Disinformation and “Bad” Financial Speculations: A Mechanism behind Financial Crises

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Abstract

Some financial speculations are similar to gambling or Ponzi schemes because they are undertaken to extract other people's economic resources. In this sense, there will be "good" and "bad" financial speculations. In this paper, I construct static and dynamic models of bad speculations and show that an important determinant of the amount of bad speculation is the economic cost (inefficiency) generated, particularly by disinformation that is disseminated for the speculation. The economic cost and amount of bad speculation are influenced by the ability and effort of regulatory authorities, and if that ability largely deteriorates, the amount of bad speculation will greatly increase and a financial crisis will occur. Hence, people must look for signs of deterioration of the ability of the regulatory authority to prevent financial crises.

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Keywords: Disinformation; Financial crisis; Financial regulation; Inefficiency; Speculation

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1 INTRODUCTION

Defining a “financial crisis” can be difficult, but it is generally understood to be serious turbulence in financial markets that accompanies economic recessions. Many studies have emphasized the importance of credit booms in predicting a financial crisis (Schularick and Taylor, 2012; Greenwood and Hanson, 2013; Baron and Wei, 2017; Krishnamurthy and Muir, 2017; López-Salido et al., 2017; Mian et al., 2017). Furthermore, past episodes of credit booms and financial crises imply that large-scale financial speculations are being conducted before and during them, which means that unless large-scale financial speculations are undertaken, large-scale turbulence in financial markets may not occur.

However, financial speculations can play an important and beneficial role for the entire economy because they can be an important origin of innovations. Without speculations (or risk-taking), fewer innovations are created and an economy grows and develops more slowly. Hence, financial speculations as a whole should not be naively criticized just because they may cause financial crises. However, it seems highly likely that some kinds of financial speculations need to be eliminated. That is, there will be “good” and “bad” financial speculations. Good speculations are beneficial to society because they are investments in technologies to create innovations. On the other hand, bad speculations are harmful because they do not generate any new economic value. Rather, they are undertaken to extract, exploit, or even steal other people’s economic resources. They are in this sense equivalent to gambling and Ponzi schemes.

Because bad speculations do not generate any new economic value, they are not classified as either production or investment activities. This means that they have to be classified as consumption because the activities of bad speculators are similar to those of gamblers. The reason why people play games in casinos even though they may expect to lose money is that they simply want to obtain utility (i.e., pleasure or happiness) from playing them. The same is true for bad speculators—they “consume” bad speculations to obtain utility.

Considering this nature of bad speculations, Harashima (2022a[1]) constructed a dynamic model that describes a mechanism of how bad speculations grow along with (usual) consumption and money in an economy. According to the model, the bad speculation–consumption ratio in an economy grows exponentially in the same manner as the money–consumption ratio. A key element in this relation is the economic damages done or costs generated by bad speculations (e.g., inefficiency) that have to be borne by the entire economy (I call these “economic costs”). However, past episodes of financial crises strongly suggest that bad speculations occasionally deviate largely from the level

[1] Harashima (2022a) is also available in Japanese as Harashima (2023a).

predicted by the bad speculation–consumption ratio, implying that the economic cost is not necessarily stable but occasionally largely fluctuates. In Harashima (2022a), however, the mechanism explaining how economic cost is determined and fluctuates is not shown. A purpose of this paper is to examine what determines and makes economic costs fluctuate and how a financial crisis is generated by these fluctuations on the basis of the model presented in Harashima (2022a) as well as the model of ranked information presented in (Harashima, 2022b) and the model of disinformation presented in Harashima (2023b, 2023c, 2024, 2025).

It seems highly likely that the economic cost generated by bad speculation is closely related to dissemination of disinformation because disinformation can be a very useful and effective tool for bad speculations, i.e., it can be used to confuse, mislead, or deceive other people to extract, exploit, or steal their economic resources, thereby damaging (via inefficiency) the entire economy. Harashima (2023b, 2023c, 2024, 2025) showed a mechanism of how inefficiency is generated in an economy by disinformation. Because of dissemination of disinformation, efficiency (particularly total factor productivity, TFP) and the success rate of investment decrease. That is, disinformation disseminated for bad speculations does damage to an entire economy, which has to bear these costs (damages).

In this paper, I first examine the nature of this economic cost following Harashima (2022a, 2022b, 2023b, 2023c, 2024, 2025) and then construct a static model of bad speculation. I show that not only the economic cost but also the regulatory cost (the costs of regulating financial markets) are important in determining the amount of bad speculations, and both costs are influenced by the ability and effort of the regulatory authority as well as the ability of investors. For a given set of abilities of the regulatory authority and investors, the amount of bad speculation is determined at a point where the economic and regulatory cost are identical. The key force to achieve this equilibrium is that a regulatory authority will tolerate bad speculations, but there is an upper limit of tolerance. At this equilibrium, the level of effort of the regulatory authority is determined, and accordingly, the level of disinformation dissemination and the amount of bad speculations are determined.

To further examine bad speculation, I numerically simulate the impacts of the deterioration of the ability of the regulatory authority on the basis of the static model of bad speculation and show that as the ability of the regulatory authority deteriorates, the level of disinformation dissemination increases. Because it seems highly likely that the amount of bad speculations is roughly proportionate to the level of disinformation dissemination, the amount of bad speculation will increase as the regulatory ability deteriorates. Conversely, as the probability of uncovering disinformation by people is higher and the probability of success of disinformation dissemination is lower, the level of disinformation dissemination decreases. In addition, as the ability of the regulatory authority is higher, the impact of the deterioration of its ability is greater.

The results of the simulation imply that a financial crisis will not be generated unless the ability of the regulatory authority largely deteriorates. How often such a large-scale deterioration occurs is an empirical question. Although answering this question may be difficult because of a lack of appropriate data, it seems likely that such a large-scale deterioration rarely occurs. However, there is no guarantee that it will never occur. Furthermore, people should still always look for any signs of deterioration of the ability of the regulatory authority to prevent a financial crisis.

The simulation results also indicate that the amount of bad speculation largely differs depending on the abilities of the regulatory authority and people. It is highly likely that these abilities are heterogeneous across economies, and therefore, the amount of bad speculation will be also heterogeneous across them, and the probability of occurrence of large-scale deterioration and an ensuing financial crisis is not zero.

2 UTILITY FROM BAD SPECULATION

2.1 "Bad" speculation

2.1.1 "Good" and "bad" speculations

Speculations in financial markets are risky and many of them will end in failure, but they are very important and beneficial for the entire economy because they help create innovations that are essential for technological progress and economic growth. However, not all financial speculations are aimed at helping to create innovations. Some are intended to extract (or exploit or even steal) economic resources that have already been generated by other people (e.g., market manipulation).

In simple terms, there are two kinds of financial speculation: "good" and "bad". Good speculations are those undertaken to create innovations and enhance technological progress. Bad speculations are those undertaken even if there is no intention to create innovations. They are undertaken to extract other people's economic resources by confusing, misleading, or even deceiving them (e.g., intentionally disseminating disinformation). The important point is that bad speculations do not generate any new economic value. In essence, they are a kind of gambling, through which no new economic value is produced, except for the joy and excitement obtained from gambling.

It is highly likely that bad speculators take more risks than the average person. Furthermore, they highly likely desire to experience the enjoyment of gambling.

2.1.2 Bad speculation as consumption

Economic agents are most simply classified into the following three categories: firm, household, and government. Which of these economic agents are bad speculators? Clearly, government would not be classified as a bad speculator. In addition, firms produce new economic values by inputting capital and labor, but bad speculators do not produce new economic value. Furthermore, firms behave to maximize profits, which means that their best choice is not to behave like bad speculators; that is, they should not gamble because the expected returns on most types of gambling are usually negative.

Many people (i.e., households), however, do choose to gamble even though the expected returns are negative because they simply want to obtain utility (i.e., pleasure or happiness) from the various forms of gambling available. That is, they do not "work" to maximize profits; rather, they enjoy "playing" the game. The same is true for bad speculators. Hence, a bad speculator is not a firm that produces new economic value but a household (consumer) that enjoys playing high-risk games.

Economic activities are most simply classified into the following three categories: production, consumption, and investment. Good speculations are clearly classified as investments because they finance innovations. On the other hand, bad speculations cannot be classified as investments because they do not create any new technology nor make capital accumulate. They also cannot be classified as production because they do not generate any new economic value. As a result, bad speculations have to be classified as consumption. This classification is consistent with the idea that bad speculators are households (consumers) and that bad speculations provide some kinds of utilities to the speculators.

2.2 Utilities obtained from bad speculation

2.2.1 The representative household

Because I am examining bad speculations in the framework of macroeconomics, the nature of the representative household that represents not only "usual" households but also bad speculators has to be examined. As noted in Section 2.1, the degree of risk aversion of bad speculators will be far lower than that of average households, which means that households are heterogeneous. However, as Harashima (2014a) showed, in a heterogeneous population, the representative household cannot be defined simply as being equal to the average household. Hence, following Harashima (2014a), I use the representative household that is defined to be consistent with sustainable heterogeneity (SH) that can be achieved through, for example, government intervention to redistribute incomes among households. SH here means a state at which all optimality conditions of all heterogeneous households are simultaneously satisfied (Harashima, 2010[2], 2012a[3], 2014b).

[2] Harashima (2010) is also available in Japanese as Harashima (2017).
[3] Harashima (2012a) is also available in Japanese as Harashima (2020b).

2.2.2 Utility function

Sidrauski (1967)'s well-known money-in-the-utility function is extended to a utility function that consists of not only "usual" consumption and money but also bad speculation as a type of consumption. This type of utility function was first presented in Harashima (2022a), and its essence is as follows.

