An Economic Theory of Disinformation

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Abstract

The impacts of misinformation and disinformation have rarely been studied in economics. In this paper, I examine these impacts using a model constructed on the basis of the concept of ranked information. The value of information is changeable and differs across people; therefore, disinformation can be used as a tool to manipulate people's behaviors. I first define misinformation and disinformation and then show the mechanism through which disinformation decreases efficiency by manipulating ranked information. Decreases in efficiency are observed as decreases in total factor productivity, lowered success rates of investment, and increased costs of bad speculations. In addition, disinformation generates economic rents and, as a result, increases inequality, possibly by a great deal. Furthermore, disinformation can cause large-scale economic fluctuations.

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1   INTRODUCTION

In information economics, information is usually assumed to be correct or at least its correctness is not regarded to be important. Therefore, the main question asked is what happens if information is possessed exclusively only by some persons, not if it is correct; that is, it is the problem of asymmetric information (e.g., Grossman and Stiglitz, 1980; Greenwald and Stiglitz, 1986; Edlin and Stiglitz, 1995; Stiglitz, 2017). Furthermore, even if some pieces of information are not correct, the main question in information economics does not change because information is assumed to have the same value for anybody regardless of its correctness. In other words, the assumption is that, when a piece of information is given, anybody can equally utilize it.

However, Harashima (2022b) showed that the value of information differs across people even if the same information is given. That is, when a piece of information is given, people utilize it differently. For example, some people think it is important but others do not. Because the value of information varies across people, the correctness of information is very important economically because people's personal judgments on its correctness significantly influences its value. That is, if a person judges the correctness of information more accurately, the value the person places on that information will be more accurate. An important point is that the value of information can be manipulated by malicious persons who intentionally disseminate incorrect information to confuse people's personal judgments on the value of information.

The reason why the value of information differs across people is because people's abilities with regard to information literacy differs. Again, a malicious person can manipulate some people whose abilities with regard to information literacy are relatively low by confusing them with incorrect information.

The problems of fake news, disinformation, and misinformation have been emphasized recently, and they have been reported widely by the media, particularly regarding recent elections in the U.S. Nevertheless, it is difficult to appropriately define what fake news, disinformation, and misinformation are. Although many definitions have been proposed (see e.g., Karlova and Fisher, 2013; Fallis, 2015; Wardle and Derakhshan, 2017; European Commission, 2018; Andersen and Søe, 2020; Ryan, et al., 2020; van Hoboken and Fathaigh, 2021), there is no universally agreed-upon definitions. Nevertheless, many proposed definitions of disinformation seem to have the following common components: they are (1) false or misleading, (2) intentional, and (3) cause harm. Definitions of misinformation seem to include element (1) but exclude elements (2) and (3).

Politically and socially, the problems of fake news, disinformation, and misinformation have been regarded to be very important and have to be taken seriously,

but they are rarely studied in economics. The reason for this neglect may lie in the difficulty of definition as discussed above; in addition, the assumption that the value of information is equal to everybody (i.e., correctness of information does not matter economically) has probably also contributed to the lack of study of this issue. As mentioned above, Harashima (2022b) showed that the value of information is changeable and differs across people and, taking this nature into consideration, presents the concept of "ranked information". Using this concept, I examine misinformation and disinformation from the point of view of economics in this paper.

For a person to achieve a purpose, that person will first have to collect and select relevant pieces of information according to their importance; that is, the person ranks pieces of information by importance. Even if the purpose is the same for many persons and given available pieces of information are identical, different persons select different pieces of information for the reasons stated above.

The importance of information is not pre-determined by, for example, an authority and is not judged equally by people. It has to be evaluated individually and personally by each person in each period for each purpose. In this process of individual evaluation, disinformation can be utilized as a tool to manipulate people's behaviors and exploit the opportunities these confused people provide. In this paper, the mechanism of how disinformation works in this process and what impacts it has on the economy are examined.

Before examining them, however, I first define misinformation and disinformation. Next, I examine the mechanism of how disinformation decreases the efficiency of economy by manipulating ranked information on the basis of the model of ranked information presented in Harashima (2022b). Decreases in efficiency are observed as decreases in total factor productivity (TFP), lowered success rates of investment, and increased costs of "bad" speculations. Disinformation not only decreases efficiency but also generates economic rents. Because of these economic rents, inequality can be widened, possibly greatly. Furthermore, disinformation can cause large-scale economic fluctuations through the channel of bad speculation.

2 RANKED INFORMATION

In this section, I briefly explain the nature of ranked information and its model on the basis of Harashima (2022b).

2.1 Utilization of information

At the present time, people can access many pieces of information, but only some of that information is useful for each particular purpose. People must select a small number of

important pieces of information from the enormous number of available pieces for any given purpose. Furthermore, they have to use pieces of information with different levels of importance or "weights". The necessity of selecting pieces of information by weighted importance means that there are ranks among pieces of information by purpose. To properly retrieve important pieces of information, it is first necessary to rank them according to their importance.

