect, less concern	3.4
		Will affect, not concern	1.4
		Will not affect	22.7
		I don't know/ didn't answer	21.1
		Item 28: Would you think Nano will affect ecological environment? And, will you concern about it?	Will affect, very concern
	Will affect, concern		22.8
	Will affect, medium concern		1.1
	Will affect, less concern		4.8
	Will affect, not concern		1.1
	Will not affect		16.0
	I don't know/ didn't answer		17.3
	Item 30: Nano can create a small monitoring device, and do you think such a device will be used to infringe on personal privacy? And, will you concern about it?		Will reduce, very concern
Will reduce, concern		19.1	
Will reduce, medium concern		1.3	
Will reduce, less concern		5.2	
Will reduce, not concern		3.1	
Will not		8.7	

		reduce	
		I don't know/ didn't answer	6.1
The degree of confidence in Nano news sources	Item 14: "Would you trust the information of Nano from media report"	Very trust	8.1
		Trust	50.1
		It depends	9.9
		Less trust	23.6
		Very not trust	3.5
		I don't know/didn't answer	4.8

1852

1853

1854

1855 **Analysis**

1856 Firstly, a descriptive analysis will be used to explore the results of the
1857 questionnaire, in order to provide an overview of the Taiwanese public's attitude,
1858 knowledge and awareness toward Nano.

1859 According to previous research based on the same data, the gender, age and
1860 educational level of participants are statistically significantly related to individuals
1861 'attitudes toward Nano(Lin, Li, et al. 2010). In order to further investigate the
1862 relationship among different framing effects, a host of variables including gender, age
1863 and educational level will be used in a regression analysis to answer the research
1864 questions. In other words, the author is curious about if and how prototypical
1865 individuals tend to hold specific frames to depict and understand Nano? Each framing
1866 effects will be set as dependent variable, and gender, age and educational level will be
1867 set as independent variables in five different regression models. The results will
1868 answer the question: Do preferences in their portrayal and definition of Nano differ
1869 based on gender, age and educational level?

1870 In addition, a regression model will be used to investigate the relationship
1871 between different framing effects (Science, Commercial prospect, National interest
1872 frame and Risk), and the degree of the public's confidence in news sources toward
1873 public attitude toward Nano.

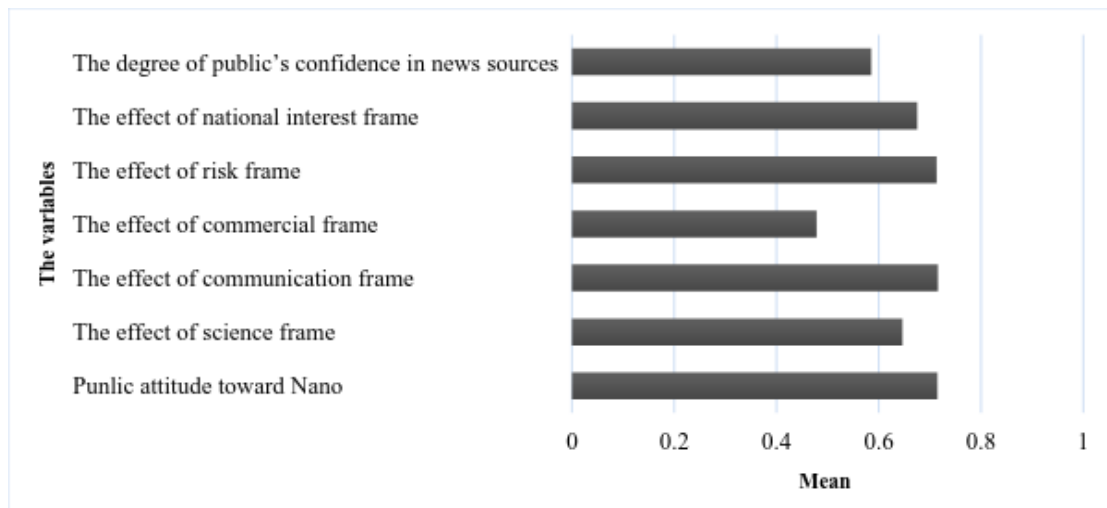
1874 **(2) The Results and Discussion of Descriptive analysis**

1875 Given that the data were collected by a telephone survey, there are some
1876 unexpected missing values (people quit the survey interview in the middle or refused

1877 to answer some question) in the raw data. All of the missing values and the scores of
1878 the participants who answered “I don’t know” are automatically replaced by values
1879 based on the results of Multiple Imputation (MI) using SPSS 21.0. The MI procedure
1880 is used in order to calculate and generate possible values for missing values, by
1881 creating several "complete" sets of data (Murnane & Willett, 2010).

1882 The 17 items chosen for this study use different score scales. In order to compare
1883 the average performance of each, the normalized score of each item is calculated by
1884 the formula: $z(\text{new scale}) = [X - \min(x)] / [\max(X) - \min(X)]$. Standardized scores (like
1885 Z scores) place the data in the same scale, but some of the rescaled values will be
1886 negative. In order to provide a more intuitive visualization and comparing results,
1887 normalization scores is being used for rescale data values from 0 to 1. The mean
1888 scores of each variable are show in the figure 9

1889 As figure 9, exclude the variable: “the effect of commercial frame”, the mean
1890 scores of other variables are all higher than 0.5. The results pointed out the public
1891 attitude toward Nano and public trust of media are both positive, and the effect of
1892 science, communication, national interest, risk frame are effective in generally in
1893 Taiwanese public.

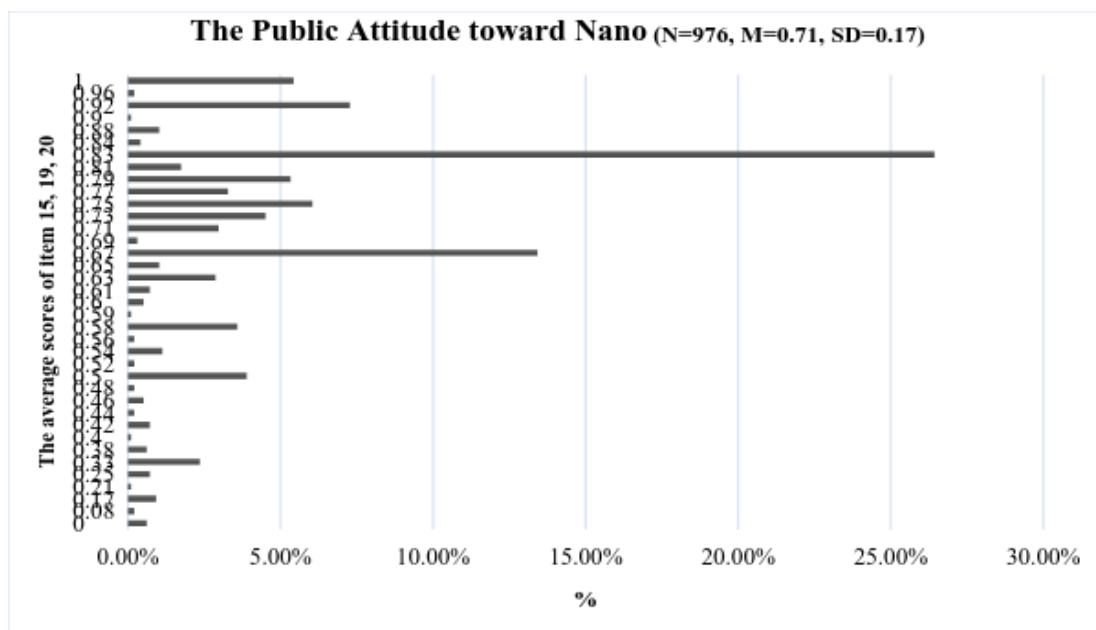


1894

1895 Figure 9. The mean scores of the all variables.
1896

1897 **Public Attitude toward Nano**

1898 The new variable “Public Attitude toward Nano” was generated by averaging the
1899 normalization score of items 15, 19, and 20. According to Figure 10, from 0 to 1, the
1900 mean of public’s attitude toward Nano is 0.73 (SD.=0.17, and 80 % of respondents
1901 scored over 0.5 points, which indicates that the public attitude toward Nano is
1902 generally positive. A total of 41 missing values and the scores of “I don’t know/refuse
1903 to answer” have been automated replaced values by the results of Multiple Imputation
1904 (MI).



1905
1906 Figure 10. The description of the public attitude toward Nano.
1907

1908 **The Effect of Science Frame**

1909 The new variable “Effect of Science Frame” was generated by averaging the
1910 normalization scores of items 22, 23 and 31 from original survey questionnaire, where
1911 higher scores indicate the participants more strongly recognize the character of
1912 science of Nano. This means the participants are more likely be affected by the
1913 science frame when considering Nano.

1914 According to Figure 11, the mean of the effect of science frame is 0.66
 1915 (SD.=0.18), and 81.7% of respondents scored over 0.5 points. These results indicated
 1916 most of the participants emphasized the character of Nano in a scientific frame. In
 1917 order words, the effect of the science frame plays an important role when individuals
 1918 are considering Nano. A total of 45 missing values and the scores of “I don’t
 1919 know/refuse to answer” have been replaced values via MI.

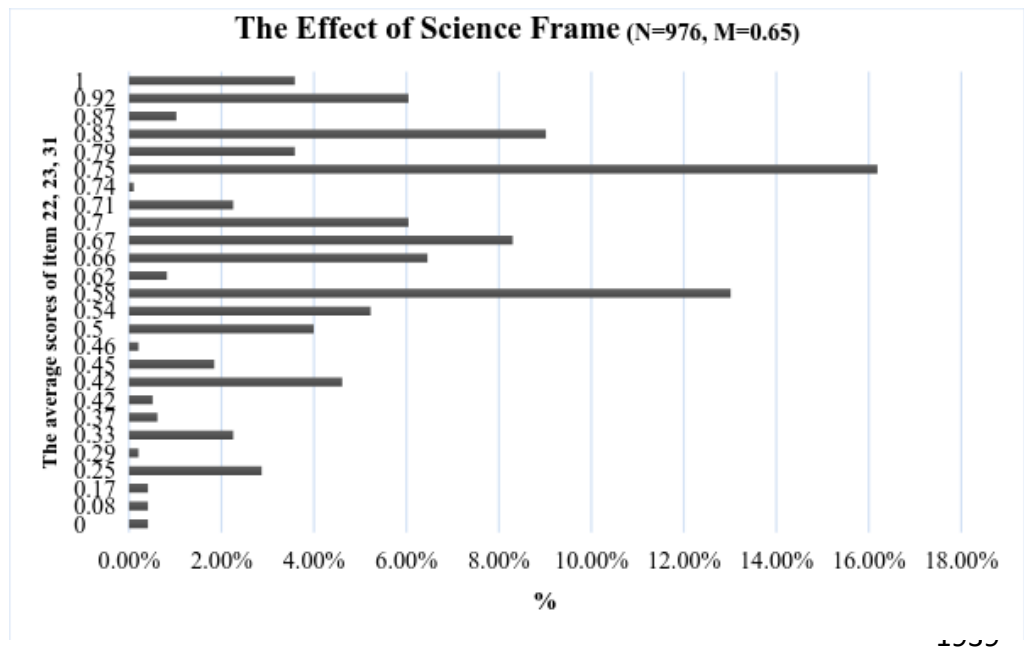


Figure 11. The description of the score of the effect of science frame

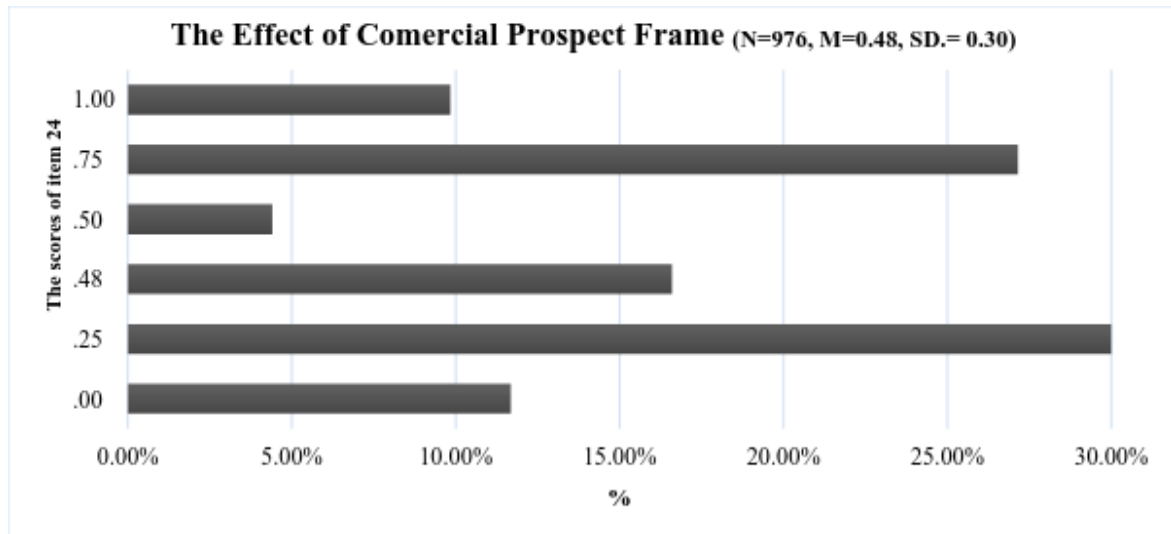
1940

1941 **The Effect of Commercial Prospect Frame**

1942 The scores of item 24 were recoded to show that higher scores indicate a
 1943 stronger effect of the commercial prospect frame. The variable of the effect of
 1944 commercial prospect frame presented the respondent’s value from 0 to 1, as in figure
 1945 12.