Let β_t be the real amount of per capita bad speculation in an economy in period t. Suppose for simplicity that m_t, c_t, and β_t are additively separable in the utility function where c_t is real "usual" consumption and m_t is real money in period t. Hence, the utility function of the representative household (u_P) is

$$u_P(c_t, m_t, \beta_t) = u_{P,c}(c_t) + u_{P,m}(m_t) + u_{P,\beta}(\beta_t) \ , \tag{1}$$

where $u_{P,c}$, $u_{P,m}$, and $u_{P,\beta}$ are the utility functions with regard to consumption, money, and bad speculation, respectively.

The utility functions with regard to consumption $u_{P,c}(c_t)$, money $u_{P,m}(m_t)$, and bad speculation $u_{P,\beta}(\beta_t)$ are all assumed to be constant relative risk aversion utility functions such that

$$u_{P,c}(c_t) = \frac{{c_t}^{1-\mu}}{1-\mu} \ , \tag{2}$$

$$u_{P,m}(m_t) = \frac{{m_t}^{1-\varrho}}{1-\varrho} \ ,$$

and

$$u_{P,\beta}(\beta_t) = \frac{\beta_t^{1-\rho}}{1-\rho} \ , \tag{3}$$

respectively, where μ, ϱ, and ρ are positive constants. By equations (1) and (3),

$$\frac{\partial u_P(c_t, m_t, \beta_t)}{\partial \beta_t} = \beta_t^{-\rho} \ . \tag{4}$$

Suppose that the economy is endogenously growing on a balanced growth path because of substitution between investments in capital and technology (see Harashima, 2013c[4], 2023). Let c_t^* be c_t at steady state in period t on a balanced growth path, i.e., c^* increases constantly. Hence,

$$\frac{\frac{dc_t^*}{dt}}{c_t^*} = \eta = \text{a positive constant} ,$$

and therefore,

$$c_t^* = c_0^* e^{\eta t} . \tag{5}$$

Hence, by equations (2) and (5),

$$\frac{du_{P,c}(c_t^*)}{dc_t^*} = c_0^{*-\mu} e^{-\mu\eta t} . \tag{6}$$

3 COSTS CREATED BY BAD SPECULATION

Like "usual" consumption and money, bad speculations not only provide utility. They also incur costs because they not only do not contribute to production activities and they disturb economic activities and generate inefficiencies, and these economic costs have to be borne by the entire economy (Harashima, 2022a).

3.1 Dissemination of disinformation

Inefficiencies are generated by bad speculations because bad speculations are usually accompanied by dissemination of disinformation. Clearly, disinformation is an important tool of bad speculation because disinformation can be used to confuse, mislead, or deceive other people to extract, exploit, or steal their economic resources. Hence, it seems highly likely that the amount of bad speculation is closely related and roughly proportionate to the level of disinformation dissemination (e.g., disinformation for market manipulation). In this section, before examining bad speculations themselves, I examine the impact of dissemination of disinformation on economic activities following Harashima (2022b, 2023b, 2023c, 2024, 2025).

3.1.1 Ranked information

The model of disinformation in Harashima (2023b, 2023c, 2024, 2025) is based on the concept of ranked information presented in Harashima (2022b). I refer to a piece of

[4] Harashima (2013c) is also available in Japanese as Harashima (2019).

information as an "Inf-piece". Let $IP_{i,w}$ be an Inf-piece with the serial number w for purpose i. A set of Inf-pieces is referred to as an "Inf-set". 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 $IS_{i,w}$ indicate that Inf-piece w (i.e., $IP_{i,w}$) is included in IS_i.

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. 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

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

for any s and r.

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. The value of $IP_{i,w}$ will likely be described by an exponentially increasing function of $N - w$. Here, let $\widetilde{IS}_{i,w}$ be the average value of Inf-sets in which the Inf-piece with rank w is included. The value of the Inf-set can be approximated by an exponentially increasing function of $N - w$; that is, $\widetilde{IS}_{i,w}$ increases exponentially as the rank of Inf-piece w rises.

The distance between each Inf-set and the correct Inf-set (i.e., the top-rank Inf-set) can be defined as follows. Let $\Theta_{i,h}$ be the Inf-set with the number $h (\in \mathbb{N})$ for purpose i. Here, let $IS_{i,w}\big|_{\Theta_{i,h}} = \sum_{IP_{i,w} \in \Theta_{i,h}} IP_{i,w}$ and $IS_{i,w}\big|_{w=1,2,\ldots,n} = \sum_{w=1}^{n} IP_{i,w}$. Let $D_{i,h}$ be the distance of Inf-set (DIS) of Inf-set $\Theta_{i,h}$, and it is defined by

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

3.1.2 Dissemination of disinformation

Based on the model of ranked information shown in Harashima (2022b), Harashima (2023b, 2023c, 2024, 2025) showed the mechanism for how disinformation generates economic rents where disinformation is defined as a part of misinformation that is deliberately disseminated by a person to obtain utility by making other people's behaviors change. As a result of dissemination of disinformation, the Inf-pieces ranks are distorted.

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,

$$D_{i,x} \leq D_{i,z} \ . \tag{7}$$

Inequality (7) means that the probability of achieving a purpose decreases because of disinformation, and therefore,

$$y\left(IS_{i,w}\big|_{\Theta_{i,x}}\right) \geq y\left(IS_{i,w}\big|_{\Theta_{i,z}}\right) \ . \tag{8}$$

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

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

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 m.

3.2 Economic costs

Because bad speculations will usually be accompanied by dissemination of disinformation, the economic cost generated by bad speculations will be roughly proportionate to the total amount of damages (inefficiency) done by the relevant disinformation. Therefore, the mechanism of economic cost can be described by the mechanism shown in the model of disinformation presented in Section 3.1 and Harashima (2023b, 2023c, 2024, 2025).

3.2.1 Inefficiency

Following Harashima (2023b, 2023c, 2024, 2025), in this section, I explain the mechanism underlying how inefficiency is generated by disinformation. Inequality (8) indicates that, because of disinformation, the levels of efficiency in individual economic activities and the entire economy are lowered. Decreases in efficiency indicated by inequality (8) in the process of production make the total factor productivity (TFP) decrease.

In the model of TFP developed in Harashima (2009, 2012b)[5], the production function is described as

$$Y = \bar{\sigma}\omega_A\omega_L A^{\alpha} K^{1-\alpha} L^{\alpha} \ , \tag{9}$$

where Y is output, K is capital input, L is labor input, α is a constant and indicates labor share, A indicates technology, ω_A and ω_L indicate productivities of laborers with regard to technology and labor inputs, respectively, and $\bar{\sigma}$ represents the efficiency of various kinds of economic and social institutions and systems. Equation (9) indicates that TFP can be divided into three elements: A, ω_A and ω_L, and $\bar{\sigma}$. Of these three elements, the elements ω_A, ω_L, and $\bar{\sigma}$ 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.

In addition, in the process of investment, the success rate of investment is lowered by disinformation because, as Harashima (2021) showed, this rate is influenced by people's abilities. Therefore, it is affected by ranked information and thereby by disinformation as with the cases of ω_A, ω_L, and $\bar{\sigma}$.

3.2.2 Economic costs created by bad speculation

Let $q\beta_t$ be the economic cost, where q is the economic cost per bad speculation and represents the degree of inefficiency generated in the entire economy because of bad speculation, particularly because of the dissemination of disinformation (Harashima, 2022a). The economic cost $q\beta_t$ is analogous to the interest $((\pi_t + r_t)m_t)$ foregone when holding money, where π_t and r_t are the inflation rate and real interest rate in period t, respectively (see Appendix A1). Therefore, in addition to $(\pi_t + r_t)m_t$, the economic cost $q\beta_t$ has to be subtracted from the amount of capital in each period in the budget constraint of the representative household (which includes the bad speculators).

3.2.3 Nature of *q*

A regulatory authority will tolerate bad speculations to some extent because it is not easy to distinguish good and bad speculations (as will be shown in Section 3.3), and thus detecting and regulating bad speculations are costly. Many small and relatively less serious bad speculations will have to be overlooked to keep regulatory costs down. Hence, q is not zero but positive (i.e., bad speculations are not completely eliminated). However, there will be an upper limit of q. That is, although a regulatory authority will tolerate bad speculations as long as the economic cost per bad speculation is lower than the upper

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

limit, it will not tolerate them if this upper limit is exceeded.

Hence, the observed average value of q indicates the regulatory authority's limit of tolerance for bad speculations in the long run. Bad speculators may be aware of the regulatory authority's tolerance limit and therefore may undertake bad speculations such that they keep the economic cost per bad speculation equal to the upper limit of q in the long run. Nevertheless, bad speculators will desire a much higher value of the upper limit of q.

3.3 Regulatory cost

3.3.1 Difficulty in detecting and regulating bad speculation

Both good and bad speculations involve uncertainty and appear to be equally risky. Furthermore, it is difficult to know the intention or motivation behind speculations, so distinguishing which is which is difficult. If a person sincerely undertakes a highly risky project with the intention of creating new technology, this speculation is considered to be good, but how can that person prove good intentions to other people if the project eventually fails? On the other hand, after a risky project that a malicious person undertook without any intention to create new technologies eventually fails, the malicious person may insist that the project failed only because of bad luck or some other reason. It may not be easy to prove that the malicious person is lying because the project was known to be very risky from the beginning. Furthermore, because bad speculators know that their true nature has to be concealed, bad speculations are generally undertaken under the guise that they are good speculations (i.e., bad speculations usually appear to be good speculations).

3.3.2 Costs to detect and regulate bad speculations

It is true that regulatory authorities want to eliminate bad speculations and to return ill-gotten gains if possible. It is also true that if all kinds of speculation (or risk-taking activities) were banned, bad speculations could be eliminated, but such a ban would be hazardous to the economy because a complete ban would also eliminate good speculations.