2.2   Retrieving and ranking information

Even if people select important pieces of information for a common purpose, their selections will be quite different from one another, much like different Web search engines generate different search results for the same topic. This occurs because people's abilities to rank and select pieces of information are highly likely to be heterogeneous. In psychology and psychometrics, the importance of fluid intelligence and crystallized intelligence has been particularly emphasized (Cattell, 1963, 1971). The ability to rank and select pieces of important information seems to require both types of intelligence.

The ranks and selections of pieces of information will largely differ across people even if they collected the same pieces of information because people have to carefully analyze and evaluate the collected pieces of information. To analyze and evaluate information, fluid intelligence is indispensable, and fluid intelligence is highly likely to differ across people similar to most other kinds of abilities. A person whose fluid intelligence is higher should be able to rank and select pieces of information more correctly than those whose fluid intelligences are lower.

2.3   Correctness

There are many possible sets of selected pieces of information for each purpose, and for a given purpose, some sets have higher probabilities to achieve the purpose than others. I define "correct" with regard to ranked information such that a set is deemed to be correct if its probability to achieve a purpose is the same as that of the top-ranked set for that purpose. Furthermore, the correct ranks of pieces of information for a purpose are those that are consistent with the correct ranks of sets for the purpose. For the purpose of this paper, "achieve a purpose" means that, under given constraints, an objective is met at the least cost in the shortest amount of time. For simplicity, it is assumed that a set that is always correct for anybody exists for any purpose.

2.4   The model of ranked information

I refer to a piece of information as an "Inf-piece". A serial number $q(\in \mathbb{N})$ is assigned to each Inf-piece, and let $IP_{i,q}$ be an Inf-piece with the serial number q for purpose i. Furthermore, I refer to a set of Inf-pieces as an "Inf-set". It is assumed for simplicity that

all Inf-sets consist of n Inf-pieces. Let IS_i be the Inf-set that is selected for purpose i from among all existing Inf-pieces. Let $IS_{i,q}$ indicate that Inf-piece q (i.e., $IP_{i,q}$) is included in IS_i.

In addition, let $y(\cdot)$ be the Inf-set production function, where the production function represents the probability to achieve a purpose. A higher value of y for an Inf-set corresponds to a higher probability that the Inf-set will achieve the purpose; therefore, the Inf-set is more correct than Inf-sets with lower values of y. It is assumed that for purpose i, if the Inf-pieces in $IS_{i,s}$ and $IS_{i,r}$ are identical except for IP_s and IP_r and $s < r$, then

$$y(IS_{i,s}) > y(IS_{i,r}) \tag{1}$$

for any s and r. Inequality (1) implies that an Inf-piece has a particular value that depends on its serial number such that the value of an Inf-piece is larger if its serial number is smaller.

Suppose that each Inf-piece has a particular value, and the value of an Inf-set is equal to the sum of values of the Inf-pieces of which the Inf-set consists. Note that the value of an Inf-piece is different from the serial number q assigned to it. On the basis of inequality (1), I define the relative value of $IS_{i,q}$ such that, if

$$y(IS_{i,s}) > y(IS_{i,r})$$

then

$$IS_{i,s} > IS_{i,r} \tag{2}$$

for any s and r. By inequality (2), the relative value of $IP_{i,q}$ is indicated such that, for purpose i, if

$$y(IS_{i,s}) > y(IS_{i,r})$$

then

$$IP_{i,s} > IP_{i,r} \tag{3}$$

because the value of an Inf-set is equal to the sum of values of Inf-pieces of which the Inf-set consists, and $IS_{i,s}$ and $IS_{i,r}$ are identical except for IP_s and IP_r. Inequality (2)

means that $IS_{i,s}$ is more correct for purpose i than $IS_{i,r}$, and inequality (3) means that $IP_{i,s}$ is more important for purpose i than $IP_{i,r}$.

If inequalities (2) and (3) hold for any s and r for purpose i, the absolute value of $IP_{i,q}$ is a decreasing function of q for purpose i. This means that $IP_{i,q}$ can be ranked by q for purpose i. Therefore, if the serial numbers of Inf-pieces are appropriately assigned for each purpose such that the serial number of $IP_{i,q}$ is equal to its rank for purpose i, the rank of $IP_{i,q}$ for purpose i is q. In this case, the value of $IP_{i,q}$ is an increasing function of $N - q$ where N is the lowest rank; that is, it increases as the rank of Inf-piece q rises. Remember that "as q rises" actually means as q (the number) gets smaller. In the following sections, it is assumed that the serial numbers are assigned as such.

2.5   *Rank–size distribution*

How the values of Inf-pieces are distributed over their ranks is an empirical question. However, it seems likely that the value of $IP_{i,q}$ will be described by an exponentially increasing function of $N - q$ as described below.