1946 The mean score of the effect of commercial prospect frame is 0.48 (SD.= 0.30).
 1947 Figure 12 also points out the distribution of the scores of the effect of commercial
 1948 frame Is potentially bimodal. According to the distribution in figure 12, the results
 1949 points out which means the perception of public to think of the role of Nano as
 1950 commercial product are bifurcated. Total 162 missing values and the scores of “I

1951 don't know/refuse to answer" have been automated replaced values by the results of
1952 Multiple Imputation (MI)

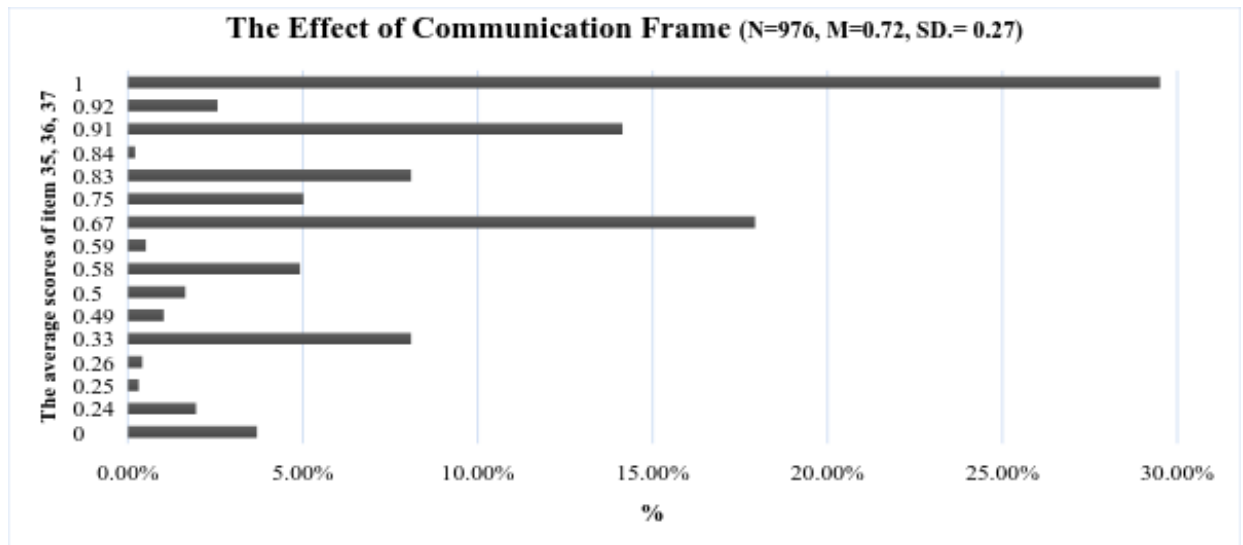


1953
1954 Figure 12. The description of the score of effect of commercial prospect frame.
1955

1956 **The Effect of Communication Frame**

1957 The "Effect of the Communication Frame" variable is generated by averaging
1958 the normalization scores of items 35, 36, and 37, which capture the effect of the
1959 commercial prospect frame with a range of 0–1, where higher scores indicate stronger
1960 effects.

1961 The mean score of the effect of communication frame is 0.75 (SD. =0.26) as
1962 figure 13. Most of the respondent's scores are higher than 0.5 points (84.5%). One
1963 interesting result is that 29.5% of participants scored 1 point. Since one of the goals of
1964 the National Program on Nano Technology (NPNT) is encouraging the development
1965 of Nano curriculum in formal education and the informal education systems like
1966 museum and scientific workshops, it is little surprise that nearly one third of
1967 participants viewed Nano via a communication-based frame. A total of 49 missing
1968 values and the scores of "I don't know/refuse to answer" have been recovered via MI.



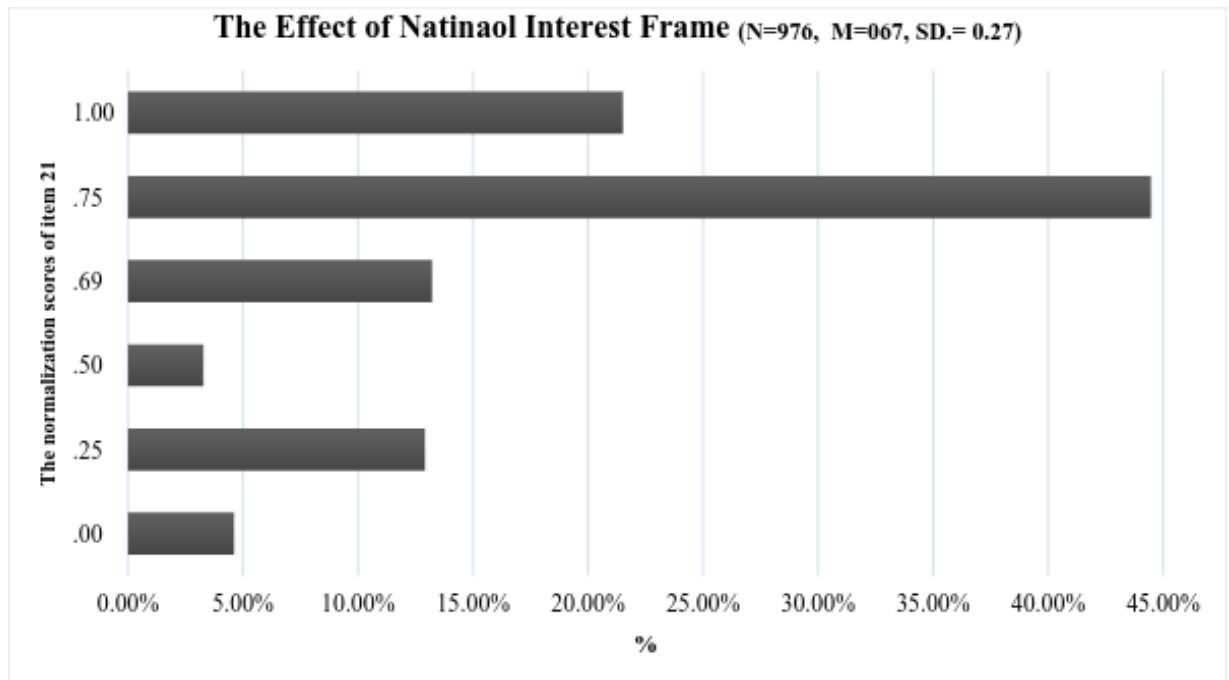
1969
1970
1971

Figure 13. The description of the score of effect of communication frame.

1972 **The Effect of National Interest Frame**

1973 The scores of item 21 were recoded with the higher scores indicating participants
1974 more highly valued the contributions of Nano toward National interests. By using
1975 item 21, the new variable “Effect of National Interest Frame” is presented by the
1976 respondent’s normalization scores from 0-1.

1977 Per figure 14, 79.2% of respondents’ scores regarding the effect of the national
1978 interest frame were higher than 0.5, and the average was 0.69 (SD.= 0.27). This result
1979 shows most of the Taiwanese public thought the development of Nano was a benefit
1980 and contribution our national competitiveness. In other words, the national interest
1981 frame is widely used to capture beliefs about Nano by the Taiwanese public. A total
1982 of 129 missing values and the scores of “I don’t know/refuse to answer” were
1983 replaced via MI.



1984

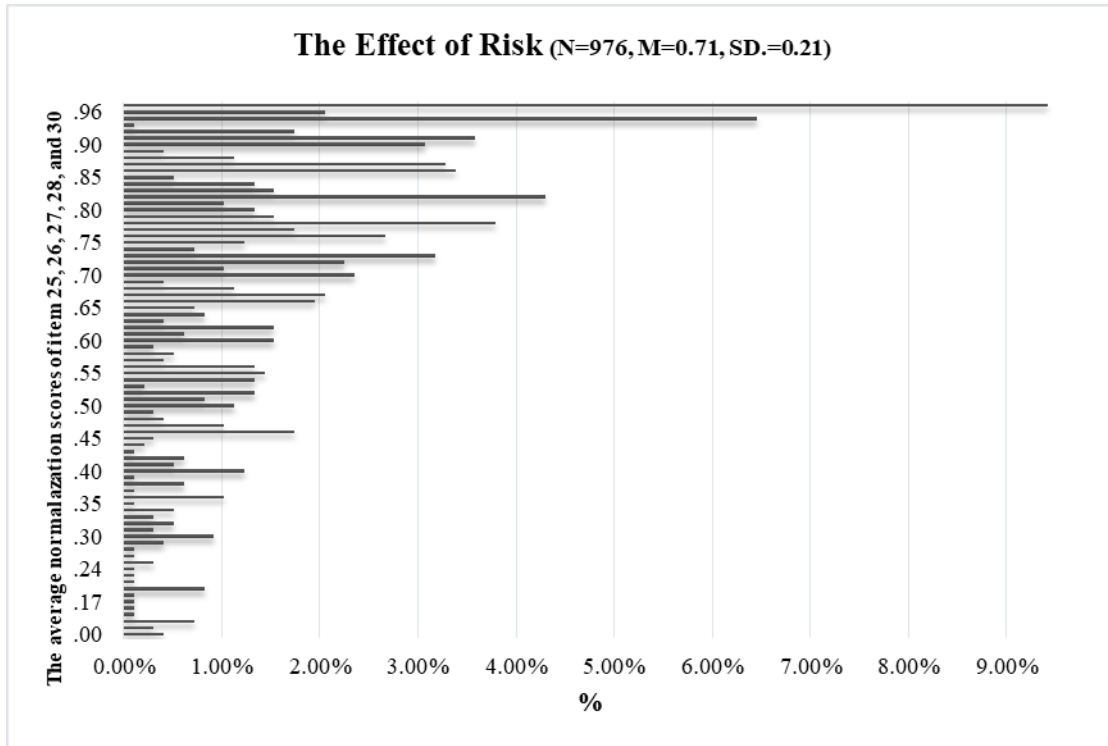
1985 Figure 14. The description of the score of effect of national interest frame.

1986

1987 **The Effect of Risk Frame**

1988 The “Effect of the Risk Frame” variable is the average normalization scores of
 1989 item 25, 26, 27, 28, 30, by which higher scores represent the participants are more
 1990 focused on the risks of Nano. In other words, if a participant has higher scores in the
 1991 effect of risk frame, it indicates that the effects of possible risk guide their views of
 1992 Nano. This generates a single measure capturing the effect of risk frame with a range
 1993 of 0–1 (as figure 15).

1994 Ranging from 0 to 1, the average score of the effect of the risk frame is 0.73
 1995 (SD.=0.21) and the trend of the effect of risk frame is skewed to higher scores as
 1996 show as figure 15. Not that 84% of respondents (with scores higher than 0.5) claim a
 1997 relatively high concern of the risk of developing Nano. The results show the risk
 1998 frame is a very common thinking strategy for Taiwanese public, when they consider
 1999 Nano. A total of 21 missing values and the scores of “I don’t know/refuse to answer”
 2000 have been replaced using MI.



2001
2002

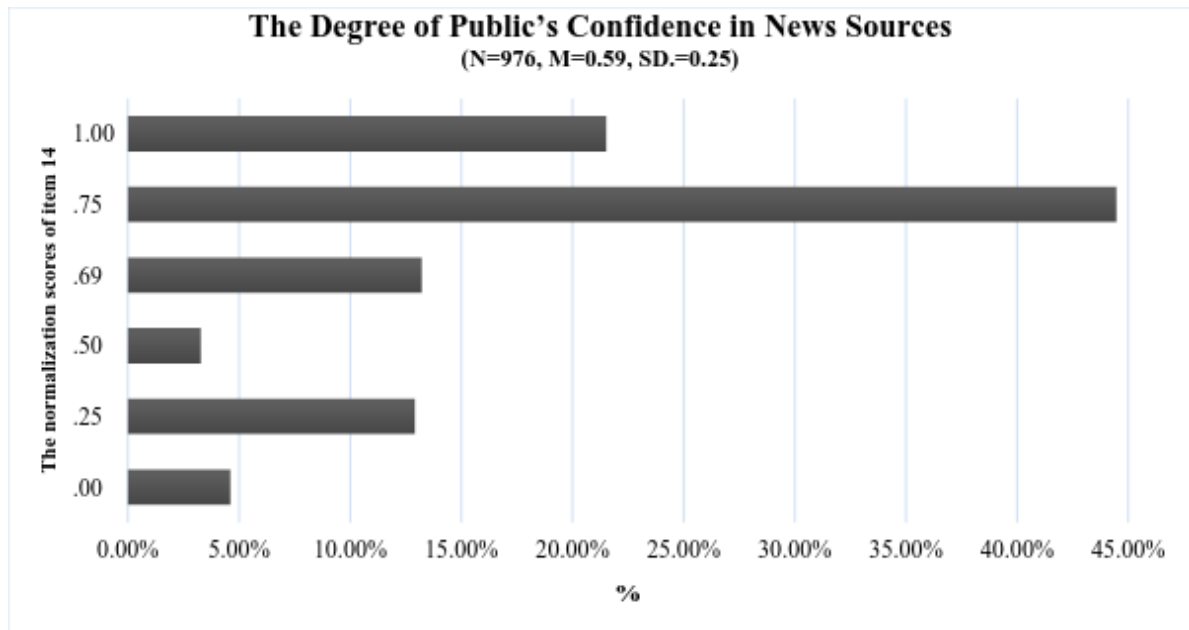
2003 Figure 15. The description of the score of effect of risk frame.
2004

2005 **The Degree of Public’s Confidence in News Sources**

2006 The scores of item 14 were recoded from the raw data such that higher scores
2007 indicate more confidence in news sources.

2008 The text of item 14, “Would you trust the information of Nano from media
2009 report,” is used to represent the degree of public’s confidence in news sources. The
2010 normalization scores of item 14 represent the degree of the public’s confidence in
2011 news sources from 0 to 1. According to figure 16, the mean of the degree of
2012 confidence of news source is 0.59 (SD.=0.25). We note that 79.2% of respondents are
2013 over 0.5 points, which means most members of the public have a high confidence in
2014 news sources. Base on this result, the public in Taiwan seems to take media reports as
2015 reliable sources to obtain information regarding Nano. Since the Taiwanese media
2016 attitude toward Nano is overwhelmingly positive, due to the effect of commercial

2017 sponsorship (commercial prospect frame), and the public in Taiwan has a high trust
 2018 toward media when considering Nano, it is a very interesting exploration to further
 2019 investigate if the public attitude are also affected by the influence of the commercial
 2020 prospect frame. A total of 122 missing values and the scores of “I don’t know/refuse
 2021 to answer” have been replaced via MI.



