Macroeconomic Analysis of Asset Bubbles and Its Policy Implications: A Review* **

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Abstract

This paper discusses the latest research trends on the asset price bubble. I discuss possible reasons why policymakers and researchers have differing opinions on the subject. I discuss a famous policy controversy, as well as the recurrent-bubble model that my collaborators and I have developed. This paper also discusses its policy implications.

Keywords: price asset bubble, rationality, economic policy
JEL Classifications: E20, E30, E44, E60, O40

I. Introduction

This paper discusses the latest research trends on the asset price bubbles. A special emphasis is put on explaining the “gap” between policy-makers and academic researchers on the subject. The same issue was addressed in a panel discussion at the end of the program at a conference held at Pompeu Fabra University in 2017. The conference brought together a group of researchers who are actively working in the field. Barlevy (2018) was one of the panelists, and wrote a survey paper based on the discussions there.

Researchers on asset price bubbles are generally frustrated because they feel that many of the insights generated by their research are not being fully applied to the policymaking. If this were the case in economics in general, we could tolerate it. However, this does not seem to be the case. Even in the field of macroeconomics, for example, the vector autoregression model developed by Sims (1980) is widely used in macroeconomic analysis as a standard tool for analyzing time series data. Accumulating empirical analyses using vector autoregression models have revealed that the impact of monetary policy on the real economy peaks with a lag of one to two years, and this finding has become the dominant perspective when considering monetary policy (Clarida et al., 1999). In studies using macroeconomic models, the real business cycle model developed by Kydland and Prescott (1982), which has evolved into the New Keynesian model by incorporating price stickiness (Woodford, 2003)

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and eventually into the dynamic and stochastic general equilibrium model by incorporating real economic frictions (Smets and Wouters, 2007), is widely used by central banks to analyze policy effects.

On the other hand, studies of asset price bubbles are not used in the policymaking at the same level. It seems that policymakers do not have a high expectation from research on asset bubbles.

II. Definition of Asset Price Bubble in Economics

According to the standard definition in economics, an asset is considered to have a "bubble" component when the market price of an asset deviates from the intrinsic value of that asset. An asset price bubble is then defined as the difference between those two values or prices. It is expressed in the formula:[1]

Asset Price Bubble ≡ Market Price of the Asset − Intrinsic Value of the Asset.

One of the reasons why communication between economists and policy makers does not always go well is because of the differences over the word "bubble." They have different ways of understanding the term. Economists have defined it rigorously. That is necessary for academic discussion. However, the economists' definition of a bubble has become much narrower than the bubble phenomenon that most people usually think of. Theories of bubbles presented by economists are often criticized for this reason.

Another problem is that the economic definition of a bubble is conceptual. Unless the intrinsic value of an asset is known, it is difficult to determine if a bubble has existed and to identify its size. For this reason, asset price bubbles are extremely difficult to study empirically.

III. Theory of Rational Bubbles

In this section, we discuss what can be learned from theoretical studies of asset price bubbles. One important lesson we can learn from the study of asset price bubbles is that *asset price bubbles can still occur even if we assume rationality of economic agents*. This type of bubble is called a rational bubble in economics. This lesson is interesting because asset price bubbles are often discussed along with the irrationality of economic agents (Kindleberger, 2001). Even if we assume the rational economic agents, it is still possible to talk theoretically about asset price bubbles.

The classic papers on rational bubbles are Samuelson (1958) and Tirole (1985). In the model developed by Tirole (1985), economic agents live in only two periods, young and old ages. A new generation is born every period, and hence there must be both young and old

[1] This definition also allows for a negative asset price bubble, but in the following discussion we shall consider positive asset price bubbles unless otherwise stated.

agents in the economy at any given time. This economic environment is the so-called "overlapping generations model."

In this setting, only the young save. The old do not save because they know they will die in the next period. The amount of savings in the economy as a whole is determined by the young. In this economic environment, if the young have a strong preference for saving, the economy as a whole may save excessively.