2.5.1   Exponentially increasing value of Inf-sets

Suppose that there is a total of N Inf-pieces in an economy, and for any purpose, each Inf-set consists of n Inf-pieces selected from among the N Inf-pieces. There are many possible combinations of n Inf-pieces in an Inf-set. Suppose that the number of possible combinations in which Inf-piece with rank q is included in an Inf-set as one of n Inf-pieces is $\varLambda$ for any purpose. A serial number is assigned to each of $\varLambda$ possible combinations in order from 1 to $\varLambda$. Note that the number of possible combinations is commonly $\varLambda$ for any q, Inf-set, and purpose. Let $\widetilde{IS}_{i,q}$ be the average value of Inf-sets in which the Inf-piece with rank q is included, and let $IS_{i,q,\lambda}$ be the value of the Inf-set that corresponds to combination $\lambda\,(\in \varLambda)$. Hence,

$$\widetilde{IS}_{i,q} = \varLambda^{-1} \sum_{\lambda=1}^{\varLambda} IS_{i,q,\lambda} \ .$$

Because the impact of a higher rank Inf-piece on $\widetilde{IS}_{i,q}$ will be larger than that of a lower rank Inf-piece, it seems likely that

$$\widetilde{IS}_{i,q} - \widetilde{IS}_{i,q+1} > \widetilde{IS}_{i,q+1} - \widetilde{IS}_{i,q+2} \ . \tag{4}$$

That is, the increase in the average value of the Inf-set when rank $q + 1$ Inf-piece is replaced with rank q Inf-piece is larger than that when rank $q + 2$ Inf-piece is replaced with rank $q + 1$ Inf-piece. Of course, there will be many cases that do not actually satisfy inequality (4), but inequality (4) seems to be satisfied in general because the top-rank Inf-piece seems to be by far the most important and useful in many cases.

Inequality (4) indicates that the value of the Inf-set can be approximated by an exponentially increasing function of $N - q$; that is, $\widetilde{IS}_{i,q}$ increases exponentially as the rank of Inf-piece q rises. Furthermore, if the production function $y(\cdot)$ is a monotonously increasing function of the value of $IS_{i,q}$, the average value of $y(IS_{i,q})$ can be also approximated by an exponentially increasing function of $N - q$; that is, it increases exponentially as the rank of Inf-piece q rises.

2.5.2   Exponentially increasing value of Inf-pieces

If inequality (4) holds, the value of $IP_{i,q}$ can also be approximated by an exponentially increasing function of $N - q$. $\widetilde{IS}_{i,q}$ can be divided into two parts: one is attributed to the Inf-sets in which the Inf-piece with rank $q + 1$ is included, and the other is attributed to the Inf-sets in which the Inf-piece with rank $q + 1$ is not. Let $\widetilde{IS}_{i,q,q+1}$ be the former and $\widetilde{IS}_{i,q,q}$ be the latter. Thereby,

$$\widetilde{IS}_{i,q} = \widetilde{IS}_{i,q,q+1} + \widetilde{IS}_{i,q,q} \ . \tag{5}$$

$\widetilde{IS}_{i,q+1}$ can similarly be divided into two parts: one attributed to the Inf-sets in which the Inf-piece with rank q is included and the other in which the Inf-piece with rank q is not. Let $\widetilde{IS}_{i,q+1,q}$ be the former and $\widetilde{IS}_{i,q+1,q+1}$ be the latter. Thereby,

$$\widetilde{IS}_{i,q+1} = \widetilde{IS}_{i,q+1,q} + \widetilde{IS}_{i,q+1,q+1} \ . \tag{6}$$

Because the Inf-sets in which both Inf-pieces with ranks q and $q + 1$ are included in Inf-set are common in $\widetilde{IS}_{i,q}$ and $\widetilde{IS}_{i,q+1}$, then

$$\widetilde{IS}_{i,q,q+1} = \widetilde{IS}_{i,q+1,q} \ . \tag{7}$$

By equations (5), (6), and (7),

$$\widetilde{IS}_{i,q} - \widetilde{IS}_{i,q+1} = \widetilde{IS}_{i,q,q} - \widetilde{IS}_{i,q+1,q+1} \tag{8}$$

for any q. Therefore, by equation (8) and inequality (4),

$$\tilde{IS}_{i,q,q} - \tilde{IS}_{i,q+1,q+1} > \tilde{IS}_{i,q+1,q+1} - \tilde{IS}_{i,q+2,q+2} \quad . \tag{9}$$

Inequality (9) means

$$IP_{i,q} - IP_{i,q+1} > IP_{i,q+1} - IP_{i,q+2} \quad . \tag{10}$$

Inequality (10) indicates that the value of an Inf-piece can be approximated by an exponentially increasing function of $N - q$; that is, the value of $IP_{i,q}$ increases exponentially as the rank of Inf-piece q rises.

2.6   Heterogeneity in Inf-sets

2.6.1   Inf-set distance

Inf-sets other than the top-rank Inf-set for a purpose are interpreted to be deviating from the correct Inf-set (i.e., the top-rank Inf-set). The distance between each Inf-set and the correct Inf-set can be defined as follows.