2022
 2023 Figure 16. The description of the score of the degree of public’s confidence in news sources
 2024

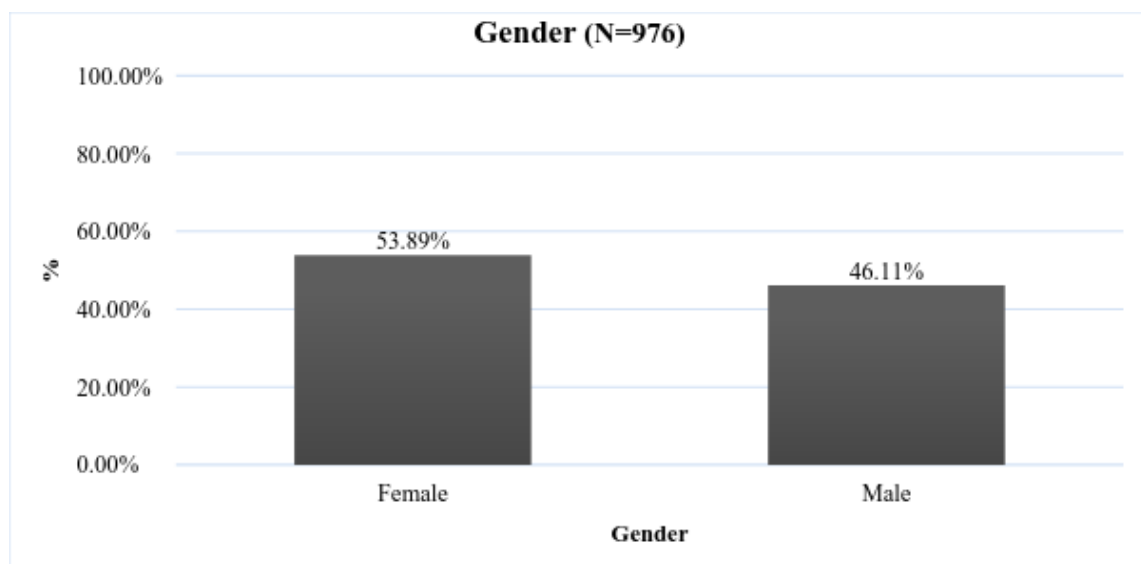
2025 **Gender, Age and educational level**

2026 A total 976 responses regarding gender have been collected from the telephone
 2027 interview survey, excluding the participants who claim he/she hadn’t heard about
 2028 Nano. 55.89% of the respondents were female (N=526) and 46.11% (N=450) of the
 2029 respondents were male in the data (as figure 17). The numbers of female are slightly
 2030 higher than male, but the numbers from the male and female are generally equally
 2031 balance in this study.

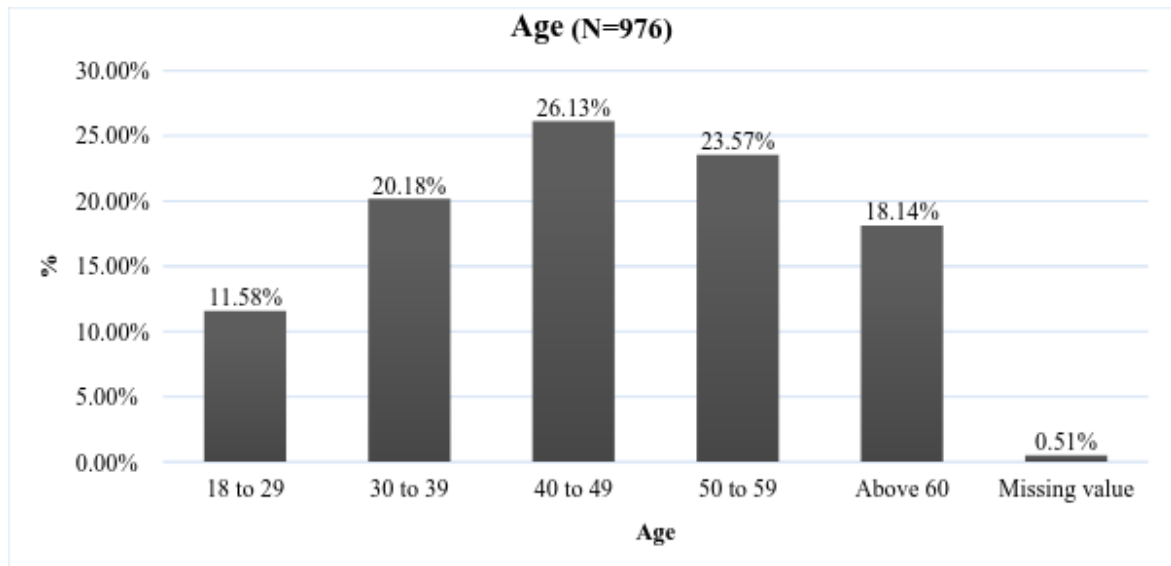
2032 The ages of the participants in the original survey were coded from 1 to 5 (1: 18
 2033 years old to 29 years old, 2: 30 years old to 39 years old, 3: 40 years old to 49 years

2034 old, 4: 50 years old to 59 years old, 5: 60 years old and above). A total of 972
2035 participants were taken into further analysis, with 4 missing values. Most of the
2036 participants in this study are between 30 and 59 years old, as seen in figure 17. The
2037 numbers of younger (18 to 29 years old) and elder (above 60 years old) participants
2038 are relatively low, but there is a balanced number in different age groups in
2039 general.

2040 The educational levels in the original survey questionnaire were coded in 5
2041 options: (1) Elementary school and under, (2) Junior high school, (3) High school, (4)
2042 College and (5) University and above. In this data set, 5 cases were missing data, so a
2043 total of 971 cases with educational levels will be used as a variable in the following
2044 analysis. Per figure 18, the most data in this study is composed of participants who
2045 received the degree of high school (30%) and university and above (38.4%). Per
2046 figure 19, more than one of third participants (38.4%, N=375) received the degree
2047 from University (as bachelor, master or doctor degree).



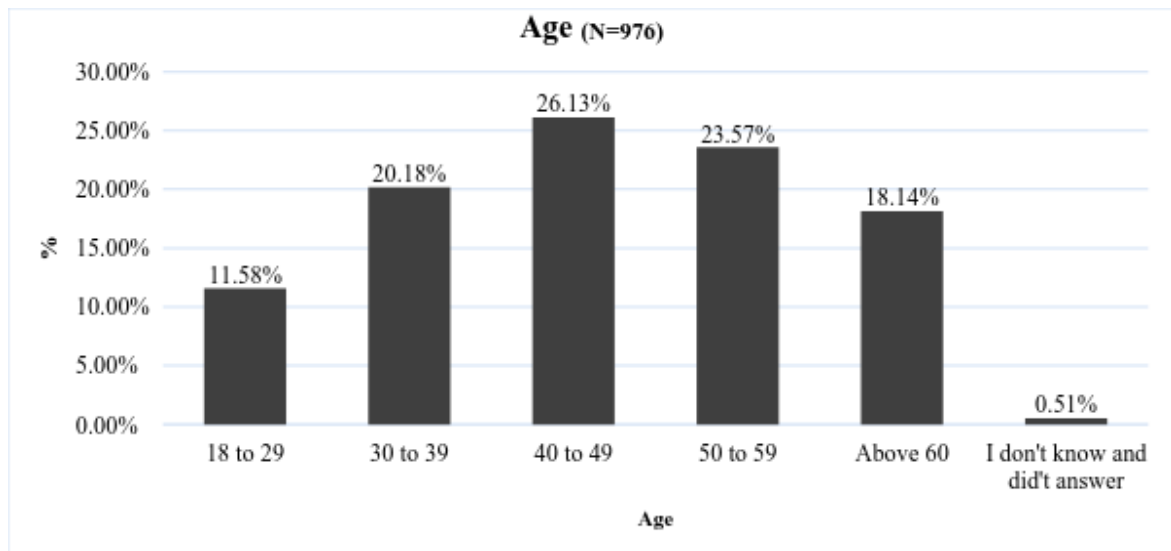
2048
2049 Figure 17. The description of the gender.



2050

2051

Figure 18. The description of the age.



2052

2053

2054

Figure 19. The description of the educational level.

2055

(3) Regression Analysis I- The relationship among different framing effects, gender, age and educational level

2056

2057

One of the research goals of this study is to figure out the relationship between

2058

the demographic characteristics of the Taiwanese public and the effects of different

2059

framing with regards to Nano. More specifically speaking, the author wants to explore

2060

the question: Do preferences in the portrayal and definition of Nano differ based on

2061

gender, age and educational level?

2062 In this regression analysis section, the different framing effects will be used as
2063 the dependent variable in each model. According to previous research based on the
2064 same survey data, researchers pointed out the gender, age, and educational level are
2065 all significant factors related to Taiwanese public attitude toward Nano (Chen, Lin, &
2066 Cheng, 2013). Thus, the gender, age, and educational level will be set as independent
2067 variables in each model.

2068 According to previous research results, people between the ages of 50 to 59 have
2069 a significant positive attitude toward Nano, compared to the other age groups (Lin,
2070 Wu, et al. 2010), so the age group of “50 to 59” will be set as reference group for the
2071 further analysis.

2072 The previous research results (Lin, Wu, et al. 2010) also suggested that
2073 individuals who receive a university degree or higher have a significant high attitude
2074 toward Nano compared to the other public receive different degrees, so the University
2075 and above will be set as reference group for the regression analysis.

2076 Since the regression analysis is based on the data which already performed by
2077 Multiple Imputation, in order to show the final results from different imputations, the
2078 pooled results of each model will be reported as table 22. And, the value of R^2 in each
2079 model are calculated by simply calculating the mean across the imputation results.
2080 The hypothesized population-level models in this study are as follows:

2081 Model 1: Science Frame_i = $\alpha + \beta_1(\text{Male}_i) + \beta_2(\text{Age}_i) + \beta_3(\text{Education}_i) + \varepsilon_i$

2082 Model 2: National Interest Frame_i = $\alpha + \beta_1(\text{Male}_i) + \beta_2(\text{Age}_i) + \beta_3(\text{Education}_i) + \varepsilon_i$

2083 Model 3: Communication Frame_i = $\alpha + \beta_1(\text{Male}_i) + \beta_2(\text{Age}_i) + \beta_3(\text{Education}_i) + \varepsilon_i$

2084 Model 4: Commercial Prospect $Frame_i = \alpha + \beta_1(Male_i) + \beta_2(Age_i) + \beta_3(Education_i) + \varepsilon_i$

2085 Model 5: Risk $Frame_i = \alpha + \beta_1(Male_i) + \beta_2(Age_i) + \beta_3(Education_i) + \varepsilon_i$

2086 Where:

2087 α is the population level evaluation of the given frame for the reference groups in
2088 all vectors and interactions (Female, 50 to 59, University and above)

2089 β_1 is the estimated effect of gender (Male:1, Female:0) on the public attitude
2090 toward the given frame.

2091 β_2 is the estimated effect of age (18 years old to 29, 30 to 39, 40 to 49, 50 to 59,
2092 60 and above, coded as 1-5) on the given frame.

2093 β_3 is the estimated effect of educational level (elementary school and under,
2094 junior high school, high school, college, university and above, code as 1, 2, 3, 4, 5, 0)
2095 on the public attitude toward the given frame.

2096 ε_i is the residual (unexplained) variance the dependent variable in each model

2097

2099 Table 22. The results of linear regression model among gender, age, educational level, five different framing effects.

		Model 1		Model 2		Model 3		Model 4		Model 5	
The effect of different framing		Science		National Interest		Communication		Commercial Prospect		Risk	
		B	SE	B	SE	B	B	B	SE	B	SE
Interception		.651***	.018	.708***	.027	.702***	.026	.490***	.031	.740***	.024
Gender	Male	.048*	.012	.047*	.019	.050**	.019	.077***	.021	-.074***	.017
Age	18 to 29	.039	.024	-.043	.036	.087*	.035	-.005	.041	-.005	.033
	30 to 39	.011	.019	-.029	.029	.008	.029	-.037	.035	-.003	.027
	40 to 49	-.009	.018	-.057*	.027	.025	.027	-.057	.034	.005	.025
	Above 60	.001	.021	.008	.029	.012	.030	.013	.043	-.017	.028
Educational Level	Elementary school and under	-.075*	.029	-.114*	.044	-.134**	.046	.006	.048	-.208***	.040
	Junior high school	-.092***	.025	-.111**	.037	-.101**	.036	-.080	.042	-.134***	.034
	High school	-.048***	.016	-.047	.024	-.032	.024	-.041	.028	-.065**	.022

	College	-.013	.021	.030	.029	-.005	.029	-.045	.033	-.052	.027
		R²=0.340***		R²= 0.169**		R²=0.285***		R²=0.187**		R²= 0.253***	

2100 *p<.05; **p<.01; ***p<.001.
2101

2102

2103 **(4) The Results and Discussion of Regression Analysis I- The relationship**
2104 **among different framing effects, gender, age and educational level**

2105 One of the research question is: Will the Taiwanese public hold a specific frame
2106 to consider Nano, or be affected by certain frames to acknowledge and identify Nano,
2107 based on their demographic characters? The relationship among different framing
2108 effects, gender, age and educational levels are presented as the results of regression
2109 model (Table 22).

2110 According to table 22, the results of model 1, 2, 3, 4 and 5 showed males, on
2111 average in the population, have significantly higher science, National interest,
2112 communication, and commercial prospect frames than females, when they consider
2113 Nano, by controlling for age and educational levels. Compared to females, males are
2114 more likely to emphasize the character of science in Nano ($B=0.048$, $p<0.05$), value
2115 the role of Nano as an agent for helping our national competitiveness ($B=0.047$,
2116 $p<0.05$) and also more agree to take Nano as an educational subject or public science
2117 communication issue which is need to communicate the related information to
2118 students or public ($B=0.05$, $p<0.01$).