Bubbles can improve resource allocation in this situation. To simplify the story, think of a bubble as a piece of paper that is inherently useless. We may call it money. The bubbly asset (money) is used as a means of exchange for different generations to trade goods. In other words, the young give a portion of their goods to the old and receive money from the old in exchange. The young store the money until they reach old age, and when they reach old age, they give it to the newly-born generation in exchange for goods. All generations repeat this transaction.

In the original allocation without money, savings were large and so were investments in capital goods. In the equilibrium with money, some of the savings are used to acquire money. If we focus on the flow of goods, it is as if the young are handing over goods to the old every period. This reduces investment in capital goods and eases the problem of overinvestment. The marginal productivity of capital, which is too low in the original allocation, also improves (rises), and the real rate of return on investment in capital goods also improves. Once the exchange ratio between money and goods is determined at an appropriate value, all generations will realize a more desirable consumption stream. Because (fiat) money is a bubble in economics, a monetary equilibrium is also a bubble equilibrium.

Notice that the argument so far is free from irrationality. The economic agents assumed by Tirole (1985) are completely rational. Even so, bubbles (= money) still appear. Irrationality is not a necessary condition for talking about bubbles.

Another important lesson that can be learned from the study of asset price bubbles is the condition for the existence of bubbles, which can be summarized as follows: *rational bubbles can only occur in environments where the real interest rate is sufficiently low.* We will briefly explain its logic.

Take the example of Tirole (1985) again. In a monetary economy, the young have two means of saving: investment in capital goods and the acquisition of money. In order for both savings instruments to be used, the "investment" in money must be as attractive as the investment in capital goods. If the yield on the investment in capital goods is positive, the bubble must produce capital gains as its price rises. If this is possible, bubbles acquire the same degree of attractiveness as capital goods investments.

By this logic, if the real interest rate is extremely high, the bubble will expand rapidly. Since capital gains are the attraction of bubble investments, they can provide sufficient gains to investors only if prices rise at a fast rate. Bubbles grow at an excessive pace and will eventually explode. If people are rational, they would not demand such a dubious asset. Therefore, when the real interest rate is high, rational bubbles do not occur.

However, if the real interest rate is sufficiently low, there is a different story. *A rational* *bubble can occur when the real rate of interest is below the growth rate of the economy.* In this low-interest rate case, even if a bubble does occur, it will not become larger than the economy because the bubble's growth rate is below the economy's growth rate. The existence of the bubble itself crowds out investment in capital and raises the real rate of interest, but if the size of the bubble is not so large, the real rate of interest and the growth rate will not be reversed. If the size of the bubble is just right, the existence of the bubble moderately crowds out investment in capital, the real interest rate and the growth rate of the economy coincide, and it is possible for the bubble, capital, and the economy to grow together at the same rate, in which case the rational bubble persists for a long time.

IV. The Lean vs. Clean Debate

The pros and cons of policy responses to asset price bubbles have been debated for a long time.[2] There are two opposing positions. One of them is expressed in the famous speech by Greenspan. The speech was given in 1996, and at that time, there was already a concern about the overheated stock market, which had lately reached the peak of the dot-com bubble. However, Greenspan was reluctant to conduct a monetary policy to cool down the asset market because it is difficult for policymakers to know in real-time whether asset price bubbles exist. If high stock prices are driven by fundamentals such as technological innovation, it is better to be run by an "invisible hand." If high stock prices are bubbles, they may burst later. Even so, policymakers should focus on preventing its spread as soon as possible after bubbles become recognizable. This is one position on the desirable policy response to asset price bubbles. Since this view was dominant among economists at the Federal Reserve Board, it is called the FED view.

On the other hand, there are economists who endorse prior intervention before the bubble bursts. They see the size of the social cost of the bubble bursting as problematic. They consider that the social cost is proportional to the size of the bubble before it bursts and that policymakers should intervene proactively in the market to eliminate bubbles as early as possible before growing whenever they detect overheating in asset markets. This view was common among economists affiliated with the Bank for International Settlements.[3] Thus, it is referred to as the BIS view. The BIS view, which endorses ex-ante intervention before the bubble burst, is often referred to as the "leaning against the wind policy." The FED view, which focuses on ex-post management of bubble bursting, is analogous to "clean" in the sense of cleaning up afterward. So this debate is called the "lean versus clean" debate too.