As assumed above, each Inf-set consists of n Inf-pieces. A serial number is assigned to each Inf-set, and let $\Theta_{i,h}$ be the Inf-set with the number $h(\in \mathbb{N})$ for purpose i. Here, let $IS_{i,q}\big|_{\Theta_{i,h}} = \sum_{IP_{i,q} \in \Theta_{i,h}} IP_{i,q}$ and $IS_{i,q}\big|_{q=1,2,...,n} = \sum_{q=1}^{n} IP_{i,q}$; that is, $IS_{i,q}\big|_{\Theta_{i,h}}$ means the value of Inf-set h (i.e., $\Theta_{i,h}$), and $IS_{i,q}\big|_{q=1,2,...,n}$ means the value of the Inf-set that consists of the top n Inf-pieces for purpose i. The "distance of Inf-set" (DIS) of Inf-set $\Theta_{i,h}$ is defined by

$$D_{i,h} = 1 - \frac{y\left(IS_{i,q}\big|_{\Theta_{i,h}}\right)}{y\left(IS_{i,q}\big|_{q=1,2,...,n}\right)} = 1 - \frac{y\left(\sum_{IP_{i,q} \in \Theta_{i,h}} IP_{i,q}\right)}{y\left(\sum_{q=1}^{n} IP_{i,q}\right)} \quad . \tag{11}$$

Equation (11) indicates that the DIS of Inf-set $\Theta_{i,h}$ ($D_{i,h}$) is the magnitude of deviation of $\Theta_{i,h}$ from the top-ranked Inf-set (i.e., the Inf-set whose value is largest for purpose i). As Inf-pieces with lower ranks (larger q) are included in Inf-set $\Theta_{i,h}$, its DIS ($D_{i,h}$) increases. If the top n Inf-pieces are all included in Inf-set $\Theta_{i,h}$ (i.e., $\sum_{IP_{i,q} \in \Theta_{i,h}} IP_{i,q} = \sum_{q=1}^{n} IP_{i,q}$), $D_{i,h} = 0$.

2.6.2   Average distance

Let $\boldsymbol{\Theta}_{i,m}$ be the set of all Inf-sets in which the highest rank Inf-piece is commonly $IP_{i,m}$. In addition, let $\boldsymbol{D}_{i,m}$ be the average DIS of $\Theta_{i,h} \in \boldsymbol{\Theta}_{i,m}$ such that

$$\boldsymbol{D}_{i,m} = E\left(D_{i,h}\big|_{\boldsymbol{\Theta}_{i,m}}\right) , \tag{12}$$

where E is an operator and means that $\boldsymbol{D}_{i,m}$ is the average DIS of all Inf-sets that are included in $\boldsymbol{\Theta}_{i,m}$. Evidently, if $m > l$,

$$\boldsymbol{D}_{i,m} < \boldsymbol{D}_{i,l} .$$

That is, $\boldsymbol{D}_{i,m}$ is a decreasing function of the value of $IP_{i,m}$, which means that it is an increasing function of $D_{i,m}$ because $D_{i,m}$ is a deceasing function of $IP_{i,m}$. Because $\boldsymbol{D}_{i,m}$ and $D_{i,m}$ similarly decrease as $IP_{i,m}$ increases, $\boldsymbol{D}_{i,m}$ will basically be linearly proportional to $D_{i,m}$.

2.6.3 Correct selection
The degree of correct selection (DCS) is defined as

$$\boldsymbol{C}_{i,m} = 1 - \boldsymbol{D}_{i,m} . \tag{13}$$

That is, $\boldsymbol{C}_{i,m}$ means how correct a selected Inf-set is when the highest rank inf-piece in the Inf-set is $IP_{i,m}$.

Here, as shown in Section 2.5, the value of $IP_{i,q}$ can be approximated by an exponentially increasing function of $N - q$. Taking this property into consideration, the average value of Inf-sets that are included in $\boldsymbol{\Theta}_{i,m}$ can be most simply modeled by

$$E\left(IS_{i,q}\big|_{\boldsymbol{\Theta}_{i,m}}\right) = \frac{v}{e^{wm}} \tag{14}$$

and

$$\sum_{q=1}^{n} IP_{i,q} = \chi E\left(IS_{i,q}\big|_{\boldsymbol{\Theta}_{i,1}}\right) = \chi \frac{v}{e^{w}} , \tag{15}$$

where v, w, and $\chi(> 1)$ are positive constants. $\sum_{q=1}^{n} IP_{i,q}$ in equation (15) indicates the value of the top-rank Inf-set for purpose i as shown in equation (11). In addition, the production function is modeled most simply such that

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$$E\left[y\left(IS_{i,q}\big|_{\Theta_{i,m}}\right)\right] = y\left[E\left(IS_{i,q}\big|_{\Theta_{i,m}}\right)\right] = x\left[E\left(IS_{i,q}\big|_{\Theta_{i,m}}\right)\right]^{z}, \qquad (16)$$

where x and $z(0 < z < 1)$ are positive constants. By equations (11), (12), (14), (15), and (16), therefore,

$$\boldsymbol{D}_{i,m} = E\left(D_{i,h}\big|_{\Theta_{i,m}}\right) = 1 - \chi^{-z}e^{1-m}. \qquad (17)$$

Hence, by equations (13) and (17),

$$\boldsymbol{C}_{i,m} = 1 - \boldsymbol{D}_{i,m} = \chi^{-z}e^{1-m}. \qquad (18)$$

Equation (18) means that $\boldsymbol{C}_{i,m}$ is most likely approximately an exponentially increasing function of $N - m$; that is, DCS exponentially increases as the rank of Inf-piece $IP_{i,m}$ rises.