2119 An interesting result of the gender difference to influent different framing effects
2120 are male tend to consider Nano as a commercial product ($B= 0.077$, $p<0.00$) and are
2121 relatively less concerned with the risks of Nano ($B=-0.074$, $p<0.00$) than females,
2122 when controlling the age and educational levels of participants. These results are
2123 interesting because the exploring of the media presentation toward Nano in Taiwan in
2124 author's last two studies pointed out that Nano commercial news articles are mostly
2125 promoting the Nano cosmetic (like beauty masks) and household products (like air
2126 cleaner), and according to the writing of those Nano commercial news articles, the

2127 target audience is likely female. Furthermore, since males are more likely to value the
2128 contributions of Nano toward the developing of science and our national interest, that
2129 could be the reason why male are not so worried about the risks of Nano. It will be a
2130 very interesting research question to explore how gender differences impact an
2131 individual's consuming behaviors of Nano products, since the authenticity and related
2132 effects of Nano products has already raised the emphasis of different national
2133 government (André Donk, Julia Metag, Matthias Kohring 2012a; Dudo, Choi, et al.
2134 2011).

2135 By controlling the gender and educational levels, the difference of framing effect
2136 between age group from 50 to 59 and other age groups are not very prominent. Only
2137 two framing effects are statically significantly influenced by participant's age, by
2138 comparing to the age group from 50 to 59: National Interest ($B=-.057$, $p<0.05$) and
2139 Communication frame ($B=0.087$, $p<0.05$). The participants aged 40 to 49 have
2140 significantly lower scores framing Nano as a helper to our national competitiveness.
2141 This unique results could be explained by the employee's age structure in
2142 manufacturing and technical industry in Taiwan. According to the authors' study 2,
2143 Business Company is an important main actor in producing Nano news articles, since
2144 the one of the goals of the most highly funded government Nano program, the
2145 National Program on Nano Technology (NPNT), is shepherding industrial
2146 transformation by emerging Nano techniques. Most of the companies who benefited
2147 from NPNT are in the manufacturing and technical industries. According to a news
2148 article from a famous elite financial magazine, Common Wealth Magazine, the age of
2149 the owner and CEO in the top 10 wealth manufacturing and technical industries are
2150 around 50 to 60 years old (Chen, 2015), as like the age reference group in this study.
2151 In general, even though the differences are not statistically significant we note that all

2152 the B values in model 4, other age groups all give less emphasis for Nano as a helper
2153 toward our national interest than the reference age group 50 to 59(the age of owner
2154 and CEO in top 10 wealth manufacturing and technical industries).

2155 And the employees in manufacturing and technical industry whose age from 40
2156 to 49 are facing a brutal ageism, when compared to younger employees. The former is
2157 not familiar with emerging techniques and also have less energy to learn something
2158 new. That maybe a reason why the participants whose age from 40 to 49 didn't hold
2159 the national interest frame to view Nano. If Nano is a vital developing goal for
2160 manufacturing and technical industry to enhance our national competitiveness, the
2161 public age from 40 to 49 may feel more worries about their future career
2162 development, so they would rather not value Nano as a helper of our national
2163 development. According to our results, if industries transform by using Nano as an
2164 improving agent, the focus should not only be on introducing, researching and
2165 developing emerging techniques of Nano but also on the related on-the-job training
2166 for all employees in order to concentrate a mutual vision between companies and
2167 employs in Taiwan.

2168 Another significant difference between the reference age group (from 50 to 59)
2169 and their peers is in the effect of communication frame. As seen in table 22, in model
2170 3, the results showed the participants aged from 18 to 29 are more willing to describe
2171 Nano as educational subject or public science communication issue which is need to
2172 communicate the related information to students or public. According to a national
2173 survey of Human Resource Statistics, conducted by the Taiwanese Directorate
2174 General of Budget, Accounting and Statistics (DGBAS) of Executive Yuan the
2175 average age of college graduation and beginning working age in Taiwan is 22 years

2176 old(Taiwanese Directorate General of Budget 2017). The participants aged 18 to 29
2177 are still in or are just leaving our educational system, so it could be an explanation of
2178 why participants in this age group tend to capture Nano by communication frame. The
2179 results seem to reflect a dire situation: when the Taiwanese public touches upon Nano,
2180 most of the public doesn't recognized the importance of the science communication
2181 toward Nano.

2182 Even though one of the goals of NPNT is developing the related curricula and
2183 ways to obtain information related to Nano in our formal and informal educational
2184 systems, the results in this study showed there still a lot of room to improve to raise
2185 the awareness of the Taiwanese public in regards to the public scientific debate and
2186 discussion toward Nano. Since the risks and concerns of developing Nano have
2187 already be presented by researchers from different fields (Macnaghten et al. 2005),
2188 ways to improve our policies and strategies of science communication toward Nano
2189 should become the next vital goal for our government in the next stage of NTPT.

2190 In terms of the effect of participant's educational levels toward different framing
2191 effect, controlling for gender and age, the results (per table 22) indicate that there is
2192 no significant difference between individuals who completed college and who
2193 completed university and above.

2194 A surprising result in model 4 is presented on table 22. When considering the
2195 Nano products, there is no difference between different educational levels. However,
2196 commercial news articles are the most numerous articles in our media, based on
2197 author's last two studies. This results may imply that the Taiwanese public may
2198 demonstrate no difference when distinguishing various Nano product commercials in
2199 our media. Since fake Nano products have been reported in Taiwan, how to help the

2200 public have more abilities to choose Nano products and more regulations of Nano
2201 products should be vital attention for our government.

2202 In table 22, excluding the role of commercial prospect which presented by Nano,
2203 individuals who only received the degree of elementary and junior high school show
2204 statically significantly less emphasis the role of Nano in our daily life, than the
2205 individuals who received the degree from university. Regardless of if it is the
2206 character of science ($B=-.075$, $p<0.05$), national interest ($B=-.134$, $p<0.01$),
2207 communication ($B=-.114$, $p<0.05$), and risk ($B=-.208$, $p<0.001$) of Nano, the public
2208 that have only elementary and junior high degrees tend to have less awareness of the
2209 value of Nano in each fields. The lack of related curricula and science communication
2210 efforts toward Nano in our formal education system can be supported by the above
2211 results (as table 22). These results support the reason why it is so important to use
2212 media to raise public awareness, opinions and attitude toward Nano. In Taiwan, after
2213 graduating and leaving the formal educational system, the main resource for the
2214 public to obtain and update their knowledge and information is media (Lin, Tseng,
2215 Liu, & Chang, 2012). Thus, exploring and invigilating media representation and
2216 attitude should be a focus for the Taiwanese researchers who work in the fields of
2217 science communication and public understanding of science, and those results can be
2218 a point of reference for future government budget arrangement and supported in order
2219 to encourage more beneficial science communication projects and programs by
2220 cooperation of government, academic researchers, and media.

2221 According to the results comparing different educational levels, if an individual
2222 has a lower educational level (below junior high school), he/she will have less
2223 understanding of Nano, and not only in the scientific knowledge frame, but also the

2224 awareness of the benefits and risks of Nano toward our daily life, compared to the
2225 individuals who have university degree. Individuals who received the high school
2226 diploma give less consideration to the importance of Nano by using the scale of
2227 science and risk. The above results indicate there is still a lot room for our formal
2228 educational system to develop more related curricula in the stages of elementary,
2229 junior high school and, high school. Maybe the interest of individuals toward science
2230 could be vary, but understanding the benefits and risks of Nano (or any emerging
2231 science and technology) toward our life should be a common scientific literacy for a
2232 modern citizen.

2233 In summary, based on our results of Regression Analysis I- The relationship
2234 among different framing effects, gender, age and educational level: gender plays an
2235 important factor in how individuals view and consider Nano. Further investigations of
2236 gender differences in the consumption patterns of Nano products would be a worthy
2237 study for our understanding of the gender differences in the media commercial effect
2238 and consuming preference toward new scientific/technology products. And the
2239 influence of age toward Taiwanese public's value of Nano shows the importance of
2240 the focusing efforts toward on-the-job training and that policies of science
2241 communication should be emphasized. In the end, the important of future research of
2242 media representation and attitudes toward emerging science is supported by the
2243 results of the education and commutation frame, in order to encourage more
2244 beneficial science communication projects and programs in the media and enhance
2245 public scientific literacy for each Taiwanese citizen.

2246 **(5) Regression Analysis II- The relationship among public attitude toward Nano,**
2247 **framing effects and degree of the public confidence in news source.**

2248 In this section, the regression analysis will be used to provide the results of the
2249 how is the public attitude toward Nano be influenced by the different five framing
2250 effect (science, commercial prospect, national interest, communication and risk
2251 frame) and the degree of the public confidence in news source.

2252 According to the previous research base on the same survey data in this study 3,
2253 Lin, Li and Chou (2010) pointed out the age, gender and education level will
2254 contribute the certain effect to shape the public attitude toward Nano. Thus, the
2255 gender, age and educational level are being used as control variables to fit the
2256 regression models. Since the variable of educational level are nominal variables
2257 (elementary school and under, junior high school, high school, college and university
2258 and above), the university and above are set as reference group for further analysis.

2259 The research questions toward the relationship among public attitude, framing
2260 effects and public's confidence in news source are separated in to more specific
2261 questions: (1-1) Do different five framing effects and public confidence in news
2262 source have different effects on public attitude toward Nano, controlling for the
2263 gender, age and educational level of participants? (1-2) What is the most affective
2264 framing effects on public attitude toward Nano, controlling for the gender, age,
2265 educational level and public confidence in news source of participants? (1-3) what is
2266 public confidence in news source's effect on public attitude toward Nano, controlling
2267 for the gender, age and educational level and different framing effects of participants?

2268 Since the regression analysis is based on the data which already performed by
2269 Multiple Imputation, in order to show the final results from different imputations, the
2270 pool results of each model will be reported as table 23. And, the value of R^2 in each

2271 model are calculated by simply calculating the mean across the imputation results.

2272 The equation of regression models are described as following:

2273 Model 1: Public Attitude toward Nano_i = $\alpha + \beta_1(\text{Gender}_i) + \beta_2(\text{Age}_i) + \beta_3(\text{Education}_i) +$
2274 ε_i

2275 Model 2: Public Attitude toward Nano_i = $\alpha + \beta_1(\text{Gender}_i) + \beta_2(\text{Age}_i) + \beta_3(\text{Education}_i)$
2276 $+ \beta_4(\mathbf{F1}_i) + \varepsilon_i$

2277 Model 3: Public Attitude toward Nano_i = $\alpha + \beta_1(\text{Gender}_i) + \beta_2(\text{Age}_i) + \beta_3(\text{Education}_i) +$
2278 $\beta_5(\mathbf{F2}_i) + \varepsilon_i$

2279 Model 4: Public Attitude toward Nano_i = $\alpha + \beta_1(\text{Gender}_i) + \beta_2(\text{Age}_i) + \beta_3(\text{Education}_i) +$
2280 $\beta_6(\mathbf{F3}_i) + \varepsilon_i$

2281 Model 5: Public Attitude toward Nano_i = $\alpha + \beta_1(\text{Gender}_i) + \beta_2(\text{Age}_i) + \beta_3(\text{Education}_i) +$
2282 $\beta_7(\mathbf{F4}_i) + \varepsilon_i$

2283 Model 6: Public Attitude toward Nano_i = $\alpha + \beta_1(\text{Gender}_i) + \beta_2(\text{Age}_i) + \beta_3(\text{Education}_i) +$
2284 $\beta_8(\mathbf{F5}_i) + \varepsilon_i$

2285 Model 7: Public Attitude toward Nano_i = $\alpha + \beta_1(\text{Gender}_i) + \beta_2(\text{Age}_i) + \beta_3(\text{Education}_i)$
2286 $+ \beta_9\mathbf{T}_i + \varepsilon_i$

2287 Model 8: Public Attitude toward Nano_i = $\alpha + \beta_1(\text{Gender}_i) + \beta_2(\text{Age}_i) + \beta_3(\text{Education}_i)$
2288 $+ \beta_4(\mathbf{F1}_i) + \beta_5(\mathbf{F2}_i) + \beta_6(\mathbf{F3}_i) + \beta_7(\mathbf{F4}_i) + \beta_8(\mathbf{F5}_i) + \beta_9\mathbf{T}_i + \varepsilon_i$

2289 α is the population level evaluation of media item “i” for the reference groups in all
2290 vectors and interactions (Female, 50 to 59, University and above)

2291 β_1 is the estimated effect of gender (Male:1, Female:0) on the public attitude toward
2292 Nano item “i”.

2293 β_2 is the estimated effect of age (18 years old to 29, 30 to 39, 40 to 49, 50 to 59, 60
2294 and above, coded as 1-5) on the evaluation of media item “i”.

2295 β_3 is the estimated effect of educational level (elementary school and under, junior
2296 high school, high school, college, university and above, code as 1, 2, 3, 4, 5) on the
2297 public attitude toward Nano item “i”.

2298 $\beta_4, \beta_5, \beta_6, \beta_7, \beta_8$ are the estimated effect of a vector of five different framing effect
2299 variables on the public attitude toward Nano item “i”.

2300 β_9 is the estimated effect of a vector of public confidence in news source variables on
2301 the public attitude toward Nano item “i”.