Even so, regulatory authorities work hard to minimize the economic costs $q\beta_t$ as much as possible. In addition, most kinds of market manipulation are prohibited or strictly regulated in many countries. However, gray areas still exist. Furthermore, new, unnoticed, and more complicated methods of bad speculation are created constantly because huge amounts of economic resources can be obtained by such conduct even though it is highly risky. Harashima (2015, 2018b) showed that bluffs in financial markets are one such kind of speculation.

Therefore, an important point is how intensely or strictly gray areas and new innovative methods of bad speculation should be investigated and regulated. Investigating and regulating bad speculations conducted in gray areas and perpetrated using innovative methods requires more costs than those conducted in "black" areas using traditional or known methods. It is highly likely that as a regulatory authority more intensely investigates and regulates bad speculations conducted in gray areas using new methods, the unit regulatory cost will increase.

4 USUAL AMOUNT OF BAD SPECULATION

4.1 Level of disinformation dissemination

As mentioned in Section 3, many bad speculations seem to be accompanied by the dissemination of disinformation. Therefore, it seems highly likely that the amount of bad speculation is roughly proportionate to the level of dissemination of disinformation. Hence, to examine the amount of bad speculation, I briefly explain a model of disinformation dissemination that was constructed in Harashima (2023b, 2023c, 2024, 2025).

4.1.1 Environment

Suppose that there are many identical bad speculators and "innocent" or "naïve" investors, and they negotiate for one type of deal, contract, or project. Bad speculators behave to obtain rewards from bad speculations as much as possible by manipulating investors (i.e., by disseminating disinformation in gray areas), which is technically lawful (i.e., within the tolerance of the regulatory authority). That is, they distort an investor's Inf-set with regard to the deal by including lawful disinformation into negotiations.

Let m be the highest rank Inf-piece in the Inf-set of an investor with regard to the deal. Suppose that m is continuous ($0 \leq m$), and therefore $m = 0$ indicates the top rank, and that initially $m = 0$ for any investor. I define the level of disinformation dissemination such that the level of disinformation dissemination is ψ if the highest rank Inf-piece m is aimed to be changed from 0 to ψ (> 0). A larger value of ψ means dissemination of more serious disinformation.

4.1.2 Probability of uncovering disinformation

It is highly likely that as ψ increases, an investor can more easily notice whether or not disinformation is disseminated because, as shown in Section 3.1, $\boldsymbol{D}_{i,m}$ is most likely an increasing function of m, and as $\boldsymbol{D}_{i,m}$ increases (i.e., as m increases), it becomes more apparent that disinformation is present. Considering the nature of $\boldsymbol{D}_{i,m}$ shown in Section 3.1, the probability of uncovering disinformation will increase rapidly as ψ increases when ψ is relatively small, but it will increase slowly when ψ is relatively large. Hence, for a given set of investors, the probability of uncovering ($P(\psi)$) can be most simply modeled as

$$P(\psi) = 1 - e^{-\delta\psi} , \tag{10}$$

where δ is a positive constant.

4.1.3 Rewards to bad speculators

As ψ increases, the rewards obtained by a bad speculator who successfully disseminates disinformation will increase in proportion to the corresponding increase in probability of an investor making a mistake. A "mistake" in this case means that the investor naively and wrongly believes the disinformation that the bad speculator has tried to include in the investor's Inf-set. It is likely that because $\widetilde{IS}_{i,\psi}$ decreases exponentially as the rank of Inf-piece ψ decreases (i.e., the value of ψ increases), as shown in Section 3.1, an increase in the value of ψ will make the probability of making a mistake (and consequently, the reward) increase rapidly when ψ is relatively small; conversely, it will increase slowly when ψ is relatively large. Hence, the reward per deal for the bad speculator when the dissemination of disinformation succeeds ($R(\psi)$) will be most simply modeled as

$$R(\psi) = \gamma\left(1 - e^{-\zeta\psi}\right) , \tag{11}$$

where γ and ζ are positive constants.

4.1.4 Optimal level of disinformation dissemination

Each of many identical bad speculators disseminates disinformation to make investors misunderstand that the benefit from a deal is higher than those of good speculators who do not disseminate disinformation because the probability of success of the deal is higher. A bad speculator selects a level of disinformation dissemination of ψ so as to maximize the expected reward, and the expected reward to a bad speculator for a given ψ (i.e., $\tilde{R}(\psi)$) can be calculated by

$$\tilde{R}(\psi) = R(\psi)[1 - P(\psi)] \tag{12}$$

and by equations (10), (11), and (12),

$$\tilde{R}(\psi) = \gamma\left(e^{-\delta\psi} - e^{-(\zeta+\delta)\psi}\right) .$$

The expected reward is maximized if

$$\frac{d\left(e^{-\delta\psi} - e^{-(\zeta+\delta)\psi}\right)}{d\psi} = 0$$

is satisfied, and thereby, it is maximized if the level of disinformation dissemination is selected to satisfy

$$\psi = \zeta^{-1}\ln\left(1 + \frac{\zeta}{\delta}\right)(> 0)\ . \tag{13}$$

Equation (13) means that an optimal level of disinformation dissemination always exists because the value of ψ that satisfies equation (13) is always positive.

Because the amount of bad speculation will be roughly proportionate to the level of relevant disinformation dissemination, the amount of bad speculation will be determined roughly according to (or consistent with) equation (13). That is, it moves similarly to the movement of the optimal ψ.

4.2 Other factors that affect the amount of bad speculation

Factors other than ψ also can affect the amount of bad speculation. These include the ability of the regulatory authority, as well as the that of the investors.

4.2.1 Ability and effort of the regulatory authority

An important factor that can affect the amount of bad speculation is the ability of the regulatory authority. It is highly likely that the values of ζ and δ in equation (13) are influenced by the activities of the regulatory authority, because if its ability is higher, it can detect and prevent a larger number of and more serious bad speculations (or equivalently the dissemination of disinformation) as well as newly developed methods of bad speculation sooner. As the performance of the regulatory authority increases, the parameter with regard to investors' uncovering disinformation (δ) will become higher, and the parameter with regard to rewards of bad speculators (ζ) will become smaller.

Another important factor is the "effort" of the regulatory authority, where effort means the number (or intensity) of regulatory activities. For the same reason as with its ability, if the regulatory authority's effort is greater, the parameter with regard to uncovering disinformation (δ) will be larger and the parameter with regard to rewards (ζ) will be smaller. That is, δ will be an increasing function of both ability and effort of the regulatory authority, and ζ will be a decreasing function of them. Accordingly, the level of disinformation dissemination and the amount of bad speculation are influenced by the ability and effort of the regulatory authority through δ, ζ, and ψ in equation (13).

Furthermore, if the ability of the regulatory authority is higher, the economic cost per bad speculation (q) will be smaller for the same reason as with the cases of the ability and effort. In addition, if the ability of the regulator is higher, the regulatory cost per bad speculation will be also smaller because the regulatory authority can detect and regulate bad speculations more effectively and efficiently.

For the same reason, if more efforts are made, the economic cost per bad speculation (q) will also be smaller. However, if more efforts are made, the regulatory cost per bad speculation will be higher like supply curves that are usually upwards sloping. For example, increasing the number of investigations (increasing effort) means that bad speculations in paler gray areas are also investigated, and therefore, investigating tasks become more difficult, which raises the cost of the investigation. Furthermore, to increase efforts, less experienced and competent personnel have to be additionally assigned as regulators.

4.2.2 Ability of investors

The ability of investors also matters. It is highly likely that ζ and δ are influenced by the activities of investors (i.e., their abilities). If investors can uncover bad speculations at higher probabilities because they have more ability or are more intelligent, the parameter with regard to uncovering (δ) will be larger and the parameter with regard to rewards (ζ) will be smaller. Hence, δ will be an increasing function of the ability of investors, and ζ will be a decreasing function.

In addition, the ability of investors is highly likely relevant to the economic cost per bad speculation. If their abilities are higher, the cost will decrease because investors will not be easily deceived and can more often identify disinformation by themselves, and thus many planned bad speculations will fail to attract investors. Hence, the economic cost per bad speculation will also be a decreasing function of the ability of investors.

Similarly, the regulatory cost per bad speculation will decrease if investors' abilities are higher because they can more often see through disinformation by themselves, and the regulatory authority can concentrate on a smaller number of more serious bad speculations, which will increase the efficiency and performance of the regulatory authority. Hence, the regulatory cost per bad speculation will be a decreasing function of the ability of innocent investors.

4.3 Static model of bad speculations

4.3.1 Model

Let Λ_R and ϵ be the ability and effort of the regulatory authority, respectively, Λ_I be the average ability of investors, and v be the regulatory cost per bad speculation. Considering the factors examined in Section 4.2, δ and ζ can be assumed to be

$$\delta = f_\delta(\Lambda_R, \Lambda_I, \epsilon) \tag{14}$$

and

$$\zeta = f_\zeta(\Lambda_R, \Lambda_I, \epsilon) \ , \tag{15}$$

respectively, where

$$\frac{\partial \delta}{\partial \Lambda_R} > 0 \ , \tag{16}$$

$$\frac{\partial \delta}{\partial \Lambda_I} > 0 \ ,$$

$$\frac{\partial \delta}{\partial \epsilon} > 0 \ ,$$

$$\frac{\partial \zeta}{\partial \Lambda_R} < 0 \ , \tag{17}$$

$$\frac{\partial \zeta}{\partial \Lambda_I} < 0 \ ,$$

and

$$\frac{\partial \zeta}{\partial \epsilon} < 0 \ .$$

In addition, the economic cost per bad speculation (q) can be assumed to be

$$q = \ f_q(\Lambda_R, \Lambda_I, \epsilon) \ , \tag{18}$$

where

$$\frac{\partial q}{\partial \Lambda_R} < 0 \ , \tag{19}$$

$$\frac{\partial q}{\partial \Lambda_I} < 0 \ ,$$

and

$$\frac{\partial q}{\partial \epsilon} < 0 \ , \tag{20}$$

and the regulatory cost per bad speculation (v) can be assumed to be

$$v = f_v(\Lambda_R, \Lambda_I, \epsilon) \ , \tag{21}$$

where

$$\frac{\partial v}{\partial \Lambda_R} < 0 \ , \tag{22}$$

$$\frac{\partial v}{\partial \Lambda_I} < 0 \ ,$$

and

$$\frac{\partial v}{\partial \epsilon} > 0 \ . \tag{23}$$

An important point is that $\frac{\partial q}{\partial \epsilon}$ in inequality (20) is negative, but $\frac{\partial v}{\partial \epsilon}$ in inequality (23) is positive. As mentioned in Section 4.2.1, the reason for a positive $\frac{\partial v}{\partial \epsilon}$ is that a greater amount of effort means that a regulatory authority investigates and detects even smaller bad speculations sooner but with additionally assigned less experienced and competent regulators. As a result, the unit regulatory cost increases even though the unit economic cost decreases.