3 MISINFORMATION AND DISINFORMATION

3.1 *Distinguishing misinformation from other information*

Generally, misinformation is recognized as information that is false, incorrect, inaccurate, and furthermore, misleading or biased. However, it is not easy to precisely distinguish misinformation from other information because it is not easy to discern the genuineness, authenticity, or accuracy of information.

3.1.1 Support of the majority

One criterion that can be used to distinguish misinformation from other information is if the majority of people agree that the piece of information is true (i.e., it is not misinformation). However, this criterion is very problematic. Even if the majority agree that it is correct at the present, it may be proved to be wrong and not accepted by the majority in the future. Mainstream theories that are supported by the majority have often changed over time. If there are two opposite theories, one or the other or both must be wrong (i.e., misinformation).

In addition, the views that the majority support will differ not only temporally but also spatially, for example, across countries. Therefore, even if a piece of information is treated as misinformation in one country, it may not be in other countries.

3.1.2 Costs and efforts

Verifying the correctness of information entails costs. Some misinformation can be easily found to be false at a small cost, but other misinformation may not easily be uncovered even if large expenditures are made to uncover the truth. Furthermore, some misinformation can never be identified as such no matter how hard you try because of its nature, for example, because it is impossible to verify it physically or methodologically. In these cases, it is difficult to distinguish misinformation from other information.

3.1.3   Unexpected phenomena

Unexpected phenomena are frequently observed. Because they are unexpected, they can be hard to explain by the current orthodox, standard, or mainstream theories. This implies that any current mainstream theory may be shown to be wrong in the future. On the other hand, there are always heterodox or unconventional theories, even though a very small number of people believe in them. If a significant unexpected phenomenon is observed, an existing heterodox theory may be used to explain it, and that theory may begin to be supported and believed far more widely than before, if only temporarily.

3.2   Distinguishing disinformation

Common sense recognition of the difference between disinformation and misinformation is that the former is a part of the latter, and it is disseminated with malicious intent (i.e., the difference between them lies in the intention of dissemination). However, it is difficult to discern whether a piece of misinformation is disseminated with malicious intent or not because it is not easy to know another person's intentions.

In addition, although some people may indeed disseminate misinformation with malicious intent, other people may disseminate that same information without it because they wrongly believe that it is not misinformation. This type of behavior can often be observed in the context of political activities. The question arises whether this kind of dissemination of misinformation with benevolent intentions should also be categorized as disinformation.

3.3   Definition of misinformation and disinformation
3.3.1   Misinformation

Defining misinformation is equivalent to defining "correct" information. However, for the same reasons discussed in Section 3.1, it is not easy to define what is correct. Nevertheless, it is highly likely that information that is objectively correct and true exists, even if humans cannot verify it. The validity of this claim cannot be proved, but in this paper, I assume such objectively correct information as follows:

Assumption: There are objectively correct pieces of information regardless of whether

people know them.

Even though nobody may know a truth or fact, the truth or fact itself exists. Based on this assumption, I define "misinformation" in this paper as follows:

Definition 1: Misinformation is a part of information that is not objectively correct.

3.3.2   Disinformation

Common sense definitions of disinformation usually depend on existence of malicious intentions, but because it is difficult to judge people's intentions as discussed in Section 3.2, in this paper I define disinformation as follows,

Definition 2: Disinformation is a part of misinformation that is deliberately disseminated by a person to obtain utility by making other people's behaviors change.

Definition 2 means that even if a person does not have a malicious intention (e.g., the person does not know that the information he or she is deliberately disseminating is misinformation), it is disinformation if the person disseminates it to obtain some utility by making other people's behaviors change. That is, even if a person believes that a piece of information is not misinformation, it still can be considered to be disinformation, depending on how it is used. Note that Definition 2 indicates that misinformation that is disseminated with a malicious intention is of course included in disinformation and will be an important component of disinformation.

3.4   *Value of a piece of misinformation*

Definition 1 implies that the value of misinformation in the model of ranked information shown in Section 2 is zero. Hence, it is assumed that the value of $IP_{i,q}$ is zero if $IP_{i,q}$ is misinformation.

4   MECHANISM OF IMPACT OF DISINFORMATION

4.1   *Manipulation of information*

Disinformation can manipulate people's process of ranking and selecting important pieces of information, and as a result, it changes or distorts the Inf-sets that people select.

4.1.1   First phase: manipulation in Step 1

In real life, people may not be easily manipulated in most cases. This means that for disinformation to be effective, subterfuge may be necessary so that the disinformation makes it into the set of pieces of information people collect in step 1 of the process of ranking and selecting pieces of information. Alternatively, a piece of disinformation may be camouflaged as a correct one. Such tricks or camouflages may resemble search engine optimization (SEO) and spamdexing for Web search engines. The first phase of disseminating disinformation is successful if a piece of disinformation infiltrates into the pieces of information collected in step 1.