2302 ε_i is the residual (unexplained) variance of public attitude toward Nano “

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Table 23. The results of Multivariate Multiple Regression Model among gender, age, educational level, five different framing effect and public's confidence level in news source

		Model 1		Model 2		Model 3		Model 4		Model 5		Model 6		Model 7		Model 8	
		B	SE	B	SE	B	B	B	SE	B	SE	B	SE	B	SE	B	SE
Interception		.738* **	.018	.494* **	.029	.552* **	.024	.668* **	.026	.689* **	.023	.881* **	.026	.590* **	.023	.481* **	.034
Gender		.045* *	.013	.027* *	.012	.033* *	.012	.040* *	.013	.038* *	.013	.033* *	.013	.039* *	.012	.015	.011
Age	18 to 29	.009	.023	-.006	.021	.020	.021	.000	.022	.009	.023	.003	.022	-.004	.021	-.009	.020
	30 to 39	.002	.019	-.002	.018	.010	.018	.002	.019	.006	.019	-.002	.019	-.002	.018	-.002	.017
	40 to 49	-.014	.017	-.011	.016	.001	.016	-.017	.017	-.009	.018	-.015	.017	-.014	.016	-.006	.015
	Above 60	-.007	.019	-.007	.018	-.009	.017	-.008	.019	-.008	.019	-.007	.018	-.012	.018	-.012	.016
Educational Level	Elementary school and under	-.128* **	.027	-.099* **	.025	-.098* **	.025	-.114* **	.027	-.128* **	.027	-.154* **	.026	-.114* **	.025	-.100* **	.023
	Junior high school	-.123* **	.025	-.089* **	.023	-.094* **	.024	-.113* **	.024	-.115* **	.025	-.137* **	.024	-.099* **	.024	-.079* *	.022
	High school	-.066* **	.015	-.048* *	.015	-.054* **	.015	-.063* **	.015	-.062* **	.015	-.074* **	.015	-.060* **	.015	-.049* **	.014
	College	.001	.019	.005	.018	-.007	.018	.001	.019	.005	.019	-.007	.018	-.006	.018	-.009	.017
Different five framing	Science			.376* **	.033											.224* **	.039

effects	National interest					.263* **	.023									.131* *	.030	
	Communication							.101* **	.024							.031	.024	
	Commercial prospect,									.100* **	.020						-.005	.019
	Risk											- .180* **	.026				- .116* **	.024
Public confidence in news source													.257* **	.023		.157* **	.022	
			$R^2=0.088$ ***	$R^2=0.225$ *** $\Delta R^2=0.137$ ***	$R^2=0.234$ *** $\Delta R^2=0.146$ * **	$R^2=0.110$ *** $\Delta R^2=0.022$ ** **	$R^2=0.115$ *** $\Delta R^2=0.027$ ** *	$R^2=0.134$ *** $\Delta R^2=0.046$ ** *	$R^2=0.212$ *** $\Delta R^2=0.124$ ** *	$R^2=0.354$ *** $\Delta R^2=0.266$ ** *								

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*p<.05;

**p<.01;

***p<.001

2308 **(6) The Results and Discussion of Regression Analysis II- The relationship**
2309 **among public attitude toward Nano, framing effects and degree of the**
2310 **public confidence in news source.**

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2312 In this section, the regression analysis results of the relationship among public
2313 attitude toward Nano, framing effects and degree of the public confidence in news
2314 source, by controlling participants' gender, age and educational level are presented as
2315 table 23, in order to answer following research question: (1-1) Do different five
2316 framing effects and public confidence in news source have different effects on public
2317 attitude toward Nano, controlling for the gender, age and educational level of
2318 participants? (1-2) among different affective factors (different framing effect and
2319 public's confidence toward news source), what is the most affective factor toward
2320 public attitude toward Nano, by controlling for the gender, age, educational level and
2321 public of participants?

2322 In order to answer question 1: "Do different five framing effects and public
2323 confidence in news source have different effects on public attitude toward Nano,
2324 controlling for the gender, age and educational level of participants?", the results of
2325 model 1 to 7 are provided on table 23. The results of the last column in table
2326 23 showed the change of R^2 between Model 1(control variables) and Model 2(science
2327 frame), model 1 and model 3(national interest frame), model 1 and model
2328 4(communication frame), model 1 and model 5(commercial prospect frame), and
2329 model 1 and model 6(risk frame), model 1 and model 7(degree of the public
2330 confidence in news source). According to the results of the change of R^2 between
2331 model 1 and other models, the effect of science frame ($\Delta R^2 = 0.137$, $p < 0.01$), national
2332 interest frame ($\Delta R^2 = 0.146$, $p < 0.01$), communication frame ($\Delta R^2 = 0.022$, $p < 0.01$),
2333 commercial frame ($\Delta R^2 = 0.027$, $p < 0.01$), risk frame ($\Delta R^2 = 0.046$, $p < 0.01$), and the
2334 degree of the public confidence in news source ($\Delta R^2 = 0.124$, $p < 0.01$) statically

2335 significantly impact public attitude toward Nano, by controlling gender, age and
2336 educational level. The results showed the effects of science, national interest,
2337 communication, commercial prospect, and risk frame and the degree of the public
2338 confidence in news source are all have significantly different impact for public's
2339 attitude toward Nano, by controlling gender, age and educational level. In other
2340 words, the following analysis results of the different effective of different frames and
2341 the degree of the public confidence in news source toward public attitude toward
2342 Nano should be provided for further discussions.

2343 The results of model 8 in table 23 are responded to the questions two: among
2344 different affective factors (different framing effect and public's confidence toward
2345 news source), what is the most affective factor toward public attitude toward Nano, by
2346 controlling for the gender, age, educational level and public of participants? The most
2347 effective factor to impact public attitude toward Nano is the effecting of science frame
2348 as shown by the significant coefficient of .224($p < 0.001$) and following by the
2349 effective of public confidence in news source($B = .157$, $p < 0.001$), risk frame($B = -.116$,
2350 $p < 0.01$) and national interest frame($B = .131$, $p < 0.01$). The interesting results in model
2351 8 showed even the framing effect of communication and commercial prospect are
2352 show the significantly impact in model 5 and 6, but when we consider and add more
2353 different factors into the final model 8, the impact of communication and commercial
2354 prospect frame are disappeared.

2355 According to the above results, if the participants have more concerns of the risk
2356 of Nano (using the risk frame to consider Nano), their attitude toward Nano will
2357 significantly lower. However, based on the static analysis results in this study 3, the
2358 effect of public's risk awareness toward Nano still can't compete with the impact of

2359 the overwhelming positive attitude which constructed by public's emphasis on the
2360 science and national interest contributions of Nano. Thus, the general public attitude
2361 toward Nano still present an extreme positive attitude (Scale from 0 to 1, $M=0.73$,
2362 $SD.=0.17$), as the result on table 23.

2363 One of an interesting results showed in model 8 is the effecting of commercial
2364 frame is not significantly impact public attitude toward Nano. However, according to
2365 the finding in study 1 and 2, the commercial Nano products promotion articles which
2366 affected by commercial sponsorships are the most exposure news articles in
2367 Taiwanese media reports toward Nano. This results may point out, public seems not
2368 very aware about Nano as a products or even they aware Nano is be used in the
2369 products in our everyday life, but they won't take it in the consideration and further
2370 form their attitude toward Nano. "Are/why public didn't view Nano as a technology
2371 be used in the products in our everyday life?" and "why public didn't aware of the
2372 possible concerns about Nano products?" could be the following research questions to
2373 investigate.

2374 In this final regression results of model 8, we can see the effect of science and
2375 national interest frames play the vital roles to influent Taiwanese public's attitude
2376 toward Nano. In order words, when controlling participant's gender, age and
2377 educational level, if the participants more tend to use science and national interest
2378 frame to construct and interpret Nano, their attitude toward Nano are more positive in
2379 this study. It is a very worrying results which indicated when come in to the
2380 considering of science and national interest, Taiwanese public seems to hold a
2381 positive attitude, which mean the related risks or concerns come along with science

2382 researching and national development are not come in to public's minds when they
2383 think of science and national development.

2384 It is very dangerous way to consider "science" and "National interest". Using our
2385 study context as an example, the damages and risks of Nano developing are already
2386 being found and presented by many researches in ethical, social, and environmental
2387 fields (Macnaghten et al. 2005; Scheufele et al. 2007; Hansen et al. 2008). In Taiwan,
2388 numbers of the risk and concerns of developing Nano and related regulation policies
2389 building have been wildly discuss in law, public health and occupational injury
2390 researches, and the reports and safety working manual related to Nano working injury
2391 which published by Taiwanese government (Institute of Labor, Occupational Safety
2392 and Health, 2014,2015; Wan-Ping Ho, 2014). Even Nano as an agent to help our
2393 scientific and national competitive are fruitful, but the research evidences are already
2394 provided to show that there are many worthy concerns toward Nano developing.
2395 However, there is a gap of risk awareness toward Nano among government/researches
2396 and public, when we discuss the issues related to science and national interest. The
2397 possible explanation for the awareness gap among government/ researchers and public
2398 is the lacking of communication.

2399 If we switch our attention on the impacts of public confidence in new source
2400 toward public attitude toward Nano, the results showed in model 8 pointed out the
2401 public's trust toward news sources significantly influent their attitude toward Nano, if
2402 a participant have a more trust toward news source, he/she are tending to hold a more
2403 positive attitude toward Nano. The exploring results of media representation of Nano
2404 in Taiwan (study 1 and 2) pointed out the news articles which emphasize on the
2405 character of science and national interest of Nano in Taiwanese media, are

2406 overwhelming positive and rarely bring the negative discussion about Nano into the
2407 news articles. This single-oriented reporting about the roles of Nano in science
2408 researches and national development issues could cause a blindly worship of Nano but
2409 couldn't consider a more comprehensive view to figure out the whole consequence of
2410 science and technology developing for our society, especially when it come into the
2411 public issues related to emerging science.

2412 The results of the higher educational public are tending to have more positive
2413 attitude toward Nano can be considered as a support evidence to this worrying about
2414 the public worship toward Nano (the emerging science), by comparing the
2415 participant's educational level and controlling other possible factors. Even received a
2416 university/collage degree, the higher educational public in Taiwanese didn't have
2417 more risk awareness toward Nano (as table 23, in model 8). Thus, there is not only the
2418 related knowledge provided in our formal/informal educational system, but the
2419 changing and improving the communication among government, researches and
2420 public in Nano issues should be the most important goal for our future Nano policies
2421 building. Otherwise, all the efforts of the researchers and government toward the
2422 investigating of Nano impacts are not be benefited to enhance our public's
2423 understanding of Nano.

2424 In sum, Taiwanese public's attitude toward Nano are overall very positive. Even
2425 the effecting of risk frame toward public attitude toward Nano is significantly, but still
2426 can't compete with the huge positive effects from science and national interest
2427 frames. The higher education of public didn't bring more attention toward the risks of
2428 Nano, even the related damages has already been proofed and provide by many
2429 researches, which means the shortage of understanding about the limitation and

2430 uncertainty of emerging science/technology should be concerns and improved in our
2431 future formal education. Why Taiwanese public always thinking the bright side of
2432 Nano but ignore the dark side is an important research question to follow up. And, the
2433 lacking of science communication toward Nano between government, researchers and
2434 public in Taiwan is a worthy concern for our future developing of Nano. According to
2435 this, the related discussions of the new types and opportunities of science
2436 communication in Taiwan toward Nano or any emerging science/technology will be
2437 discussed in the final conclusion by the author.

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2457 **8. Conclusions**

2458 **(1) Summary of the empirical findings**

2459 In this section, I present a summary of the results of the previous three empirical
2460 studies, and discuss what information was uncovered about media representation and
2461 public attitude toward Nano in Taiwan. The main findings of my three studies will be
2462 briefly presented in this section.

2463 According to study 1's results, there was a total of 1739 Nano news articles in
2464 United Daily News data from 2002 to 2009, 44% of news articles are in the "Nano
2465 product" theme, 31% in "Policy" theme and more than half of news articles use the
2466 "Commercial prospect" frame (53.6%) to describe Nano, while only 14.2% of Nano
2467 articles use the "National interest" frame to emphasize the role of Nano as a lever for
2468 national competitiveness. In general, the agenda setting and framing of Nano in the
2469 Taiwanese media are derived by commercial sponsorship and the National Program of
2470 Nanotechnology (NPNT), which can be seen from the numerous news articles that are
2471 related to Nano products and policy themes, and the high exposure of the commercial
2472 prospect and National interest framings. The impression and role of Nano in the
2473 media has been shaped as an emerging scientific tool which not only benefits public
2474 daily life but also increases the national economic competitiveness of Taiwan. Thus,
2475 since the effects of agenda setting and framing seemed to impact the media's attitude

2476 toward Nano, which was overwhelmingly positive (89% of news article hold positive
2477 toward Nano).

2478 Following study 1's results, in study 2, the author tried to answer: Why is the
2479 attitude toward Nanotechnology so unitarily positive in Taiwanese media? Who are
2480 the most visible actors of Nanotechnology in the Taiwanese media discourse, and
2481 what is the relationship among main actors, framing effects, and the media's attitude
2482 toward Nano?

2483 The results of study 2 indicate the most dominant main actor in the Taiwanese
2484 Nano news is "Business Company", which was always the leading actor toward Nano
2485 in the Taiwanese media from 2002 to 2009, followed by "Research institution of
2486 university" and "Government agencies", "Government research institutions", and
2487 "Scientists". Different actors do have different preference of certain frame usage, but
2488 excluded "Research institution of university" which tend to use "Science" frame to
2489 describe Nano. Commercial sponsorships and National Program of Nanotechnology
2490 (NPNT) strongly affect the others main actor's voice in the media: "Business
2491 Company" actors strongly prefer to portray Nano by a "Commercial prospect" frame
2492 and "Government agencies and research institutions" use the "National interest"
2493 frame to promote Nano's contribution toward Taiwan's national competitiveness. The
2494 other worthy pointed findings in study 2 are that the "Risk" frame toward Nano are
2495 rarely used, and that actors from Education, Interest Groups, and International have
2496 less coverage in Nano news articles in Taiwan, which can explain why Taiwanese
2497 media evaluation is so positive toward Nano news.

2498 This is inn contrast to the previous research from the US and Europe, where
2499 vocal minorities can voice concerns about Nano in the media (Dudo, Choi, &

2500 Scheufele, 2011; Siegrist, Stampfli, Kastenholz, & Keller, 2008; Stephens, 2005;
2501 Tyshenko, 2013). Even though the work related risks and concerns caused by Nano
2502 particles in industry , which can lead to lung injury and dust fires and explosions,
2503 have already been presented by the Taiwanese government and researchers (Taiwan
2504 Institute of Labor, Occupational Safety And Health, 2011; Wong, 2010, 2011) the
2505 results of my studies still show that risk awareness toward Nano are rarely mentioned
2506 in Taiwanese media (Study 1) and are rarely held by the Taiwanese public(study 2) ,
2507 let alone generative reflection and discussion about the related concerns of
2508 environmental impact, public health, and ethics which may be caused by developing
2509 Nano (Macnaghten, Kearnes, & Wynne, 2005).