4.3.2 Determination of the amount of bad speculation

Suppose that Λ_R and Λ_I are exogenously given and constant. Figure 1 indicates the curves of q and v on the unit cost (q or v)–effort (ϵ) plane for a given set of Λ_R and Λ_I. By inequalities (20) and (23), the curve of q is downward sloping and that of v is upward sloping. Therefore, a unique intersection exists (point *E*) at which $q = v$.

Point *E* indicates a kind of equilibrium. The key force behind this equilibrium is the behavior of the regulatory authority. It tolerates bad speculations as far as $q \leq v$, which functions to make q and v converge at intersection *E*, similar to a price mechanism. The regulatory authority considers the balance between costs and benefits of regulation activities and tolerates bad speculations as long as costs exceed benefits (i.e., $q < v$). However, there is a limit of tolerance that is reached at *E* ($q = v$). When $q > v$, the regulatory authority will not tolerate bad speculations because benefits exceed costs.

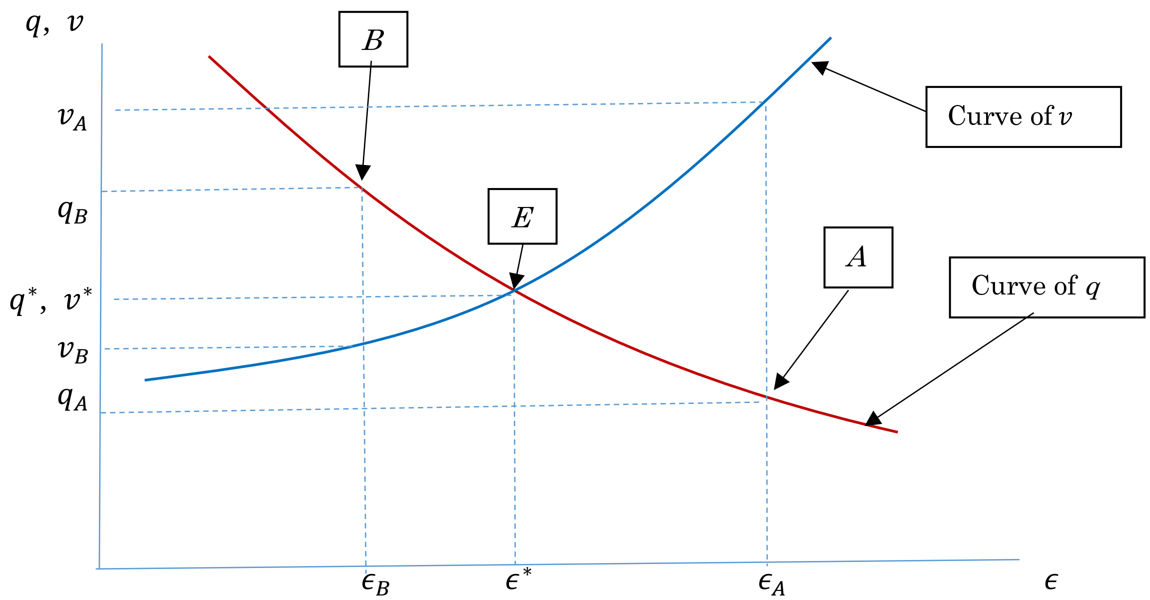

Figure 1: Curves of q and v, and the equilibrium. All terms are defined and described in the text.

For example, at point *A* in Figure 1 at which $q = q_A$, $v = v_A$, and $\epsilon = \epsilon_A$, the regulatory authority tolerates bad speculations because $q_A < v_A$ and thus inputs a smaller amount of effort than ϵ_A. As a result, by equation (18) and inequality (20), q increases from q_A and v decreases from v_A as far as $q < v$. On the other hand, at point *B* in Figure 1 at which $q = q_B$, $v = v_B$, and $\epsilon = \epsilon_B$, the regulatory authority does not tolerate bad speculations because $q_B > v_B$ and thus inputs a larger amount of effort than ϵ_B. As a result, by equation (18) and inequality (20), q decreases from q_B and v increases from v_B as far as $q > v$. Eventually, q, v, and ϵ are stabilized at intersection *E* (i.e., $q = v$). In this case, q^*, v^*, and ϵ^* are q, v, and ϵ, respectively, at point *E*.

At equilibrium *E*, the values of δ and ζ are also uniquely determined by the value of ϵ^* and given values of Λ_R and Λ_I because δ and ζ are functions of Λ_R, Λ_I, and ϵ as indicated by equations (14) and (15), respectively. Let δ^* and ζ^* be δ

and ζ at point E, respectively. As a result, by equation (13), the level of disinformation dissemination (ψ) is uniquely determined by δ^* and ζ^* at equilibrium E. Let ψ^* be ψ at point E. Because the amount of bad speculation is roughly proportionate to the level of disinformation dissemination, the amount of bad speculation is also uniquely determined at equilibrium E.

4.4 Dynamic model of bad speculation

In this section, I briefly explain the nature of bad speculation in a dynamic model on the basis of the static model developed in Section 4.3 and the dynamic model presented in Harashima (2022a).

4.4.1 Optimization

Suppose that capital can be accumulated in an economy, the regulatory authority behaves to keep $q = q^*$, and q^* is constant for any period. The representative household that represents all households including bad speculators maximizes its expected utility

$$Max\ \ E_0 \int_0^\infty u_P\,(c_t, m_t, \beta_t) \exp(-\theta_P t) dt \tag{24}$$

subject to

$$\dot{a}_t = (r_t a_t + w_t + z_t) - [c_t + (\pi_t + r_t) m_t + q^* \beta_t] - g_t\ , \tag{25}$$

where θ_P is the rate of time preference of the representative household, r_t is the real interest rate, π_t is the inflation rate, w_t is the real wage, z_t is lump-sum real government transfers, a_t is wealth, g_t is government expenditure in period t, $a_t = k_t + m_t$, and k_t is real capital. As explained in Section 3.2.2, the economic cost $q^* \beta_t$ is subtracted in the budget constraint of the representative household, i.e., equation (25).

As the result of optimization, the economy endogenously grows on a balanced growth path because of substitution between investments in capital and technology (see Harashima, 2013, 2023). By equations (24) and (25),

$$\frac{\partial u_P(c_t^*, m_t, \beta_t)}{\partial \beta_t} = q^* \frac{\partial u_P(c_t^*, m_t, \beta_t)}{\partial c_t^*} \tag{26}$$

is held on a balanced growth path. Equation (26), which describes the relation between c_t^* and β_t, is analogous to equations (A7) and (A8) in Appendix A3, which describe the relation between c_t^* and m_t. Because c_t^* and m_t compete with each other as the source of utility, consumption (c_t^*) and bad speculation (β_t) also compete with each other from the perspective of the representative household as the source of utility. Of course, β_t competes with not only c_t^* but also m_t, and therefore, by equations (A8) and (26),

$$\frac{\partial u_P(c_t^*, m_t, \beta_t)}{\partial c_t^*} = (\pi_0 + r_t)^{-1} \frac{\partial u_P(c_t^*, m_t)}{\partial m_t} = q^{*-1} \frac{\partial u_P(c_t^*, m_t, \beta_t)}{\partial \beta_t}$$

holds on a balanced growth path.

In addition, equation (26) indicates that bad speculation (β_t) is not a free variable. It is subject to preferences μ and ρ, the economic cost per bad speculation q^*, and variable c_t^*. In particular, bad speculation is anchored by consumption (c_t^*).

4.4.2 Trends due to bad speculation

By equations (4), (5), and (6),

$$\beta_t = q^{*^{-\frac{1}{\rho}}} c_0^{*\frac{\mu}{\rho}} e^{\frac{\mu\eta}{\rho}t} . \tag{27}$$

Therefore, by equations (5) and (27),

$$\frac{\beta_t}{c_t^*} = q^{*^{-\frac{1}{\rho}}} c_0^{*\left(\frac{\mu}{\rho}-1\right)} e^{\frac{\mu-\rho}{\rho}\eta t} . \tag{28}$$

Equation (28) indicates that, if $\rho < \mu$, the ratio of bad speculation to consumption ($\frac{\beta_t}{c_t^*}$; equivalently, the ratio of bad speculation to output) and therefore the ratio of bad speculation to output have upward trends and increase exponentially. If $\rho > \mu$, they trend downward, and if $\rho = \mu$, they trend neither upward nor downward.

Whether $\rho = \mu$, $\rho < \mu$, or $\rho > \mu$ is an empirical question, similar to the case of ϱ and μ, but it will be true that consumption is far more indispensable for people's lives and survival than bad speculation. This means that people can accept a large fluctuation in bad speculation but cannot tolerate the same type of fluctuation in consumption. Hence, it seems highly likely that $\rho < \mu$; that is, the ratio of bad speculation to consumption ($\frac{\beta_t}{c_t^*}$) will generally have an upward trend. Therefore, as an economy develops, this ratio will increase. This result, however, is obtained under the assumption that the value of q^* is kept constant for any period.