4.1.2 Second phase: manipulation in step 2

To make disinformation effective eventually, the process of ranking and selecting pieces of information must be manipulated after the information is collected (step 2). One way of manipulation is to include information that cannot be easily verified or is intrinsically unverifiable. Even if the information looks incorrect, it is hard to disprove it. Its correctness can be only perceived with probabilities, and people therefore become more uncertain because of the disinformation. If the level of perceived uncertainty increases sufficiently, the disinformation succeeds, and DCS will be made further more different among people.

There are other ways to manipulate information. One is to use "borrowed" authority. For example, persons of authority who have already passed away may have presented views when they were alive that have been proved to be wrong. If the disinformation includes these incorrect views, it may confuse people who only know the name of the person but not exactly what they said and did. Another way is to include information that is closely related to a belief or faith that is held by some people but regarded to be scientifically incorrect by others.

These ways of manipulation, and others, take advantage of uncertainty, ambiguity, ignorance, prejudice, and bigotry. If the influence of these factors is increased by some external changes in the surrounding environment (e.g., a severe economic recession), the probability that the manipulation works effectively may greatly increase.

4.2   Effect of manipulation

As a result of manipulation in the second phase, a person may reach an incorrect conclusion, although the person would not have reached that conclusion in the absence of being exposed to the disinformation. Consequently, the person wrongly gives higher ranks to disinformation and other pieces of information that are connected to the disinformation. That is, the Inf-pieces ranks are distorted, and DCS decreases because of the disinformation.

Suppose that for purpose i, a person selects Inf-set x if a piece of disinformation

z is not disseminated, but selects Inf-set z if it is. Disinformation will degrade the value of the Inf-set and increase DIS, and therefore,

$$D_{i,x} \leq D_{i,z} \,. \tag{19}$$

Equation (19) means that an Inf-piece in Inf-set x can be replaced with disinformation z whose value is zero. It is also possible that some other Inf-pieces in Inf-set x will be accordingly replaced with Inf-pieces whose values are relatively low. Note that if Inf-set x already includes some pieces of disinformation and one of them is replaced with disinformation z, $D_{i,x} = D_{i,z}$. In addition, if no piece of information in Inf-set x is replaced when disinformation z is disseminated, also $D_{i,x} = D_{i,z}$. Nevertheless, in many cases, strict inequality in equation (19) will hold.

Inequality (19) means that the probability of achieving a purpose decreases because of disinformation, and therefore,

$$y\left(IS_{i,q}\big|_{\Theta_{i,x}}\right) \geq y\left(IS_{i,q}\big|_{\Theta_{i,z}}\right) \,. \tag{20}$$

The degrees of decrease in the probability of achieving a purpose by disinformation will be heterogeneous across people because fluid intelligences are heterogeneous across people, and the probability is essentially influenced by fluid intelligence as discussed in Section 2. If the fluid intelligence of a person is higher, the decrease in the probability for the person will be smaller.

4.3   Inefficiency

Inequality (20) indicates that, because of disinformation, the levels of efficiency in not only various individual economic activities but also the entire economy are lowered.

4.3.1   Decrease in productivity

Decreases in efficiency indicated by inequality (20) in the process of production are observed as decreases in productivity. If disinformation affects only a small number of people, the decrease in productivity of the entire economy may be negligible, but if it affects a large number of people simultaneously, the productivity of the entire economy can significantly decrease.

In the model of TFP developed in Harashima (2009, 2012b)[1], the production function is described as

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[1] Harashima (2009, 2012b) are also available in Japanese as Harashima (2016, 2020b), respectively.

$$Y = \bar{\sigma}\omega_A\omega_L A^\alpha K^{1-\alpha}L^\alpha \;, \tag{21}$$

where Y is outputs, K is capital inputs, L is labor inputs, α is a constant and indicates labor share, A indicates technologies (mostly scientific technologies), ω_A and ω_L indicate productivities of laborers with regard to technology and labor inputs, respectively, and $\bar{\sigma}$ indicates the accessibility to capital and represents the efficiency of various kinds of economic and social institutions and systems.

Equation (21) indicates that TFP can be divided into three elements, i.e., A, ω_A and ω_L, and $\bar{\sigma}$. Of these three elements, A is basically irrelevant to ranked information, but the elements ω_A, ω_L, and $\bar{\sigma}$ matter (see Harashima, 2022b). Because all three are significantly influenced by fluid intelligence as shown in Harashima (2009, 2012b), they are affected by ranked information and thereby disinformation (see Harashima, 2022b). That is, because of disinformation, ω_A, ω_L, and $\bar{\sigma}$ (and therefore TFP) can be decreased.

4.3.2   Decrease in the success rate of investment

As indicated in Harashima (2021b), the success rate of investment is also influenced by fluid intelligence. Hence, as with the cases ω_A, ω_L, and $\bar{\sigma}$, disinformation can lower the success rate of investment.