This is a good opportunity for economists to contribute. However, bubble researchers have not yet greatly succeeded in providing useful insights into this controversy, partly because it is difficult to describe the costs of bubbles theoretically.

Recall the model of "bubble" by Tirole (1985). The necessary condition for a bubble to

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[2] Takeda (2010) surveys the controversy in detail in the Financial Review.
[3] See Borio and Lowe (2002) for example.

occur is for the real interest rate to be lower than the economic growth rate. The real interest rate is low because of excessive saving. When a bubble emerges, investment in capital goods is crowded out, but that is not a bad thing for social welfare since there was too much investment to start with. In the model of Tirole (1985), bubbles are desirable and should not be regulated. This "surprising" result is actually not uncommon. In fact, the result that bubbles increase social welfare is often found in rational bubble theories.

Herein lies the main reason for the difference between economists and policymakers. They have very different views of bubbles. Policymakers often think that bubbles are bad and should be regulated. Economists, however, do not necessarily see it that way. At least theoretically, it is not at all obvious whether bubbles raise or lower social welfare.

Research is underway to fill this gap. For example, Allen et al. (2021) construct an economic model in which the economy stagnates after a bubble bursts because of the default costs. Biswas et al. (2020) also described stagnation after a bubble bursts due to downward rigidity in nominal wages. In either case, even if an asset price bubble is good for the economy while it exists, it can be "bad" in total because of the hard times that await after it bursts.

V. Recurrent Bubbles

Guerron-Quintana et al. (2022) analyzes the cost of asset price bubbles from a different angle. Bubble bursting has been analyzed in existing studies of rational bubbles. In a pioneering work of Weil (1987), bubbles suddenly burst with a certain probability. However, he does not consider the possibility of bubbles reemerging after the burst.

If the occurrence of a bubble were a rare event, it would be realistic enough to assume that the burst occurs only once and never again. However, as Kindleberger (2001) and recent empirical studies have shown, bubbles appear and burst quite frequently (Blanchard et al., 2015; Cerra and Saxena, 2008; Jorda et al., 2015). It is not at all surprising that people experience multiple bubbles in their lifetime.

Motivated by these issues, Guerron-Quintana et al. (2022) develop a theoretical model that explicitly incorporates the situation where bubbles are stochastically generated and burst repeatedly. We assumed infinitely lived agents. The economy alternates stochastically between bubbly regime and fundamental regime, and households have a correct understanding of the stochastic process. This environment allows us to analyze how people's expectations about the occurrence of bubbles affect the economy.[4]

Discussing the model of recurrent bubbles in its original form would be too technical. Therefore, this paper discusses only the essence of the theory in a simplified setting.

Let's forget about bubbles for a moment. Our economy has the following structure. The economy has a representative infinitely-lived household. Households have many members. Members are atomistic and reside on a unit interval. At the beginning of each period, mem-

[4] Martin and Ventura (2012) consider a similar situation in an overlapping generation model. Each economic agent lives for only two periods. Therefore, expectations of future bubbles do not influence the behavior of economic agents.

bers are homogeneous. However, during a period, the members become separated and are randomly assigned roles that they play in that period. Specifically, they become investors with a probability π and workers with a probability $1 - \pi$. The investors are given an opportunity to invest in capital goods with a linear technology that converts a unit of goods into a unit of capital goods. The workers do not have the opportunity to invest in capital goods, but they supply an exogenously determined fixed quantity of labor services to the labor market. At the end of each period, the roles of investors and workers are lost, and the members become homogeneous again. This large family structure is assumed by closely related studies including Del Negro et al. (2017) and Shi (2015).