2510 The data used in Study 1 and 2 were drawn from the United Daily News data
2511 base (2002 to 2009). The United Daily News data base included four papers: (1)
2512 Economic Daily News, which emphasizes local, world economic and financial news,
2513 (2) United Daily News, one of three biggest newspapers in Taiwan, (3) United
2514 Evening News, and (4) Min-Sheng Daily, which focuses on entertainment, sports,
2515 outdoor life, home, and consumer news. All four newspapers belong to the United
2516 Daily news group is a fully private commercial operation and their main profit comes
2517 from the sale of advertising space in their periodicals and dailies. Thus, the possible
2518 reasons to explain the differences between Taiwan and the US/EU are not only the
2519 effect of commercial sponsorship and intentional promotion by the Taiwanese
2520 government by the National Program of Nanotechnology (NPNT), but also that Nano
2521 scientific knowledge and applications are disconnected and nanotechnology is not
2522 valued as a popular science communication issue in the Taiwanese media. In other
2523 words, even though Nano is an emerging science and technology which is widely
2524 used in different applications and products in our daily life, the Taiwanese public

2525 seems to not have enough background knowledge and, more seriously, have no
2526 intention/interest to connect the related knowledge and information toward Nano.

2527 As opposed of the US and EU governments, which have already increased the
2528 attention to the possible risks and damages from developing Nano (FDA, 2012; Shin,
2529 2013), the Taiwanese government's has rarely done so. For example, the government
2530 rarely mentioned the present/future risks of Nano by using a "Risk" frame in the
2531 media coverage, according to study 2's results. Thus, even though previous research
2532 results from other countries have provided fruitful references for developing and
2533 furthering public engagement with Nano issues in Taiwan, the local characteristic of
2534 the Taiwanese public, such as lacking awareness of related risk regulations, and
2535 lacking the connection between Nano knowledge and products, should be taken into
2536 account.

2537 Based on the results of study 1 and 2, it can be stated that the response to Nano
2538 has been overwhelmingly positive, regardless of the frames taken by actors or the
2539 media. Thus, in Study 3 the author attempted to determine 1) what the public's
2540 attitude toward Nano is given the "worshipping Nano" media context in Taiwan, and 2)
2541 do individuals have different preferences in their portrayal and definition of
2542 Nanotechnology, based on their gender, age and educational level?

2543 The data for study 3 were collected based on the 2013, "The Risk Perceptions
2544 about Nanotechnology and Policy Research", which was fund by Taiwan's
2545 Environmental Protection Administration. The sampled data were collected in 2013
2546 from 1,077 telephone survey respndents over 18 years of age. In order to investigate
2547 public opionion about the use of Nano in their everyday lives, the original

2548 questionnaire items were reselected base on the meaning of the item's stem. Each
2549 item's stem in the original questionnaire focused on the certain characteristic of Nano.

2550 According to the different meanings and descriptions of an item's stem, items
2551 were reclassified to present each participant's valuing of different characteristicistics
2552 of Nano. The idea is: If a participant gives a more positive answer or higher scores to
2553 the item's context which values a certain characteristicistic of Nanotechnology, it
2554 reflects that he/she is more likely to use a certain frame to consider Nanotechnology
2555 and has thus been effected by the certain frame when he/she touches upon
2556 Nanotechnology. For example, Item 31 in the original questionnaire is: "Someone
2557 said if we want to control the use of nanotechnology, it is likely to affect the
2558 developing of scientific research. Would you agree or not?" If a participant gives a
2559 more negative answer to Item 31's context, which values the "science" characteristic
2560 of Nanotechnology, it reflects that he/she recognizes the role of Nanotechnology as
2561 "science" and has thus been effected by the science frame when he/she touches upon
2562 Nanotechnology. According to above reclassification strategy, 17 items were selected
2563 from the original survey instrument and reclassified to represent each frame's effect
2564 toward the public's attitude toward Nano for further analysis in study 3.

2565 Not surprisingly but a little disappointingly, the results of study 3 indicated that
2566 the Taiwanese public's attitude toward Nano is extremely positive, which is consistent
2567 with Taiwanese media's overwhelming positive attitude. The average values of the of
2568 public's attitude toward Nano are positive, but males presented more positive attitudes
2569 toward Nano and much preferred to emphasize the characteristic of science in
2570 Nanotechnology, value the role of Nano as an agent for helping our national
2571 competitiveness, and also were more likely to agree to take Nano as an educational

2572 subject or public science communication issue which is need to communicate the
2573 related information to students or public. The very surprising finding of gender
2574 difference in study 3 is that males are more likely to consider Nano as a commercial
2575 product and are relatively less concerned with the risks of Nano than females, even
2576 though Nano commercial news articles are mostly promoting Nano cosmetics (like
2577 beauty masks) and household products (like air cleaner), and according to the writing
2578 of those Nano commercial news articles, mostly the target audience are the female
2579 audiences.

2580 Views on Nano were also stratified across educational levels. According to the
2581 results of study 3, if a prototypical individual has a lower educational level (below
2582 junior high school), he/she will have less understanding of Nano, and not only in the
2583 scientific knowledge, but also the awareness of the benefits and risks of Nano toward
2584 our daily life, compared to the individuals who have university degree. Even the
2585 individuals who received the high school degree give less consideration to the
2586 importance of Nano through the lenses of science and risk. The above results indicate
2587 there is still a lot room for our formal educational system to developing more related
2588 curriculums in the stage of elementary, junior high school, and high school.

2589 The results also show that the fact that more highly educated individuals tend to
2590 have more positive attitudes toward Nano can be viewed as evidence to this worrying
2591 trend about the public worship toward Nano (the emerging science), by comparing the
2592 participant's educational level and controlling other possible factors. Even subjects
2593 who received a university/collage degree, the higher educational public in Taiwan,
2594 didn't have more risk awareness toward Nano. Thus, there is not only the related
2595 knowledge provided in our formal/informal educational system, but changing and

2596 improving the communication among government, researchers, and the public in
2597 Nano issues should be the most important goal for our future Nano policy building.

2598 According to Shamos' and Miller's views, basic science and technology
2599 knowledge is an important factor for public to join science and social issues and form
2600 their opinions toward certain science/technology issues (Miller, 2011; Shamos, 1995).
2601 Thus, review and research (Bauer, 2009; Sturgis & Allum, 2004) pointed out that the
2602 use of a "deficit model" to discuss science/technology communication or public
2603 understand/ engagement of science and technology has been criticized. But in term of
2604 Taiwan's attitude toward Nano, the basic knowledge and related information toward
2605 Nano are still much needed basic materials for Taiwanese citizens to increase the
2606 public's' awareness of risk of Nano and more importantly, to bring more public
2607 attention and motivation to understanding and engaging Nano development in
2608 Taiwan. Thus, in Taiwan, the deficit model is not only used to "educate" the public
2609 but also to give a related "knowledge weapon" to build a related equal knowledge
2610 baseline with scientist and government in the debate and fights of related Nano issues.

2611 To summarize, interesting results from study 1 and 2 are that the "Science"
2612 frame, "Commercial prospect" frame, and "Education" frame are rarely used together
2613 to describe Nano in media coverage which indicated the disconnect between Nano
2614 knowledge and Nano applications in daily life. The results of the study 3 showed that
2615 the public's attitude toward Nano is overwhelmingly positive, and even the people
2616 with higher education levels did not show a higher understanding of Nano's risks,
2617 which means the shortage of understanding about the limitation and uncertainty of
2618 Nano or any new emerging science and technology should be a major concern, which

2619 can be addressed by improving our future formal education and science
2620 communication institutions.

2621 In short, my results showed that the Taiwanese media attitude and public attitude
2622 toward Nano are both overwhelming positive. These findings raise the following
2623 concerns. Firstly, the impression and role of Nano in the media has been shaped as an
2624 emerging scientific idol which not only benefits public daily life but also increases the
2625 national competitiveness of Taiwan. In addition, the low risk awareness of the public
2626 and media toward Nano and relatively weak connection between the public and
2627 scientists in Taiwan are also hinted at in the results of the above three studies.
2628 According to my results, Nano has become a vital component of helping Taiwan's
2629 future science and technology development and national competitiveness. However,
2630 important aspects of the science communication of Nano weren't attended to by the
2631 media or public, even though the application and products of Nano has already been
2632 used in their daily lives. Thus, the suggestions based on the aforementioned studies
2633 will be discussed in following section. These include (1) the reflection of "agenda
2634 setting" and "framing" will be provided with the intention of these concepts becoming
2635 the basis of future science communication research in Taiwan, (2) The role of
2636 scientists in our future scientific social discourse and, (3) the approaches and
2637 opportunities of science communication in Taiwan.

2638 (2) On "Agenda setting" and "Framing"

2639 According to the literature review, the theoretical background of the three studies
2640 is based on the two concepts: "Agenda setting" and "Framing". After exploring the
2641 media representation and public attitude toward Nano, the reflections and connections
2642 of the stated results toward the theoretical background are discussed in this section.

2643 The need to clarify the definitions of “agenda setting” and “framing” has been
2644 pointed out by Scheufele and Tewksbury (2007). Thus, in study 1, “agenda setting”
2645 has been defined as “what does media think is the higher importance and priority for
2646 the public, for certain issues compared to others” and “framing” is defined as “how
2647 the same information can be presented/constructed in different ways”. In order words,
2648 study 1 investigated how Nano issue can be reported by different themes (agenda
2649 setting effect) and what characteristic of Nano can be captured and described in
2650 different ways (framing) in a news articles. Within the contexts of the above
2651 definitions of agenda setting and framing, study 1 further investigated whether the
2652 different frame’s usage varied among news articles in different themes and how the
2653 Nano themes and frames are used separately or in combinations within the news. As a
2654 follow-up to study 1, study 2 used the same definitions of framing to explore the
2655 relationship among main actors, framing effects, and media attitudes toward Nano in
2656 Taiwan. The coding progress and results in study 1 and 2 used “theme” to present the
2657 “agenda setting effect” and “frame” to present “framing effect”, a response to the
2658 need for a clarification between “agenda setting” and “framing”. By the above efforts
2659 of distinguishing “agenda setting” and “framing”, the results of study 1 and 2 present
2660 a detailed exploration of the relationship between news articles’ ‘theme” and “frame”,
2661 the actor in the Nano news articles, and “media attitude” and captured a complex view
2662 of the media’s presentation of Nano in Taiwan.

2663 In the previous studies, the framing effects can be generally classified in to two
2664 ways: “equivalency framing” and “emphasis framing”(Cacciatore et al. 2016).

2665 Equivalency framing is based on psychological research (Cacciatore et al. 2016;
2666 Tversky &Kahneman 1973), which focused on how an equivalent information being

2667 described or contextualized in different ways will cause variation in the audience's
2668 views or opinions. The most common method in the research investigating the effect
2669 of equivalency framing was in a research environment similar to laboratory, which
2670 divided the participants into two groups: experimental and control group, and tried to
2671 use different storytelling styles to describe the same information toward certain issues.
2672 Researchers then tested how participant's reflections toward the same issue were
2673 effected by different "framing" styles.

2674 Emphasis framing follows from work in sociology (Cacciatore et al. 2016;
2675 Goffman 1974; Gamson 1985), which emphasizes that "frame" is the schema for
2676 individuals to realise the world. In this tradition, what an individual "selects" as
2677 salient characteristic from presented information is the focal point. In the other words,
2678 in sociological definition of framing, the participant or the audience becomes a more
2679 active actor by "choosing" what data are worthy to focus on in the whole information
2680 landscape.

2681 However, according to the experiences of practicing the two definition of
2682 framing in three studies, the laboratory research environment of "equivalency
2683 framing" rarely exists in the daily media context and the effect of "equivalency
2684 framing" and "emphasis framing" often appear in the same time in a news articles.
2685 The two definitions of framing can't be classified clearly in the media. First of all, the
2686 issues in media are normally reported by different frames in the same news articles.
2687 Secondly, what coverage number of information can be defined as "equivalent"?
2688 Depending on the intention of reporters and main actors in the news articles, or the
2689 limitation by the word numbers and the themes of news articles, issues in our daily
2690 life (such as Nano), can be discussed by different focusing views and voices.

2691 Especially given that, as an emerging science, the research and applications of Nano
2692 are evolving day by day, it is difficult to define and analyse whether different Nano
2693 news articles which use different frames are reported based on the same information.

2694 For example, in a news articles which reports, “Taiwanese government
2695 announce to invest huge funding for the scientific research and industry-university
2696 cooperation project by National Program of Nanotechnology” at least three frames
2697 were used by the reporter to define Nano: 1) Nano as an new breakthrough science
2698 (using “Science” frame), 2) Nano as an new technology that can be used to produce
2699 new products to improve the quality of public life (using “Commercial” frame), and
2700 3) Nano products made by Taiwan help raise Taiwan’s national competitiveness
2701 (using “National interest” frame). The act of producing News articles is rooted in the
2702 “sociological root’s frame” which is how interviewee (actor) and reporters work
2703 together to emphasise certain characteristics of Nano, and the “psychological root’s
2704 frame” in which the reporter uses different frames to construct the related Nano
2705 “equivalent” information into a news article. Furthermore, different audiences who
2706 read these news articles may choose different frames (by sociology root) to figure out
2707 “what is Nano” and further form their attitude and opinions toward Nano. Thus, the
2708 definition of framing effect based on psychology and sociology roots can be
2709 approximately clarified in the daily media context.

2710 Accordingly, in order to respond and try to further solve the ambiguousness of
2711 the definitions of framing, in author’s study 1 and 2, the framing usage in one news
2712 article was specifically clarified into main, second and third theme/frame. By
2713 distinguishing the salient, secondary, and third theme and frame in news articles, one
2714 can not only investigate more specific theme/frame usage to figure how the agenda

2715 setting/framing effect affected media attitude toward Nano in more detail ways, but
2716 also can see what types of theme and frames were often used simultaneously and,
2717 further, to discuss how the agenda setting/framing effect is used to inform the media
2718 attitude toward Nano. The idea of detailed and clarified framing usage is not new,
2719 having first been introduced by Carver, Rodland, and Breivik (2012). The idea of
2720 distinguishing the theme and frame usage in a news article by their salience can
2721 provide more detailed observations of descriptive analyses of the usage of theme and
2722 frame, but when it comes to use usage of frame as a dependant/independent variable,
2723 the analysis will become a problem. Accordingly, Carver, Rodland, and Breivik
2724 (2012) didn't provide details on how to analyse the frame usage when we want to
2725 figure out the relationship among different frames.