4.3.3   Inefficiency due to "bad" speculation

Taking risks can provide rewards—innovations. Taking risks can be interpreted as "speculation", and there are two kinds of speculation: "good" and "bad". Good speculations are those undertaken to help generate innovations and technological progress, and bad speculations are those undertaken even if there is no intention to create innovations. Instead, they are used to exploit other people's economic resources by confusing them, intentionally misleading them, or even deceiving them.

Harashima (2022a) presented a model of bad speculation in which bad speculators obtain utility from bad speculations as well as from consumption. That is, undertaking a risky project itself makes a bad speculator happy, in much the same way a gambler enjoys playing games in a casino. However, bad speculations not only give utilities but also incur costs because bad speculations do not contribute to productive activities in an economy and, moreover, disturb economic activities and generate inefficiencies. Harashima (2021b) showed that bad speculations reduce production and consumption at steady state or on a balanced growth path.

Clearly, bad speculations are closely related to disinformation. Disinformation is an important tool of bad speculation because disinformation can be used to confuse, mislead, or even deceive other people to exploit their economic resources. That is, disinformation can reduce the efficiency of an entire economy through the channel of bad

speculations.

4.4 Economic rents

Inequality (20) also indicates that disinformation increases economic rents that are generated because of ranked information. Economic rents originating in disinformation take various forms. One is through the channel of mistakes in business dealings. Harashima (2020c) showed that mistakes in business dealings generate economic rents such that winners can receive excess payments and presents a model of these rents. Because mistakes in business dealings are largely influenced by fluid intelligence, this type of economic rent can be increased by disinformation. Inequality (20) indicates that disinformation will increase the probability of mistakes in business dealings.

Harashima (2020c) showed that because fluid intelligence is heterogeneous across people, the effect of the same piece of disinformation can also be heterogeneous across people. Hence, even if two parties are exposed to the same disinformation, changes in the probability of mistakes in business dealings will differ between them.

In the model in Harashima (2020c), the degrees of honesty of persons also matter when considering the economic rents generated by mistakes in business dealings. Disseminating disinformation basically means a lower degree of honesty. Harashima (2020c) showed that a lower degree of honesty in a person increases the economic rents of that person.

Finally, other non-economic extra gains (e.g., political gains) can be obtained by disseminating disinformation.

4.5 Economic fluctuations

As discussed in Section 4.3.3, disinformation and bad speculation are closely related. Nevertheless, as Harashima (2022a) indicates, the costs of bad speculation may usually stay at a relatively low level because governments keep the cost of bad speculation at a low level. Until the cost of bad speculation exceeds a critical point of a government's tolerance, the government overlooks bad speculations. Even so, bad speculators will always strongly desire a much larger amount of bad speculations, along with their higher risks and higher returns. Hence, they may occasionally undertake bad speculations whose costs greatly exceed the government's tolerance. In some cases, their attempts may succeed because a government overlooks them due to a lack of competency or some kinds of corruption. Hence, as Harashima (2022a) indicates, bad speculation can be an important source of economic fluctuations; therefore, disinformation also can be a source of fluctuations.

4.6 Incentive

Despite the negative effects on an economy (i.e., decreases in efficiency and increases in economic rents), disinformation is rampant because people who want to exploit the opportunities that disinformation provides always exist. Although some of the economic rents generated by disinformation will spill over to other people without compensation, similar to technology spillover, there is no doubt that the person who disseminated it receives a considerable amount of those rents if the disinformation dissemination is successful.

In addition, incentives for disseminating disinformation without any malicious intent can exist if some utilities are obtained, as indicated in Assumption 2. For example, a person may disseminate disinformation because the person wants to guide other people onto a perceived "right" path without knowing that it is misinformation.

When a person disseminates disinformation, the probability that the person obtains economic rents and other non-economic gains is not negative. On the other hand, the income of the person who disseminates it may accordingly decrease because the efficiency of the entire economy (i.e., TFP) decreases. If the expected amount of economic rents and values of other non-economic gains due to disinformation exceeds the decrease in incomes due to the decrease in TFP, an incentive to disseminating disinformation is generated. Furthermore, if disseminating disinformation is not punished by authorities, the incentive will become stronger.

Nevertheless, there is a risk that it will become known that a person is disseminating disinformation, and that the person may be criticized, blamed, and possibly punished in various forms by society. This risk can be seen as a kind of cost to disseminating disinformation. The incentive will remain, however, if the expected net rents, gains, or incomes are still positive even after considering all the costs.

5   MACRO-ECONOMIC IMPACT OF DISINFORMATION

5.1   *Purpose*

Many pieces of various kinds of disinformation have been disseminated, but most of them have not had a large impact on the entire economy. The reason for the small impact is probably that the number of people concerned for each individual piece of disinformation is usually small. However, if many people are concerned with a piece of disinformation, it can have a large impact on economy. This means that if disinformation is disseminated for a purpose that is commonly shared by most people, the scale of the. impact of the disinformation can be large.

As shown in the model of ranked information in Section 2, purpose is an

important element in the value of information. Most purposes are individual and personal, but some purposes are common to a large number of people (e.g., a national goal). Disinformation aimed at this type of common purpose can have a large impact on the macro-economy. In this sense, the scale of the impact of disinformation will depend on the number of people who share a common purpose.