The household maximizes the following utility function:

$$E_0\left[\sum_{t=0}^{\infty}\left(\underbrace{\beta}_{\text{discount rate}}\right)^t \log\left(\underbrace{c_t}_{\text{consumption per household member}}\right)\right].$$

Capital goods are fully depreciated each period. Therefore, the stock of investment goods in the next period is determined by the following equation:

$$\underbrace{K_{t+1}}_{\text{capital stock in period t+1}} = \pi \times \underbrace{i_t}_{\text{investment per investor}}. \tag{1}$$

It will be optimal for investors to invest all the funds they have. In other words, the following equation holds,

$$i_t = \underbrace{r_t}_{\text{rental price of capital}} \times K_t. \tag{2}$$

On the other hand, since workers do not have investment opportunities, they exclusively finance household consumption. In other words, the equation,

$$\frac{c_t}{1-\pi} = r_t K_t + \underbrace{w_t}_{\text{wage}} \times l,$$

holds. This is the basic setup for households.

The production side is very simple. Firms produce goods using a Cobb-Douglas production function under perfect competition. In equilibrium, the amount of produced goods is

$$Y_t = \underbrace{A_t}_{\text{technology}} K_t^{\alpha}\left((1-\pi)\underbrace{l}_{\text{working hours per worker}}\right)^{1-\alpha}$$

The first-order conditions for the profit-maximizing producer are

$$w_t = (1-\alpha)\frac{Y_t}{l}$$

and

$$r_t = \alpha \frac{Y_t}{K_t}.$$

The technology level A_t is endogenously determined and is given by

$$A_t = \underbrace{\bar{A}}_{\text{scale parameter}} (K_t)^{1-\alpha}.$$

Note that there is an externality from capital to the level of technology. This assumption makes the production function constant returns to scale, and hence economic growth occurs through capital accumulation. This is an assumption often used in endogenous growth theory. However, households do not recognize that their investment behavior affects the level of technology.

In this economic environment, the resource allocation in equilibrium can be obtained analytically. First, substituting the (2) equation into the (1) equation, we obtain

$$K_{t+1} = \pi r_t K_t.$$

Dividing both sides by K_t yields

$$\underbrace{g_t}_{\text{speed of capital accumulation = economic growth rate}} \equiv \frac{K_{t+1}}{K_t} = \pi r_t.$$

Now, since there is no uncertainty in the economy, the economic growth rate in an economy without bubbles is given by the following equation:

$$g_f = r\pi.$$

Here, r is the rental price of capital, which is a constant given by $r \equiv \alpha Y_t/K_t = \alpha \bar{A}((1-\pi)\,l)^{1-\alpha}$ in equilibrium.

Although there is no market for trading capital in the economy, we can hypothetically calculate the price of capital goods in equilibrium in such a market. The price of a capital good, if it is traded, should satisfy the following equation:

$$\frac{1}{c_t} q_t = \beta \frac{1}{c_{t+1}} r_{t+1}(1-\pi+\pi q_{t+1}). \tag{3}$$

The left-hand side represents the marginal utility that the household loses in the current period by buying one unit of the capital good. The right-hand side represents the discounted present value of the marginal utility that households will gain in the next period by buying a unit of the capital good. This is for the following reasons. First, the capital good purchased in the current period will generate r_{t+1} of revenue for each member of the household in the next period. For workers, all of this revenue converts to their earnings, but investors can earn even higher earnings by investing it in capital goods. This is the reason that the term $(1 - \pi + \pi q_{t+1})$ is multiplied by r_{t+1} on the right side, which correctly reflects that the investors have superior investment opportunities. This equation can also be solved analytically, and the shadow price of the investment good in equilibrium is

$$q_f = \frac{\beta}{1-\beta}\,\frac{1-\pi}{\pi}$$

These are the resource allocations for the no-bubble case.

There can be a rational bubble in this economy. Suppose now that there are only M units of “bubble assets,” which are intrinsically useless. You can think of it as a piece of paper or as the ownership rights (stock) of the producer of the good.[5] We will ignore the possibility of a bubble bursting for the moment.