5 UNUSUAL AMOUNT OF BAD SPECULATION

5.1 Effects of reduced ability of the regulatory authority

5.1.1 Reduction of the ability of the regulatory authority

Equation (28) indicates that the amount of bad speculation is anchored to that of consumption, which means that unless consumption largely fluctuates, the amount of bad speculation does not largely fluctuate. However, it seems likely that the amount of bad speculation has occasionally fluctuated on a far larger scale than consumption and that these fluctuations are independent of consumption, suggesting that the amount of bad speculation can increase far beyond the amount that equation (26) predicts.

Equation (28) holds only if q^* is constant, that is, if the ability and effort of the regulatory authority as well as the abilities of investors are kept unchanged. Indeed, the abilities of investors will not change largely and suddenly, but it seems likely that the practical ability of the regulatory authority can change largely within a short period. Examples include (1) after a change of administration, deregulation can be strongly promoted in a wide area of economic activities and thus the amount of bad speculation in gray areas would increase; (2) a change in leadership at the regulatory authority may change the regulators' motivation; or (3) a new, more complicated and revolutionary method of market manipulation is developed. In these cases, although the absolute skill levels of regulators will not change suddenly and largely, their practical abilities to deal with bad speculation may change within a short period independent of any movement of consumption.

5.1.2 Effects on q^* and v^*

Here, I examine the impact of a reduction in the ability of the regulatory authority on the economy on the basis of the static model used in Section 4.3. Suppose that the ability of the regulatory authority deteriorated from Λ_R to $\tilde{\Lambda}_R$, where $\tilde{\Lambda}_R < \Lambda_R$. Accordingly, by equations (18) and (21), the values of q and v change, and by inequalities (19) and (22), the curves of q and v shift upwards as shown in Figure 2.

Because of the deterioration, the equilibrium intersection shifts from E to $\tilde{E}$, and $q^* = v^*$ increases to $\tilde{q}^* = \tilde{v}^*$. Nevertheless, the direction of change in effort from ϵ^* to $\tilde{\epsilon}^*$ is unclear (although ϵ is depicted to shift to the left in Figure 2, it can shift to the right, depending on the shapes of the q and v curves), but the scale of change in ϵ^* will be small because the effects of changes in q and v curves on ϵ^* have a cancelling effect, as shown in Figure 2.

At the same time, because of the deterioration from Λ_R to $\tilde{\Lambda}_R$, δ decreases and ζ increases by equalities (14) and (15) and inequalities (16) and (17). Accordingly, the level of disinformation dissemination increases from ψ^* to $\tilde{\psi}^*$ by equation (13).

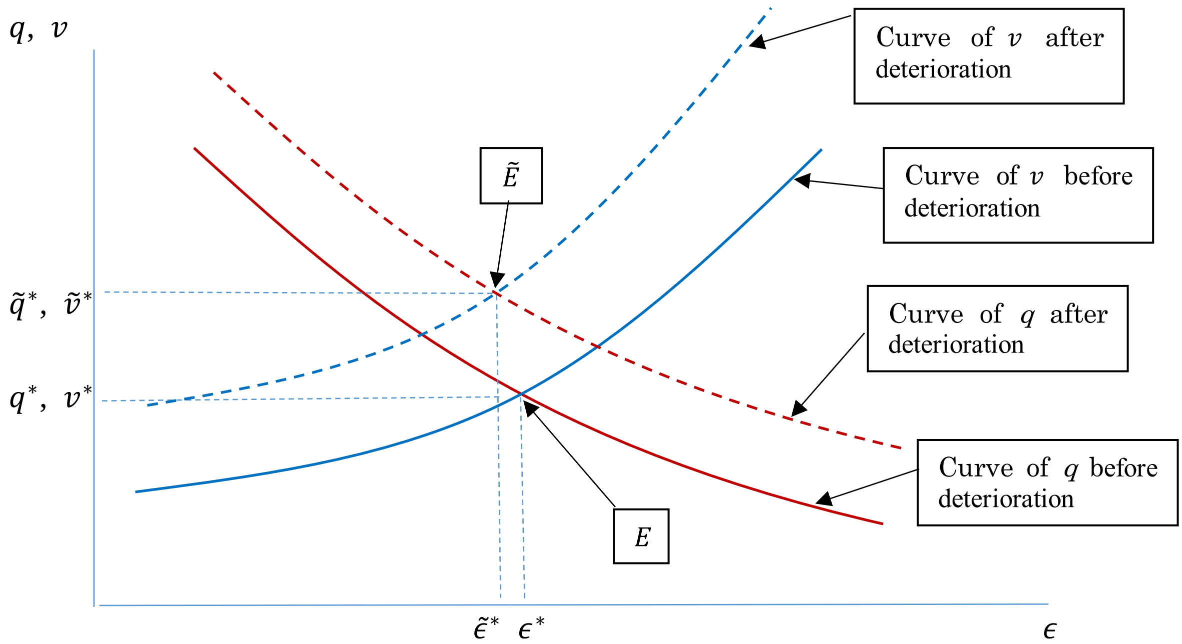

Figure 2: Effects of deterioration of Λ_R on the curves of q and v and the equilibrium (E)

5.1.3 Effects on ψ^* and bad speculations

I assume that if the ability of the regulatory authority (Λ_R) deteriorates from $\Lambda_{R,0}$ to $\tau\Lambda_{R,0}$, the parameter with regard to uncovering disinformation (δ) decreases from δ_0 to $\tau\delta_0$, and the parameter with regard to rewards increases from ζ_0 to $\tau^{-1}\zeta_0$, where τ $(0 < \tau \leq 1)$ is a parameter that describes the magnitude of deterioration, and δ_0, ζ_0, and $\Lambda_{R,0}$ are the initial values of δ, ζ, and Λ_R, respectively. In addition, it is assumed that Λ_I and ϵ are not affected by τ. This means that equations (14) and (15) are specified to be

$$\delta = \tau\delta_0 = f_\delta(\tau\Lambda_{R,0}, \Lambda_I, \epsilon) \tag{29}$$

and

$$\zeta = \tau^{-1}\zeta_0 = f_\zeta(\tau\Lambda_{R,0}, \Lambda_I, \epsilon)\ . \tag{30}$$

A smaller value of τ indicates a lower ability of the regulatory authority ($\Lambda_R = \tau\Lambda_{R,0}$), a smaller value of the parameter with regard to uncovering disinformation ($\delta = \tau\delta_0$), and a larger value of the parameter with regard to rewards ($\zeta = \tau^{-1}\zeta_0$).

The values that δ_0 and ζ_0 take are empirical questions. Nevertheless, it seems likely that if the regulatory authority does its work properly, the uncovering disinformation parameter (δ) is large and the reward parameter (ζ) is small. Hence, in the base case, I set δ_0 = 10 and ζ_0 = 0.1. In addition, I set the initial value of τ to be unity. The value of ψ is calculated by equation (13), and therefore,

$$\psi(\tau) = \tau\zeta_0^{-1}\ln\left(1 + \tau^{-2}\frac{\zeta_0}{\delta_0}\right) .$$

Because $\frac{\zeta_0}{\delta_0}$ = 0.01 and $0 < \tau \leq 1$,

$$\frac{\tilde{\psi}^*}{\psi^*} = \frac{\psi(\tau)}{\psi(1)} \cong \tau^{-1} > 1 .$$

That is, if the ability of the regulatory authority deteriorates from 1 to τ, the level of disinformation dissemination increases by τ^{-1} times, which means that the amount of bad speculation will also increase similarly.

Note that equation (27) shows the relationship between β_t and q^*, but it holds only under the assumption that q^* is constant, which means that it generally holds only in the long run. Therefore, the property of short-run fluctuations of bad speculations due to the deterioration of the regulatory authority cannot necessarily be known from equation (27).

5.2 Simulation

Because the amount of bad speculation and the level of disinformation dissemination will move similarly, the disinformation dissemination reward $\tilde{R}(\psi) = \gamma\left(e^{-\delta\psi} - e^{-(\zeta+\delta)\psi}\right)$ is a good surrogate variable for the amount of bad speculation. This means that we can roughly estimate the effect of the deterioration of the regulatory authority on bad speculation by calculating the change in $\tilde{R}(\psi)$ using equations (10), (11), (12), (29), and (30).

To know the magnitude of the effect on bad speculation, therefore, I simulate the values of $\tilde{R}(\psi)$ for various values of τ such that the ability of the regulatory authority deteriorates from τ = 1 to 0.95, $(0.95)^2$, $(0.95)^3$, …, $(0.95)^{27}$, and for various values of δ_0 and ζ_0, on the basis of equations (10), (11), (12), (29), and (30). In addition, I set γ =1.

First, I simulate the cases with δ_0 = 0.1, 0.5, 1, 2, 5, and 10, while the value of ζ_0 is kept the same as in the base case (i.e., ζ_0 = 0.1) for each deteriorated value of τ.

Figure 3 shows the simulated values of $\tilde{R}(\psi)$ for the respective values of τ. The base case ($\delta_0 = 10$ and $\zeta_0 = 0.1$) is depicted by the green dash-dot line. The results indicate that for any value of δ_0, as the ability of the regulatory authority deteriorates (i.e., as τ decreases), and as the initial parameter with regard to uncovering disinformation (δ_0) decreases, $\tilde{R}(\psi)$ increases, which means that the amount of bad speculation increases.