In addition, if pieces of disinformation are independent of each other but very similar, they will collectively be able to have a greater effect on the economy. For example, each instance of fraud is usually small, but the combined amount of money obtained in similar kinds of fraud can be very large. Disinformation can affect the entire economy through this channel. Note that similar kinds of fraud basically target the corresponding similar kinds of purpose (e.g., insurance fraud).

Similar to individual and personal purposes, commonly shared purposes will change temporally and spatially. For example, a purpose may be pursued in one period or country but not in others. Purposes will change over time, regardless of whether the purposes were achieved or not, and new ones will emerge.

It is unlikely that rent seekers will disappear from the economy; therefore, it also unlikely that disinformation that is disseminated to obtain economic rents will disappear. Because disinformation is disseminated aiming at specific purposes, the pieces of disinformation will change as the purposes change. In addition, the number of pieces of information can fluctuate according to changes in the surrounding economic, political, or social environments, possibly greatly.

5.2   Combined inefficiency

According to equation (20), the value of the economic impact of a piece of disinformation z for purpose i ($\Gamma z,i$) can be most simply modeled by

$$\Gamma_{z,i} = -P_i \left[y \left(IS_{i,q} \big|_{\Theta_{i,x}} \right) - y \left(IS_{i,q} \big|_{\Theta_{i,z}} \right) \right],$$

where P_i is the outcome if purpose i is achieved. Because of the successful dissemination of a piece of disinformation z, the outcome decreases by $\left| \Gamma_{z,i} \right|$ even though the amounts of inputted resources are the same; that is, efficiency decreases.

Suppose that many pieces of disinformation that are very similar to z are also widely and ubiquitously disseminated. In this case, the combined impact of these pieces of disinformation can be approximately described as the aggregation of $\Gamma_{z,i}$ over such pieces of disinformation. However, it may not be easy to aggregate $\Gamma_{z,i}$ because there may be redundancy among the impacts. Hence, the value of the economic impact of the pieces of disinformation that are very similar to z $\left(\widetilde{\Gamma_{x,z}} \right)$ can instead be modeled as

$$\tilde{\Gamma}_{x,z} = -\left(\Lambda_x - \Lambda_{x,z}\right),$$

where Λ_x is GDP if the pieces of disinformation that are very similar to z are not disseminated under environment x, and $\Lambda_{x,z}$ is GDP if they are disseminated and all other things are equal. Note that under environment x, many pieces of disinformation other than those that are very similar to z can also be disseminated.

5.3 Economic inequality

Harashima (2022b) indicates that it seems highly likely that a very few people with very high fluid intelligences will select exceptionally more correct Inf-sets for most purposes; therefore, this select group of people can enjoy exceptionally high productivities and large amounts of economic rents. That is, because information is ranked, the level of economic inequality will be increased. An important point is that even if the same information is equally given to all people, economic inequality will still increase.

As Becker (1980) and Harashima (2010, 2012a, 2020d)[2] showed, in dynamic economic models, heterogeneous rates of time preference, degrees of risk aversion, persistent rents, and success rates of investment result in extreme economic inequalities if they are left alone; that is, all capital will eventually be possessed by the most advantaged household. Of these four factors, heterogeneous persistent rents and success rates of investment are generated by ranked information and therefore by disinformation. That is, disinformation can cause an extreme economic inequality.

5.4 Economic fluctuations

Bad speculations can occasionally fluctuate largely and therefore generate large economic fluctuations as shown in Harashima (2022b). Because bad speculations are often executed using disinformation, disinformation can be seen as a source of large economic fluctuations. For example, an unrealistically optimistic economic view that is actually disinformation may be appealing to many people. If people change their behaviors largely and wrongly, an economic bubble may eventually be generated, which was the original purpose of the bad speculators. Many such attempts will fail, but the probability of success is not zero.

CONCLUDING REMARKS

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[2] Harashima (2010, 2012a, 2020d) are also available in Japanese as Harashima (2017, 2020a, 2021a), respectively.

The value of information is changeable depending on situations and differs across people. This variability is economically very important because it means that a malicious person can manipulate the value of information a person expects by disseminating disinformation. The problems of fake news, disinformation, and misinformation have been recently widely reported in the political scene, particularly in elections in the U.S. Politically and socially, the problems of fake news, disinformation and misinformation have been regarded to be serious, but they are rarely studied in economics. I examined misinformation and disinformation from the point of view of ranked information (Harashima, 2022b) and its impact on economics.

The importance of each piece of information has to be evaluated individually and personally by each person in each period for each purpose. I defined misinformation and disinformation, and then showed the mechanism of how disinformation decreases efficiency by manipulating ranked information on the basis of the model of ranked information presented in Harashima (2022b). Decreases in efficiency are observed as decreases in TFP, lowered success rates of investment, and costs of bad speculations. Disinformation not only decreases efficiency but also generates economic rents. Because of these economic rents, inequality widens, possibly by a great deal. Furthermore, disinformation can cause large-scale economic fluctuations.

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