2726 Thus, in studies 1 and 2, calculating usage of frames and themes in a more
2727 specific ways required the author to develop a data weighting strategy to solve the
2728 analysis problem, a solution than can furthermore allow investigations into the
2729 relationships among themes, frames, and media attitude. The details of the data
2730 weighting strategy have been described in the section on data weighting in detail. The
2731 general idea is an article can include 9 codes (3 themes and 3 frames) at most, the
2732 combination of theme and frame are 9 styles at most. In order to calculate the usage of
2733 theme and frame, each article can be seen as 9 parts and each part will be weighted by
2734 the combination weight which is contributed both by the frame and theme. According
2735 to above data weighting strategy, one can further investigate how the different themes
2736 and frames are often used simultaneously in the same news articles. By concretizing
2737 the relationship and appearance of different themes and frames in a news article, the
2738 author can explore when the media used a certain frame or them to capture Nano,
2739 what characteristic of Nano are often emphasised, ignored, or missing in the news

2740 context. For example, by exposing the relationship of different usage of frames in the
2741 media in study 1, the results pointed out that Nano knowledge (science frame) appears
2742 less frequently with Nano applications and products (commercial prospect frame) in
2743 the media. Thus, this finding can provide evidence to suggest our future science
2744 education policies could focus on presenting a more comprehensive connection and
2745 imagination of Nano knowledge and applications. Thus, this data weighting strategy
2746 of theme and frame usage in media could be seen as a reference for future researchers
2747 who analyse different agenda setting and framing effects in one news articles.

2748 In term of the definitions of framing, at the first, the working definition of
2749 “Equivalency framing” (by psychological root) has been practiced in studies 1 and 2,
2750 which focus on how the same information of Nano is presented by different frames.
2751 Thus, one hopes to see the media representation of Nano in Taiwan and further
2752 investigate how each individual frame’s usage influences media attitude toward Nano
2753 (study 1) and the relationship among different actors and frames’ usage and further
2754 explain the overwhelming positive attitude toward Nano in Taiwan media (study 2).

2755 In study 3, the research goal followed the working definition of “emphasis
2756 framing” (by sociological root) to investigate if the publics’ attitude is related to their
2757 confidence in the media and their preferences of different frame’s usage to emphasise
2758 the certain characteristics of Nano. In other words, the intent was to investigate two
2759 things: 1) how the public chooses different frames to portray Nano and then form their
2760 attitude toward Nano, and 2) does the overwhelming positive media attitude effect
2761 their attitude toward Nano? The questionnaire used in study 3 to collect public’s
2762 responds is constructed by items which were based on the individual frame to
2763 investigate whether the public “selects/emphasizes” certain characteristics of Nano as

2764 salient and important, and if their attitude toward Nano are effected by their selective
2765 attention of Nano. For example, one of the science frame-based items asks: ‘Someone
2766 said if we want to control the use of nanotechnology, it is likely to affect the
2767 developing of scientific research. Would you agree or not?’, which emphasized the
2768 science characteristic of Nano, and asks participants to answer their degree of consent
2769 toward this description. According to participant’ answers of science frame based
2770 item, one can figure out whether this individual participant emphasized the “science”
2771 characteristic of Nano.

2772 According to author’s experience conducting these three studies, distinguishing
2773 the meaning of framing only by their psychological or sociological root tradition
2774 seems not cleared enough. In study 3, the sociological root’s definition of frames
2775 (Emphasis framing) can be used appropriately to investigate how individual’s frame
2776 to affect their attitude toward Nano. However, in study 1 and 2, the definitions of
2777 framing (equivalency framing) by psychological root do lead the confusion when it
2778 comes to clarify the relationship between media attitude and framing usage in the
2779 news article. It is nearly impossible to create a laboratory’s research environment
2780 which puts equivalent information in different Nano news articles in the real world
2781 media.

2782 The ambiguous and wide use of definitions of framing has been fully discussed
2783 by Cacciatore, Scheufele and Iyengar(2016), who claimed the “The End of Framing
2784 as we Know it ...” and pointed out the importance of the accessibility–applicability
2785 distinction of framing definitions and proposed that framing research should
2786 refocused around equivalence-based definitions. For example, the “emphasis frame”
2787 is a redundant communication concept which can be replaced by the concepts of

2788 “schema”, “priming”, “agenda-setting.” However, my opinions differ with Cacciatore
2789 et al(2016), who call for exclusive adoption of equivalence-based definitions of
2790 framing and abandonment of the definition of “emphasis framing” which they claim
2791 can blur the lines between frames, primes, and media agenda.

2792 The reason is, as stated prior, it is nearly impossible to create a laboratory-like
2793 research environment which puts the same information in different news articles in
2794 the real world media. The definition of equivalency framing seems be too rigid to
2795 practice in the real world. Since the authors’ study 1 and 2 are focused on the analysis
2796 of the frame in the news articles, in author’s opinions, future researchers who want to
2797 follow the definition of “equivalency framing” should shift the focus on the
2798 connections and relationship among story telling styles (like metaphors) in certain
2799 themes and issue. The attention should concentrate in how to telling a stories to
2800 emphasise the intention which the writer want to provide and effect audiences. This
2801 proposition is based on the changing the view of subject in the research. The
2802 definition of media in this era has been changed by the rising of “self-media”, which
2803 the intention of the writer behind the “media” are related to specific individuals and
2804 not from authorities in the media. Thus, research that tends to focus on the media
2805 context itself should more consider what the writer behind each article in media
2806 context wants to say and how to say it. Rather than focusing on how the same
2807 information can be presented in a different sequence, going back to the context of
2808 news articles in the real world, by focusing on how different metaphors and
2809 storytelling styles could be used seems to be a more important step for public
2810 understanding of science research.

2811 It means, for author's opinions, future researchers who want to follow the
2812 definition of "framing" should focus on the sociological perspective (emphasis
2813 framing), whether the research subject is public or media itself, and the more focusing
2814 on investigating how an individual or news articles try to emphasise/ have selective
2815 attention toward certain issue. The definition of framing, agenda setting, and priming
2816 effects can be clarified by more specific empirical research. For example,
2817 distinguishing the working definition of "agenda setting" (Nano can be categorized in
2818 what different themes?) and "framing" (what characteristic of Nano be captured and
2819 emphasis in the different ways?) allowed for the clarification of the two concepts in
2820 studies 1, 2, and 3; a direct response to Cacciatore et al (2016)'s claim toward
2821 "framing".

2822 In short, it is the author's opinion that framing needs to be the subject of future
2823 research. The definition of framing should focus on the "process" of the "framing
2824 forming", which emphasises the initiative of the research subject (media or public).
2825 Like the distinction of "agenda setting" and "framing", by giving an operational
2826 definition of framing base on the sociological root, and more attention of how the
2827 frame formed by media/public in the empirical research, the distinction, typology and
2828 of framing will made progressively clearer.

2829 **(3) The Approaches and Opportunities of Science Communication in** 2830 **Taiwan – Media and Education**

2831 In the earlier discussion of study 3, there was a noted need for the discussions of
2832 the new types and opportunities of science communication in Taiwan. Thus, this
2833 section will focus on how to improve our science communication in different ways.
2834 Based on the findings of study 1 and 3, there two possible ways this may happen: (1)

2835 new media approaches and platforms for public understanding of and engaging with
2836 science and technology, and (2) changes to the formal science education system in
2837 Taiwan, specifically recommending 12 years of compulsory science education. And,
2838 in the final, the author will discuss (3) the self-reflection about the research scope and
2839 methodology, and hope can provide to future researcher in PUS and SC fields in
2840 Taiwan as the reference.

2841 The evidence for looking at new approaches and opportunities can be found in
2842 study 1. The results show that science communication and education toward
2843 Nanotechnology are only most valued in the news related to education themes, but do
2844 not take into account in the discussion of Nano policies, Nano science, and Nano
2845 products. In other words, nanotechnology is not valued as a popular science
2846 communication issue in the Taiwanese media. The disconnection between Nano
2847 knowledge and Nano applications in daily life are quite apparent, even for the higher
2848 educated public, who didn't show more attention toward the risks of Nano. This
2849 indicates the shortage of understanding about the limitation and uncertainty of Nano
2850 or any new emerging science and technology is an important issue in science
2851 communication. How to bring more attentions and connections between science
2852 knowledge and scientific applications/products in the daily life is a vital issue for
2853 science communication in Taiwan.

2854 In order to respond the need for stronger connections between scientific
2855 knowledge and applications/products, I recommend the use of a popular business
2856 marketing style which is already common in the Taiwanese public's daily life:
2857 "Sponsored posts", which should be seen as a new media approach and platform for
2858 public understanding of and engagement in science and technology.

2859 The increase in “Sponsored posts” follows the rise of “Self-media”. The most
2860 salient difference between sponsored posts and traditional commercials is that
2861 “Sponsored posts” are generally written and promoted by a single famous
2862 blogger/vlogger on social media (like Facebook, Instagram) or internet platforms (like
2863 YouTube, WeChat Public Platform). In Taiwan, the use of “Sponsored post” by
2864 blogger/vlogger has become a popular way for product marketing. The bloggers and
2865 vloggers’ promotional posts normally have more conveniences and reliabilities than
2866 traditional commercials for audience. The famous blogger/vlogger normally start by
2867 sharing their fruitful experiences, insightful ideas, or opinions toward a certain topic
2868 (like cosmetic, cooking or 3c products), and thus build an aura of “authority” for their
2869 audience. By operating their fans pages or channel independently, the
2870 bloggers/vloggers can have more interactions directly with their fans (audience) and
2871 by building and sharing their life and ideas on their pages and channels with their
2872 audience, they can let audiences have more connections and be familiar with the
2873 bloggers/vloggers, making the audience more willing to trust their promotions toward
2874 certain products(許舒涵 2016).

2875 Many local media research in Taiwan have paid attention on the impact of
2876 “Sponsored Posts” toward Taiwan audience(Chen, 2017; Chieh, 2016; Jiang, 2016;
2877 Xu, 2016). Most of the “Sponsored Posts” in Taiwan are related to the promotion of
2878 new launching daily products (like cosmetic, household products and 3c
2879 products...etc), The common promoting description toward certain products by the
2880 promoters are normally focusing on what new science/technology are been used in
2881 those new product to make them” innovating”. Accordingly, with the strong impact of
2882 “Sponsored Post” for consumers, Taiwanese government enact the related
2883 regulations(Taiwan Ministry of Health and Welfare 2015; Taiwan Executive Yuan

2884 2015; Taiwan Ministry of Health and Welfare 2016) to regulate “Sponsored Post” like
2885 traditional commercial, which is can’t claim false effects and misleading knowledge
2886 in the products promotions, in order to protect consumer’s right and safety.

2887 If the bloggers/ vloggers violated the relevant regulation in their “Sponsored
2888 Posts”, not only the blogger/vloggers themselves will be punished, but also the
2889 business companies who hire the blogger/vloggers. Since the profits and repayments
2890 of sponsored post has become the main income for blogger/vloggers, how to write the
2891 “legal” information in the sponsored posts has become a very important task for
2892 blogger/vloggers. In other words, the blogger/vloggers should concern about how to
2893 present the “actual” and “correct” scientific and technological knowledge in their
2894 sponsored posts as the needing of making an attractive article/videos for audience.

2895 In the meantime, the common sharing of user experiences in the sponsored posts
2896 is not attractive enough now for audience(許舒涵 2016). The audience nowadays
2897 have sharper and more critical attitudes when they read sponsored posts and look for
2898 more solid and objective evidence in the articles/videos, which means only using the
2899 popularity to promoting products for blogger/vlogger is not enough.

2900 Thus, since the Sponsored Posts are normally focused on daily products and need
2901 to connect the scientific and technological information to promoting products in the
2902 descriptions of post, above is the reason that author propose that we should see
2903 “Sponsored Posts” as the new research subject to present “Science communication” in
2904 our daily life. Especially, in study 1, the results pointed out public are lacking
2905 connection between science knowledge and applications which are used in daily
2906 products, and thus investigate the Sponsored Post (related to cosmetics, healthy food
2907 or any products claimed to use innovation science/technology) should be a good

2908 approaches to look through how the blogger/vlogger how to make the science and
2909 technology self-related for public, and further investigate what kind of styles of
2910 Sponsored Post can better raise public awareness toward the new science and
2911 technology applied in their everyday products. Furthermore, how to build public
2912 scientific literacy to judge the related scientific/technical information in the sponsored
2913 post are the vital goal for Taiwanese science education.

2914 The other evidence pointing to the needing for new approaches and opportunities
2915 for science communication in Taiwan is shown in study 3. According to the findings
2916 of study 3, the Taiwanese public's attitude toward Nano are overall very positive and
2917 the higher educated public didn't bring more attention toward the risks of Nano, even
2918 though the related damages has already been proven by research, which means the
2919 shortage of understanding about the limitations and uncertainty of emerging
2920 science/technology should call for improvement in our future formal education.

2921 According to this, by author's opinion, the upcoming Taiwan curriculum
2922 reforming called "Taiwan 12 years' compulsory education" (K-12 education)" can be
2923 seen as a golden opportunity to respond author's concerns and suggestions in study 3,
2924 which Taiwanese government should resolve the problem that Taiwanese public's
2925 shortage of understanding about the limitation and uncertainty of emerging
2926 science/technology by national science education system.

2927 In order to achieve equality of education and raise national competitiveness, the
2928 Taiwanese government announced the draft of curriculum guidelines of "Taiwan 12
2929 years' compulsory education" (K-12 education) on 2015. This curriculum reform is
2930 expected to be implemented in 2019. The concept of "core literacy" is the main axis
2931 of the curriculum development, in order to maximize the coherence between the

2932 different educational stages and the integration of the various fields / subjects(Wan-
2933 Ping Ho 2014).