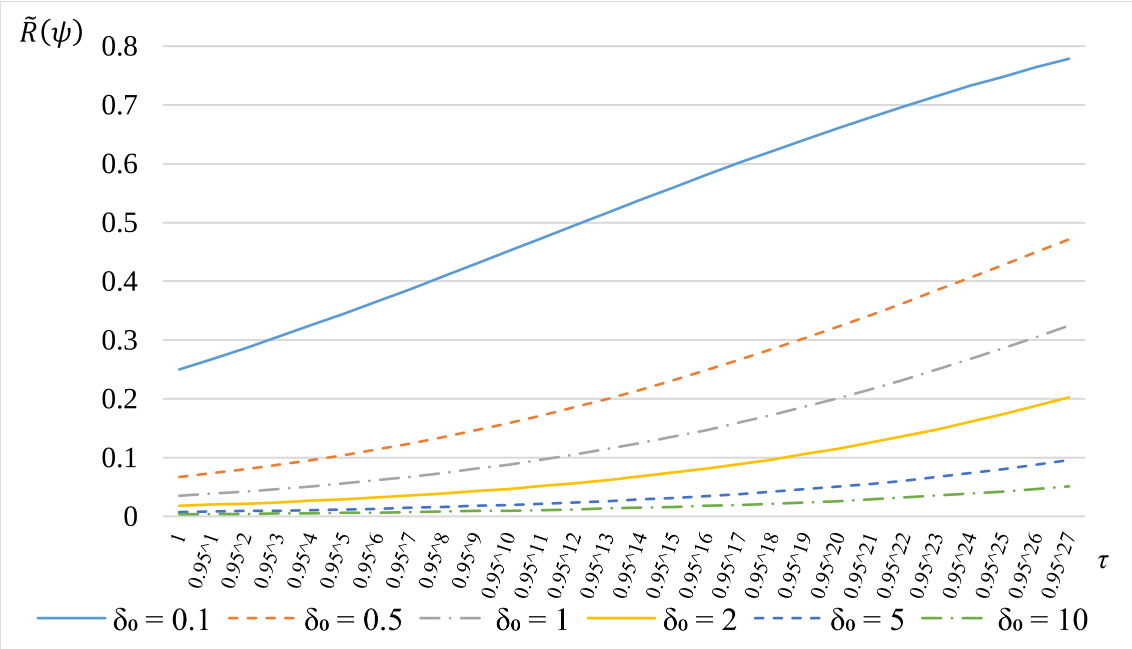

Figure 3: Effects of changes in τ on $\tilde{R}(\psi)$ for various values of δ_0

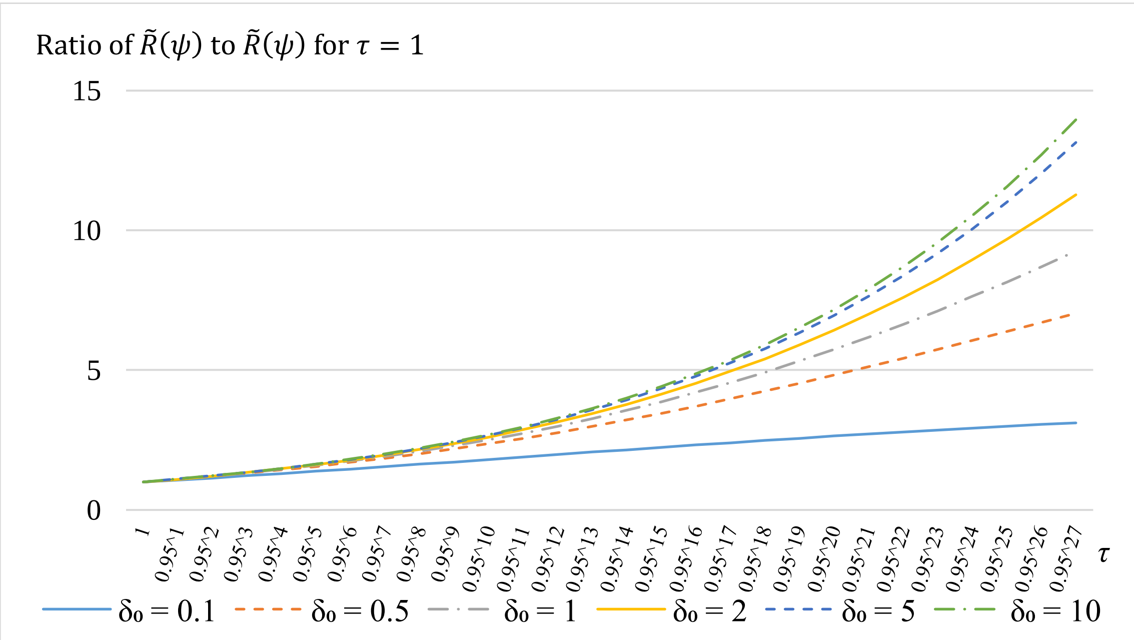

Figure 4: Effects of changes in τ on $\tilde{R}(\psi)$ for various values of δ_0: the vertical scale is the ratio of "$\tilde{R}(\psi)$ for respective τ" to "$\tilde{R}(\psi)$ for $\tau = 1$"

Figure 4 shows the same simulation results as those shown in Figure 3, but with the vertical scale changed to indicate the ratio of "$\tilde{R}(\psi)$ for respective deteriorated values of τ" to "$\tilde{R}(\psi)$ for $\tau = 1$". Figure 4 indicates that for any value of δ_0, as the ability of the regulatory authority deteriorates (as τ decreases), the ratio increases. In addition, as the initial parameter with regard to uncovering disinformation (δ_0) is higher, the ratio is higher. That is, as the probability of uncovering disinformation is initially higher, the impact of a reduction in the ability of the regulatory authority is greater, which means that as the ability of the regulatory authority is initially higher, the impact of a reduction in that ability is greater.

Next, I simulate the cases where ζ_0 = 0.1, 0.5, 1, 2, 5, and 10, while the value of δ_0 is kept the same as in the base case (i.e., δ_0 = 10), for each reduced value of τ (Figure 5). The base case (δ_0 = 10 and ζ_0 = 0.1) is depicted by the solid blue line. Simulation results indicate that for any value of ζ_0, as the ability of the regulatory authority decreases (as τ is smaller) and as the initial reward parameter (ζ_0) increases, $\tilde{R}(\psi)$ increases, which means that the amount of bad speculation also increases.

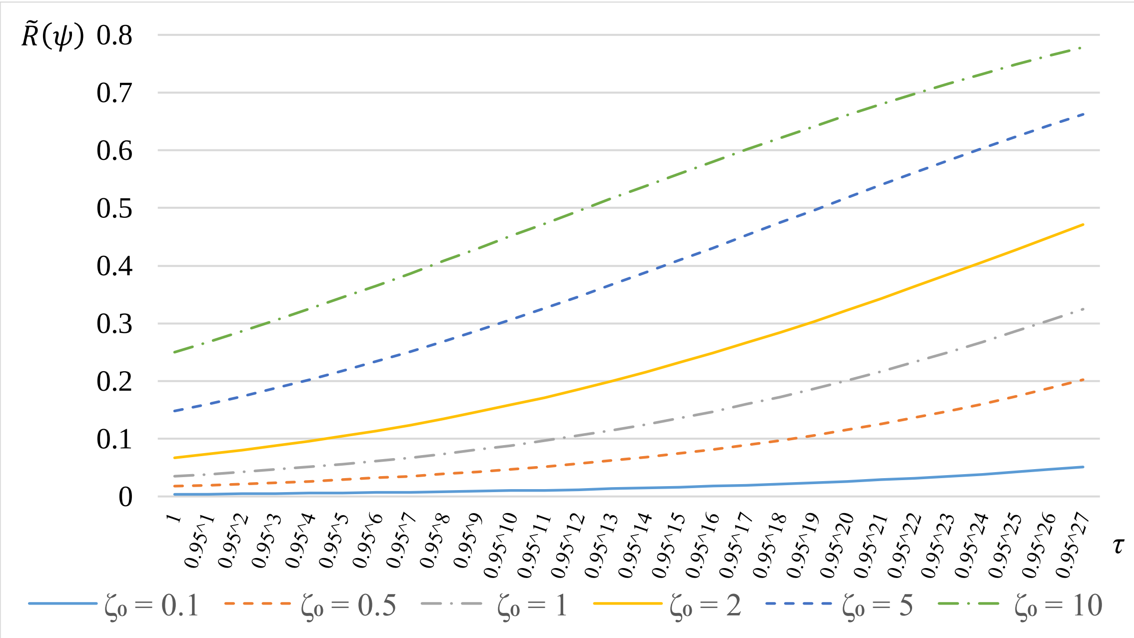

Figure 5: Effects of changes in τ on $\tilde{R}(\psi)$ for various values of ζ_0

Figure 6 shows the same simulation result as that shown in Figure 5, but the vertical scale has been changed as in Figure 4. The results indicate, that for any value of ζ_0, as the ability of the regulatory authority decreases (as τ is smaller), the ratio increases. In addition, as the initial reward parameter (ζ_0) is smaller, the ratio also is higher. That is, as the reward parameter (ζ) is initially smaller, the impact of a decrease in the ability of the regulatory authority is greater, which means that as the ability of the regulatory authority is initially higher, the impact is larger.

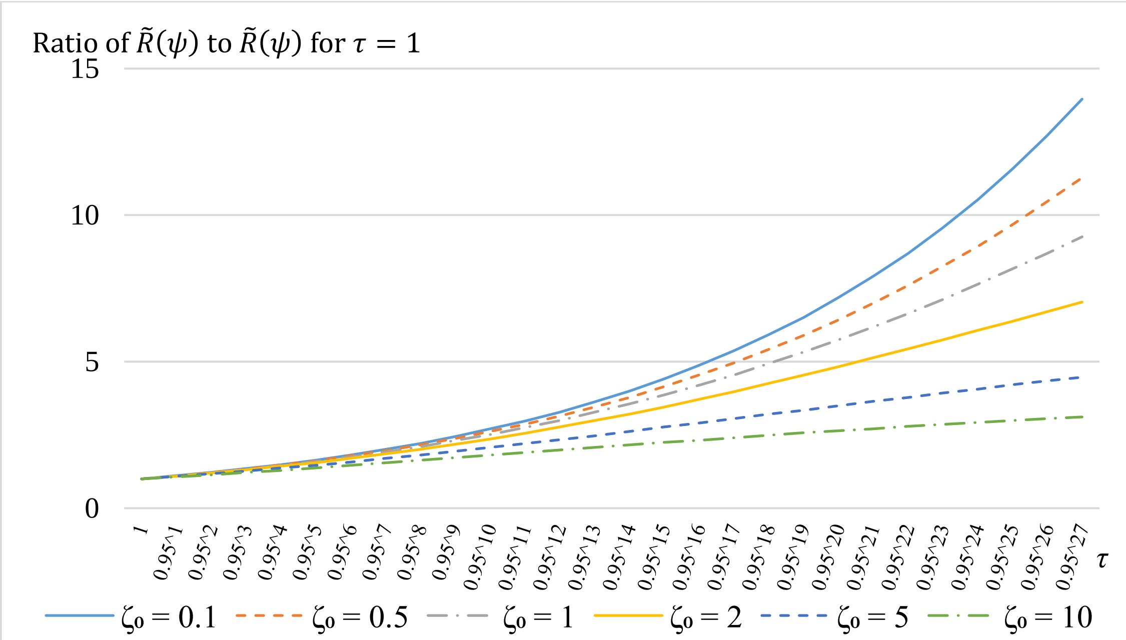

Figure 6: Effects of changes in τ on $\tilde{R}(\psi)$ for various values of ζ_0: the vertical scale is the ratio of "$\tilde{R}(\psi)$ for respective τ" to "$\tilde{R}(\psi)$ for $\tau = 1$"

5.3 Occurrence of large-scale deterioration of the regulatory authority

The occurrence of a financial crisis implies that the value of $\tilde{R}(\psi)$ largely increased, and a large increase in $\tilde{R}(\psi)$ implies that the ability of the regulatory authority largely deteriorated. Figures 3, 4, 5, and 6 indicate that in the base case (i.e., $\delta_0 = 10$ and $\zeta_0 = 0.1$), the value of $\tilde{R}(\psi)$ doubles when τ decreases from 1 to $(0.95)^7 = 0.698$, and it triples when τ decreases from 1 to $(0.95)^{11} = 0.569$. If the ability of the regulatory authority deteriorates and $\tilde{R}(\psi)$ increases on such a large scale, a financial crisis may occur. Conversely, it may not occur unless the ability of the regulatory authority decreases on a large scale.

The likelihood of the ability of a regulatory authority deteriorating by about 30% or 40% (i.e., $\tau = 0.698$ or 0.569) is an empirical question. Although it may be difficult to answer this question because of a lack of appropriate data, it seems likely that such a large-scale deterioration rarely occurs in a developed country, but it will be also true that the probability is not zero. Furthermore, Figures 4 and 6 indicate that if such a large-scale deterioration occurs in a country where the ability of the regulatory authority is initially higher, the negative impact of the deterioration is larger. This suggests that even in a country where the ability of the regulatory authority is regarded to be high, people should still always look for signs of deterioration in the ability of the regulatory authority to prevent a financial crisis.

5.4 Heterogeneity

Figures 3 and 5 indicate that the value of $\tilde{R}(\psi)$ largely differs depending on the values of δ_0 and ζ_0 for any values of τ, which means that the value of $\tilde{R}(\psi)$ largely differs depending on the values of Λ_R and Λ_I (i.e., the abilities of the regulatory authority and investors). In actuality, it is highly likely that Λ_R and Λ_I are heterogeneous across economies because people's abilities are generally heterogeneous. Therefore, the usual amount of per capita bad speculation will be also heterogeneous across economies. As Λ_R and Λ_I are higher, the usual amount of per capita bad speculation will be smaller. Notice nevertheless that, even if Λ_R and Λ_I are high, the usual amount of bad speculations will never be zero. In addition, the probability of the occurrence of a large-scale deterioration of Λ_R and an unusual amount of bad speculation along with a financial crisis also will not be zero.

6 CONCLUDING REMARKS

Financial speculation plays a very important role in helping to spur innovation, and therefore, financial speculations as a whole should not be naively criticized because there are "good" and "bad" speculations. Whereas good speculations are investments in technologies to create innovations, bad speculations do not generate any new economic value. They are not production or investment activities. Instead, they are consumption activities; that is, bad speculators obtain utility, pleasure, or happiness from "consuming" bad speculations.

Harashima (2022a) constructed a dynamic model that describes how bad speculations co-exist with "usual" consumption and money, and also shows that the bad speculation–consumption ratio in an economy can grow exponentially. A key determinant of the bad speculation–consumption ratio is the economic costs $q\beta_t$. However, economic costs are not necessarily stable and occasionally fluctuate largely. On the other hand, it seems highly likely that the economic cost generated by bad speculation is closely related to dissemination of disinformation because disinformation can be a very useful and effective tool for bad speculation. Harashima (2023b, 2023c, 2024, 2025) showed that because of the dissemination of disinformation, efficiency (particularly TFP) and the success rate of investment decrease, and thus disinformation disseminated for bad speculations damages the entire economy, which has to bear these costs (damages).

In this paper, I first examine the nature of the economic cost of bad speculation taking dissemination of disinformation into consideration, and then I construct a static model of bad speculation. I show that both the economic cost and the regulatory cost are important to determine the amount of bad speculations, and both economic and regulatory costs are influenced by the ability and effort of the regulatory authority as well as the intrinsic ability (e.g., intelligence) of investors. For a given set of abilities of the regulatory authority and investors, the amount of bad speculation is determined at a point where the economic cost and regulatory cost are identical. The key force to achieve this equilibrium is that the regulatory authority tolerates a certain amount of bad speculation, but there is an upper limit. The level of effort of the regulatory authority is determined at this equilibrium, as well as the level of disinformation dissemination and the amount of bad speculation.

The results of the numerical simulation imply that a financial crisis will not be generated unless the ability of the regulatory authority largely deteriorates. Although it seems likely that such a large-scale deterioration will rarely occur, there is no guarantee it will never occur. Furthermore, if the ability of the regulatory authority is higher to start, the negative impact of a deterioration will be larger, which suggests that even in a country where the ability of the regulatory authority is regarded to be high, people should still always look for signs of any deterioration of ability of the regulatory authority to prevent a financial crisis.

The simulation results also indicate that the amount of per capita bad speculation largely differs depending on the abilities of the regulatory authority and investors. In actuality, it is highly likely that these abilities are heterogeneous across economies, and therefore, the usual amount of per capita bad speculation will be also heterogeneous across them.

APPENDIX

In this appendix, the mechanism of money–consumption ratio is explained following Harashima (2022a).

A1 Money-in-the-utility function

Consider a model based on Sidrauski (1967)'s well-known money-in-the-utility function such that the representative household maximizes its expected utility

$$E\int_0^\infty u_P(c_t, m_t)\exp(-\theta_P t)dt \tag{A1}$$

subject to the budget constraint

$$\dot{a}_t = (r_t a_t + w_t + \sigma_t) - [c_t + (\pi_t + r_t)m_t] - g_t\ , \tag{A2}$$

where u_P and θ_P are the utility function and the rate of time preference (RTP) of a household, respectively, r_t is the real interest rate, π_t is the inflation rate, c_t is real consumption, w_t is the real wage, σ_t is lump-sum real government transfers, m_t is real money, a_t is wealth, g_t is government expenditure in period t, $a_t = k_t + m_t$, and k_t is real capital. All variables are expressed in per capita terms, and E is the expectation operator.

The term $(\pi_t + r_t)m_t$ in equation (A2) indicates the interest that the household has foregone because it held m_t. Therefore, m_t is an element that does not generate any interest; rather, it represents the economic value that arises from its functions as a medium of exchange, measure of value, and store of value. That is, the money described in the money-in-the-utility function is identical to money. On the other hand, k_t is clearly identical to capital for steady state. Hence, wealth ($a_t = k_t + m_t$) consists of capital for steady state and money.

A2 The law of motion for inflation and money

In this section, I examine the nature of money based on a model that consists of a money-in-the-utility function, in particular, on the model of inflation presented by Harashima (2007b[6]).

A2.1 The model

A2.1.1 The government budget constraint

[6] Harashima (2007b) is also available in Japanese as Harashima (2013a).

The budget constraint of a government is

$$\dot{B}_t = B_t R_t + G_t - X_t - S_t \ ,$$

where B_t is accumulated nominal government bonds, R_t is the nominal interest rate for government bonds, G_t is nominal government expenditure, X_t is nominal tax revenue, and S_t is the nominal amount of seigniorage at time t. The tax is assumed to be lump sum. All variables are expressed in per capita terms. The government bonds are long term, and the returns on the bonds, R_t, are realized only after the bonds are held during a unit period (e.g., one year). Government bonds are redeemed in a unit period, and the government successively refinances the bonds by issuing new ones at each time. R_t is composed of the real interest rate r_t and the expected change of the bonds' price by inflation $\pi_{b,t}^e$ such that

$$R_t = r_t + \pi_{b,t}^e \ .$$

Let $b_t = \frac{B_t}{p_t}$, $g_t = \frac{G_t}{p_t}$, $x_t = \frac{X_t}{p_t}$, and $s_t = \frac{S_t}{p_t}$, where p_t is the price level at time t. Here $\pi_t = \frac{\dot{p}_t}{p_t}$. By dividing by p_t, the budget constraint is transformed to

$$\frac{\dot{B}_t}{p_t} = b_t R_t + g_t - x_t - s_t$$

which is equivalent to

$$\dot{b}_t = b_t (R_t - \pi_t) + g_t - x_t - s_t \ . \tag{A3}$$

A2.1.2 Optimization of government

A government maximizes its expected utility

$$E_0 \int_0^\infty u_G \left(g_t, x_t\right) \exp(-\theta_G t) dt$$

subject to its budget constraint (i.e., equation (A3)), where u_G and θ_G are the utility function and RTP of government, respectively. The government maximizes its expected utility considering the behavior of the representative household that is reflected in R_t in its budget constraint.