2934 According to the draft of the curriculum guidelines entitled “Taiwan K-12
2935 education in Science domains”(Taiwan Ministry of Education 2014; Taiwan Ministry
2936 of Education 2016): Cultivating the student’s scientific literacy to face life in today’s
2937 Taiwanese society is a priority, and so enhancing student scientific literacy has
2938 become a national science education goal. Thus, science literacy for Taiwan K-12
2939 education are further defined as following three demotions:(1) Scientific basic
2940 knowledge and concepts, (2) the ability of scientific inquiry and problem solving (3)
2941 understanding of nature of science and scientific attitude in the draft of curriculum
2942 guidelines of “Taiwan K-12 education.” Also, especially emphasizing that student
2943 should have the ability to practice scientific literacy to effectively communicate with
2944 others, make their own opinions and decisions in the social-scientific issue,
2945 understand the limitation and uncertainty of science/technology, and the possible
2946 damages and risks come along with developing science and technology and be critical
2947 toward the relevant scientific content in the media coverage (as figure 20).

2948 Since the “high risked assessment” is still the main approach for Taiwanese
2949 students to enroll in colleges and universities and Taiwan K-12 education curriculum
2950 guidelines are the main basis which lead and formulate the direction and range of
2951 Taiwan high risked assessment (Rundgren et al. 2010), the initiatives and priorities of
2952 K-12 education curriculum guidelines can make a huge impact to lead our future
2953 student’s directions and intentions in study science.

2954 According to my experience helping to shape the “Scientific Literacy” items for
2955 our future high risked assignment in Taiwan, the future high risked scientific

2956 assessment's goal is not only focused on the examination of the student's science
2957 knowledge, but also gives more emphasis to examine student's ability to use and
2958 connect science knowledge and methods in the real world scientific issues. Thus,
2959 Taiwan's K-12 science education can become a new opportunity to respond to and
2960 solve author's concern for public's shortage of understanding about the limitation and
2961 uncertainty of emerging science/technology in study 3, and further encouraging or
2962 maybe forcing our future students to understand the multiple impacts and
2963 characteristics of science on our society.

2964 There are manifold points of self-reflection and research limitations that the
2965 author thinks should be discussed to help guide follow-up research design, and as a
2966 reference for future researchers who intend to investigate media representations and
2967 public attitudes toward emerging science in Taiwan.

2968 First of all, the data in these three studies are convenience samples, which limit
2969 the generalizability of inferences. In study 1 and 2, the news articles in the United
2970 Daily News data base only cover from 2002 to 2009, due to the limit of viewing
2971 permission. Since the NPNT project was a twelve-year long term project from 2002,
2972 study 1 and 2's data only cover the first phase of NPNT project (from 2002 to 2008)
2973 and the very early stage of the second phase (from 2008 to 2009). Thus, it is necessary
2974 to collect further news articles from 2009 to the end date of the NPNT in order to
2975 provide the more comprehensive view of Taiwan media representations toward Nano.
2976 Especially after the long term National Nano project, investigate the relationship
2977 among Government policies and how the reflection and varies of media representation
2978 toward Nano, would be a worthy research area for exploring the media effects and
2979 representation toward emerging science in Taiwan.

2980 Content analysis is used in study 1 and 2 as a research method to analyze the
2981 framing effects and actors in Nano news in Taiwan. Auto-context analysis tools in the
2982 period of author's three studies were unable to understand Chinese written language.
2983 However, with the rapid development and improvement of software for qualitative,
2984 quantitative, and mixed methods research, auto-content analysis should be considered
2985 for use in future of the bottom-up overview of Taiwan media representation. Also,
2986 social media has not only blurred the line between the media as authority and self-
2987 media, but also become the popular approach for public to present their opinions.
2988 Thus, the next step as the follow up study for these three studies would be to turn
2989 attention toward public's opinions, attitudes, and further judgments toward Nano on
2990 social media platforms.

2991 In the meantime, the survey data collection in study 3 are thank to the project
2992 "The Risk Perceptions about Nano and Policy Research", which is funded by
2993 Environmental Protection Administration, Taiwan in 2013. Given the original
2994 research and instrument design procedures of the project, the public's' scientific
2995 knowledge and interests were not measured. Thus, further investigation of the
2996 relationship and effects among the public's scientific knowledge, interests, and
2997 attitudes toward Nano could be further explored. This may give insights as to why the
2998 Taiwanese public's attitude is so overwhelming positive toward Nano. Also, the
2999 results of Relational Class Analysis (RCA) could be an improvement to determine if
3000 there are any particular patterns of Public attitude toward Nano.

3001 The traces of science and technology from modern Skyscrapers and buildings,
3002 the endless tide of cars, to the common use of 3C products and application in our
3003 daily life, are ubiquitous in modern Taiwan. According to the overwhelmingly

3004 positive media representation and public's attitude toward Nano, the dialectical
3005 tension between the pastoral ideal and the rapid and sweeping transformations
3006 wrought by machine technology in America (Marx, 1964) seems not to be widespread
3007 in Taiwan's cultural context. Or, is it because the application of Nano is too "nano" to
3008 be detected by the Taiwanese media and public?

3009 The overwhelmingly positive attitude of the media and public toward Nano in
3010 these three studies may also imply that the value of "technological
3011 determinism"(Marx & Smith, 1994) dominates our opinions and awareness toward
3012 emerging science in Taiwan, which tend to believe the science and technology can
3013 finally lead and drive our society to the better good. Especially, the "National
3014 interest" frame is a very popular approach used by Taiwan's government to promote
3015 and convince the public to accept the science and technology-oriented policies for
3016 raising our National economic competitive status. How to "revitalize the economy" is
3017 always an attractive slogan for electoral campaigns, and is often repeated in different
3018 candidate's politics in Taiwan. Thus, the attraction of promoting the economy of
3019 Taiwan comes along with the worship of the culture of science in technology may be
3020 the reason for our optimism toward developing of Nano in Taiwan from 2002 to 2009.
3021 Taking the research which investigated the progress of technology development and
3022 the interaction between technology and society in the American context as reference,
3023 according to the results of positive attitude toward Nano in these three studies from
3024 2002 to 2009, the ideology and view of Taiwan media and public hold are located on
3025 the "hard spectrum of technological determinism" (Marx & Smith, 1994), which
3026 value the benefit and power of science and technology to lead and change our society
3027 but ignore the impact and interaction between society and technology(Marx & Smith,
3028 1994). More importantly, such views tend to see the development of science and

3029 technology as independent of social connections and cultural. The roles of Nano in
3030 Taiwan media representation (study 1 and 2) and public's frame selection (study 3)
3031 has been portrayed as a hard technology, which is far away from our daily life and
3032 imagination, by the science frame and national interest frame by almost every actor
3033 (Government, scientists, k-12 school...etc). Only the actor of Business Company has
3034 a focus on the "soft side" of Nano, and value the application of Nano application in
3035 our daily life. Unfortunately, this is effected by commercial sponsorship and results in
3036 the loss of some objectivity. The disconnection of the acknowledgment toward the
3037 "hard" and "soft" side of Nano and the undetected application of Nano in our daily
3038 life in Taiwan are worthy concerns for our civic scientific literacy and diverse values
3039 and understanding toward science and technology. Thus, how to evoke our citizens'
3040 awareness of the knowledge and application of science and technology is closely
3041 related to our society, and is the important goal for future research in the field of
3042 public understanding of science, science communication, and science education.

3043 The social culture of "hard spectrum of technological determinism" in Taiwan
3044 is a worried problem be attention for our developing of science and technology.
3045 However, facing the real situation of our own problem would be the first step to
3046 change. More and more researcher has dedicated their research results toward the
3047 civic and student's risk awareness and science and technology epistemology in
3048 Taiwan (Liu et al. 2007; Mei-Hsin Lin & Fang-Ying Yang, 2011; Wong, 2010; Shih
3049 & Lin, 2017; Lin et al. 2012), which tend to evoked the related government policies
3050 and educational reform for further helping our society to form a more comprehensive
3051 and varies view toward social scientific issue in Taiwan. Audience research results
3052 and theories developed by Stuart Hall (1980) and followed by David Morley (1980)
3053 have highlighted the importance of the agency of the audience(Chen 2014; Bødker

3054 2016). The audience does not only play a passive role and receive the coding
3055 information from media, but it also has the initiative to decode the information to
3056 form its own interpretation and further participate and impact the whole process and
3057 consequence of media communication. The gender difference result in study 3 is
3058 consistent with Stuart Hall and David Morley's point, since the female has been set as
3059 the target audience for Nano commercial news articles with biased positive attitude to
3060 promote the products. However, the female's attitude toward Nano is less positive
3061 than male, according to the results of study3. It is means the information encoded by
3062 media (or business company) has been decoded and further constructed by the
3063 audience. Therefore, the meaning of the information in media communication is not
3064 "passing" by the media (passer), but rather "produced" by the audience. The
3065 increasing popularity of self-media (social media) is blurring the line between media
3066 and audience. This is the reason why the author believes the new science curriculum
3067 reform and the research agendas focused on "Sponsored Posts" in media are a valid
3068 new approach, and will provide opportunities for science communication and public
3069 understanding of science in Taiwan.

3070 In sum, according to three studies in this thesis, the author explored the media
3071 presentation and public attitude toward Nano in Taiwan. Given the results, the author
3072 proposed future goals regarding the public understanding of science in Taiwan, which
3073 should bring more public attention toward how the media effect (framing, agenda
3074 setting) and the intention of actor behind every traditional or new media will impact
3075 individual's attitude and opinion toward scientific/technological issues for the
3076 research in public understanding/society, science and technology/science education
3077 fields in Taiwan. Since the development of new science and technology is ubiquitous
3078 and inherently risky, the risk and benefit of science and modernity make us all live in

3079 a same “risk society”(Beck n.d.) .From scientist, government, politicians, business
3080 companies, experts from different fields to the lay people like you and me, we all
3081 have a duty to be concerned about what science can do in a good/bad way and be as
3082 positive as we can to join the scientific discourse for our society. After all, “we should
3083 all recognize, science is too important to be left to scientists alone”(Khan 2015).

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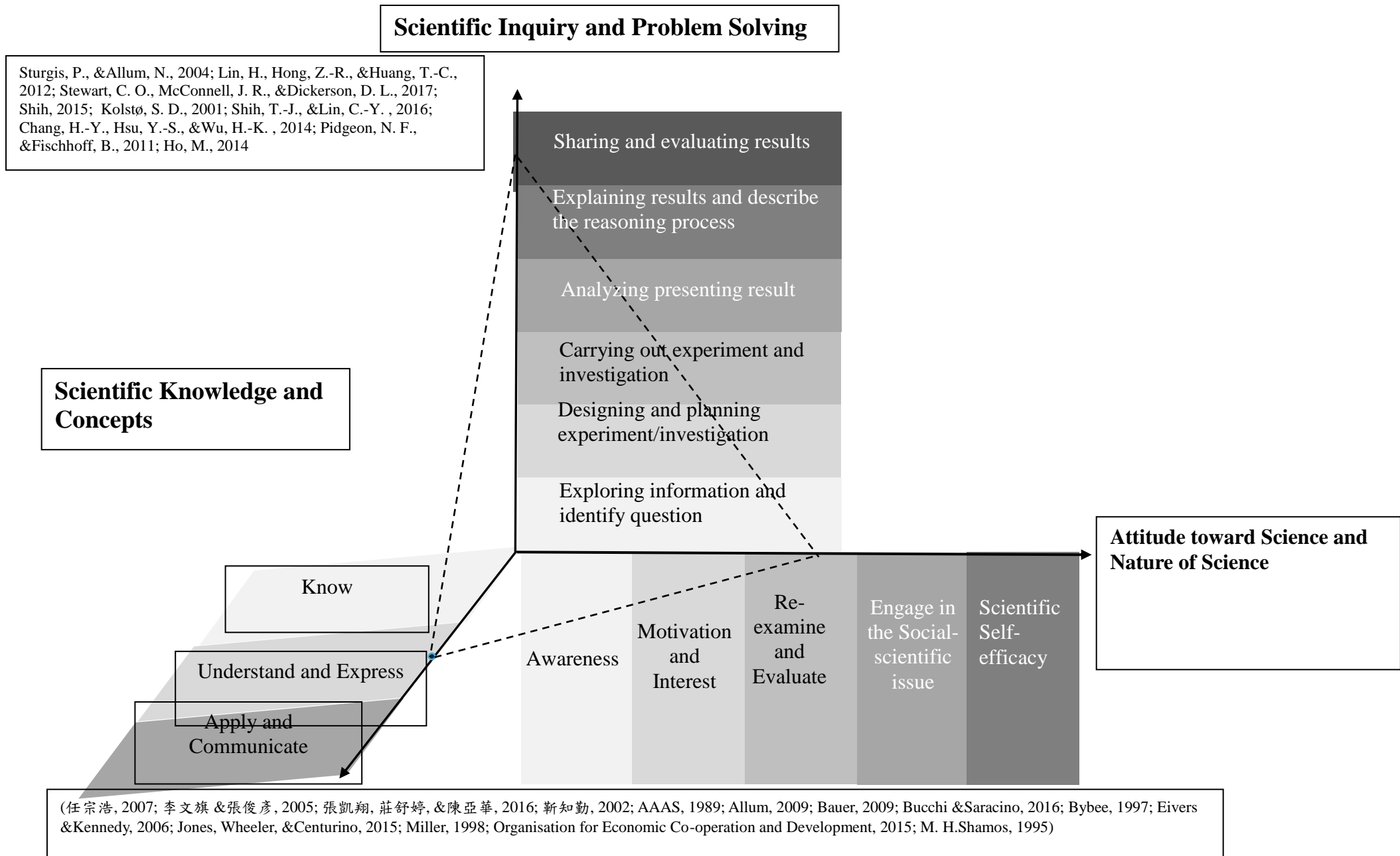


Figure 20. The Science and Technology curriculum and examine model of Taiwan- 12-year Compulsory Education

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