A2.1.3 Optimization of the representative household

The representative household also simultaneously maximizes its expected utility (i.e., equation (A1)) subject to its budget constraint (i.e., equation (A2)). It is assumed that $r_t = f'(k_t)$, $w_t = f(k_t) - k_t f'(k_t)$, $\frac{\partial u_P(c_t,m_t)}{\partial c_t} > 0$, $\frac{\partial^2 u_P(c_t,m_t)}{\partial c_t^2} < 0$, $\frac{\partial u_P(c_t,m_t)}{\partial m_t} > 0$, and $\frac{\partial^2 u_P(c_t,m_t)}{\partial m_t^2} < 0$, where $f(\cdot)$ is the production function. Population is assumed to be constant.

A2.1.4 The law of motion for inflation

Combining the optimality conditions of the representative household and government yields the law of motion for inflation that is described by

$$\pi_{b,t}^e = \pi_t + \theta_G - \theta_P$$

or

$$\int_{t-1}^{t} \int_{i}^{i+1} \pi_j dj di = \pi_t + \theta_G - \theta_P$$

at steady state such that $\dot{g}_t = 0$, $\dot{x}_t = 0$, $\dot{c}_t = 0$, and $\dot{k}_t = 0$, and

$$\lim_{t \to \infty} \pi_t = \pi_0 + 6(\theta_G - \theta_P)t^2$$

(see Harashima, 2004, 2007a, 2007b, 2007c[7], 2008[8], 2013b).

A2.2 The optimal quantity of money

The Friedman rule requires that money is supplied until the supply reaches the representative household's saturation point. The saturation point is a point such that

$$\frac{\partial u_P(c^*, m_t)}{\partial m_t} = 0 \,, \tag{A4}$$

and therefore,

$$\pi_t + \theta_P = \pi_t + r_t = 0 \tag{A5}$$

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[7] Harashima (2007c) is also available in Japanese as Harashima (2018a).
[8] Harashima (2008) is also available in Japanese as Harashima (2020a).

(see Harashima, 2004, 2007a, 2007b, 2007c, 2008, 2013b). However, the model in Section A2.1 indicates that the real quantity of money (m_t) is supplied up to the point that satisfies

$$\frac{\partial u_P(c^*, m_t)}{\partial m_t} = [\pi_0 + r_t + 6(\theta_G - \theta_P)t^2] \frac{\partial u_P(c^*, m_t)}{\partial c^*} \tag{A6}$$

at steady state, where c^* is c_t at steady state (Harashima, 2007b). That is, money (m_t) and consumption at steady state (c^*) are connected by equation (A6). Note that $\theta_P = r_t$ at steady state.

Equation (A6) indicates that, in general,

$$\frac{\partial u_P(c^*, m_t)}{\partial m_t} \neq 0$$

because

$$\frac{\partial u_P(c^*, m_t)}{\partial c^*} > 0 \ ,$$

and $\pi_0 + r_t + 6(\theta_G - \theta_P)t^2 \neq 0$. Equations (A4) and (A5) (i.e., the Friedman rule) are satisfied only if $\theta_G = \theta_P$ and $\pi_0 + r_t = 0$, which is the world the Friedman rule assumes.

A3 Upward trend mechanism

A3.1 Relation between money and consumption (output)

If an economy grows endogenously, the value of c^* will have an upward trend because technological progress is continuous, particularly on a balanced growth path. Let c_t^* be c^* in period t on a balanced growth path in an endogenously growing economy (i.e., c^* increases constantly). Hence, on a balanced growth path, equation (A6) is changed to

$$\frac{\partial u_P(c_t^*, m_t)}{\partial m_t} = [\pi_0 + r_t + 6(\theta_G - \theta_P)t^2] \frac{\partial u_P(c_t^*, m_t)}{\partial c_t^*} \ . \tag{A7}$$

It is highly likely that the term $\pi_0 + r_t + 6(\theta_G - \theta_P)t^2$ in equations (A6) and (A7) has neither an upward nor downward trend in the long run if the central bank is sufficiently independent because an independent central bank basically keeps $\theta_G = \theta_P$ (see Harashima, 2004, 2007a, 2007b, 2007c, 2008, 2013b). Therefore, here, it is assumed that $\theta_G = \theta_P$. In this case, inflation is neither accelerating nor decelerating and

$$\frac{\partial u_P(c_t^*, m_t)}{\partial m_t} = (\pi_0 + r_t)\frac{\partial u_P(c_t^*, m_t)}{\partial c_t^*} \tag{A8}$$

on a balanced growth path by equation (A7). Note that equations (A7) and (A8) mean that if $\theta_G - \theta_P \neq 0$ (i.e., inflation is accelerating or decelerating), the interest that a household forewent because it held m_t is not $(\pi_t + r_t)m_t$; rather, it is $[\pi_0 + r_t + 6(\theta_G - \theta_P)t^2]m_t$.

As c_t^* increases due to endogenous economic growth, the marginal utility of consumption $\frac{\partial u_P(c_t^*, m_t)}{\partial c^*}$ decreases because $\frac{\partial^2 u_P(c_t, m_t)}{\partial c_t^2} < 0$, and by equation (A8), that of money $\frac{\partial u_P(c_t^*, m_t)}{\partial m_t}$ also decreases. As a result, as an economy grows (i.e., as consumption and output increase), m_t increases. Therefore, both c_t^* and m_t have upward trends in a growing economy.

If the upward trend of m_t is steeper than that of c_t^*, the ratio of m_t to output (or consumption) will also have an upward trend, and consequently, the credit-output ratio can also have an upward trend.

A3.2 Money as an origin of the upward-trending credit-output ratio

Suppose for simplicity that m_t and c_t^* are additively separable in a utility function such that

$$u_P(c_t^*, m_t) = u_{P,c}(c_t^*) + u_{P,m}(m_t) , \tag{A9}$$

where $u_{P,c}$ and $u_{P,m}$ are utility functions with regard to consumption and money, respectively. Hence, by equation (A9),

$$\frac{\partial u_P(c_t^*, m_t)}{\partial m_t} = \frac{du_{P,m}(m_t)}{dm_t} \tag{A10}$$

and

$$\frac{\partial u_P(c_t^*, m_t)}{\partial c_t^*} = \frac{du_{P,c}(c_t^*)}{dc_t^*} . \tag{A11}$$

The utility function with regard to consumption is assumed to be a constant relative risk aversion utility function such that

$$u_{P,c}(c_t^*) = \frac{{c_t^*}^{1-\mu}}{1-\mu} \ , \tag{A12}$$

where μ is a positive constant. Because the economy is on a balanced growth path,

$$\frac{\frac{dc_t^*}{dt}}{c_t^*} = \eta = \text{a positive constant} \ ,$$

and therefore,

$$c_t^* = c_0^* e^{\eta t} \ . \tag{A13}$$

Hence, by equations (A12) and (A13),

$$\frac{du_{P,c}(c_t^*)}{dc_t^*} = {c_0^*}^{-\mu} e^{-\mu\eta t} \ . \tag{A14}$$

By equations (A7), (A10), (A11), and (A14),

$$\frac{du_{P,m}(m_t)}{dm_t} = \lambda {c_0^*}^{-\mu} e^{-\mu\eta t} \tag{A15}$$

on the balanced growth path where

$$\lambda = \pi_0 + r_t + 6(\theta_G - \theta_P)t^2 = \pi_0 + 6(\theta_G - \theta_P)t^2 + \theta_P \ . \tag{A16}$$

Because $\theta_G = \theta_P$, as assumed above, then by equation (A16), λ is a constant such that

$$\lambda = \pi_0 + \theta_P = \text{constant} \ .$$

On the other hand, the utility function with regard to money is also assumed to be a constant relative risk aversion utility function such that

$$u_{P,m}(m_t) = \frac{{m_t}^{1-\varrho}}{1-\varrho} \ , \tag{A17}$$

where ϱ is a positive constant. Therefore, by equation (A17),

$$\frac{du_{P,m}(m_t)}{dm_t} = m_t^{-\varrho} . \tag{A18}$$

Hence, by equations (A15) and (A18),

$$m_t = \lambda^{-\frac{1}{\varrho}} c_0^{*\frac{\mu}{\varrho}} e^{\frac{\mu}{\varrho}\eta t} . \tag{A19}$$

Therefore, by equations (A13) and (A19),

$$\frac{m_t}{c_t^*} = \lambda^{-\frac{1}{\varrho}} c_0^{*\left(\frac{\mu}{\varrho}-1\right)} e^{\frac{\mu-\varrho}{\varrho}\eta t} . \tag{A20}$$

Because consumption and output grow at the same rate on a balanced growth path, equation (A20) indicates that, if $\mu > \varrho$, both the money-consumption ratio $(\frac{m_t}{c_t^*})$ and the consumption and money but also bad speculation money-output ratio have upward trends and increase exponentially. In addition, if $\mu < \varrho$, they have downward trends, and if $\mu = \varrho$, there is no trend. Because money is a component of credits, then the credit-output ratio will have an upward trend if $\mu > \varrho$, a downward trend if $\mu < \varrho$, and no trend if $\mu = \varrho$.

Whether $\mu > \varrho$, $\mu < \varrho$, or $\mu = \varrho$ is an empirical question. Equations (A12) and (A17) indicate that, if $\mu > \varrho$, the degree of disturbance or deviation aversion (or risk aversion) with respect to consumption is higher than that with respect to money. A household will therefore accept or allow (or feel less uncomfortable from) a greater magnitude of disturbance or deviation in the amount of money it holds than in the amount of its consumption. In other words, households care less about deviations in the amount of money than in the amount of consumption. Equation (A20) indicates that the credit-output ratio has an upward trend if people actually have such preferences.

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