In this case, it is optimal for investors to sell all of their bubble assets in the market and finance their investments. In other words,

$$i_t = r_t K_t + \underbrace{p_t}_{\text{bubble asset price}} \times M \tag{4}$$

holds. Workers finance household consumption and purchase bubble assets. In other words,

$$\frac{c_t}{1-\pi} + p_t\left(\underbrace{\tilde{m}^s_{t+1} - M}_{\text{bubble asset purchase per worker}}\right) = r_t K_t + w_t l$$

holds. The first-order condition for the purchase of the bubble asset is

$$\frac{1}{c_t} p_t = \beta \frac{1}{c_{t+1}} p_{t+1}(1-\pi+\pi q_{t+1}). \tag{5}$$

The left-hand side of the equation represents the marginal utility that households lose in the current period by buying a unit of the bubble asset, and the right-hand side represents the discounted present value of the marginal utility that households gain the next period by buying a unit of the bubble asset in the current period. The market clearing condition for the bubble asset is

$$M = (1-\pi)\tilde{m}^s_{t+1}.$$

Resource allocation in this model is characterized by the following three equations. The first equation is obtained by substituting the (4) equation into the (1) equation:

$$g_b = \pi\,(r + m_b),$$

where m_b is the market value of the bubble asset divided by the capital stock, $m_b \equiv p_t M / K_t$, in steady state. Second, the equation (5) in steady state is

$$m_b = \beta\,(1 - \pi + \pi q_b)\,m_b.$$

Finally, the equation (3) in steady state can be written as

[5] The producer’s profit is zero every period, and hence the intrinsic value of the stock certificate is also zero.

$$q_b = \beta \frac{1}{g_b} r(1 - \pi + \pi q_b).$$

Is there a solution of positive m_b to the simultaneous equations given by the three equations above? Actually, it can be proved that it exists if the following conditions are satisfied.

$$\underbrace{g_f}_{\text{economic growth rate}} > \underbrace{\frac{r}{q_f}}_{\text{rate of interest earned on investments in capital goods}}. \tag{6}$$

Notice that this inequality compares the economic growth rate to the interest rate. In an economy without bubbles, since it takes q_f units of goods to purchase one unit of capital goods, one unit of goods is exchanged for $\frac{1}{q_f}$ units of capital goods. The capital good yields r of revenue per unit. Therefore, $\frac{r}{q_f}$ is the gross interest rate from investment in the capital good. In this model, the scarcity of capital goods pushes up the price of capital goods and pushes down the rate of interest on investment in capital goods, creating a bubble situation.

The economic growth rate in bubble equilibrium is given by

$$g_b = \frac{r\pi\beta}{1 - (1 - \pi)\beta}.$$

Let us compare g_f and g_b. Taking the ratio of the two, we get

$$\frac{g_b}{g_f} = \frac{\beta}{1 - (1 - \pi)\beta}.$$

Mathematically, the necessary and sufficient condition for $g_b > g_f$ is that the right-hand side of the above equation is greater than 1. In fact, rewriting the condition (6), the existence condition of a bubble equilibrium, leads to exactly the same inequality. In other words, in the economic environment we are considering, the economic growth rate in a bubble equilibrium is always higher than the economic growth rate in an economy without a bubble. The mechanism is quite simple. Bubbles make it easier for investors to obtain capital, accelerating the accumulation of capital goods and raising economic growth. Hence, bubbles are desirable.

The discussion so far is a review of what existing studies have discussed. We now consider the recurrent bubbles model in which people have expectations that a bubble may occur in the future.

To examine what happens on the “eve of a bubble’s birth,” consider the following scenario. Let us assume that there is no asset price bubble initially. However, with a certain probability, the regime will change, and bubble assets will begin to circulate. Assume that lump-sum bubble assets are distributed to households at the moment the regime changes. To simplify the discussion, assume that the type of bubble is a stochastic bubble developed by

Weil (1987). That is, we assume that the bubble has a certain probability of bursting and that after the burst, the bubble will neither occur nor be expected to occur again.

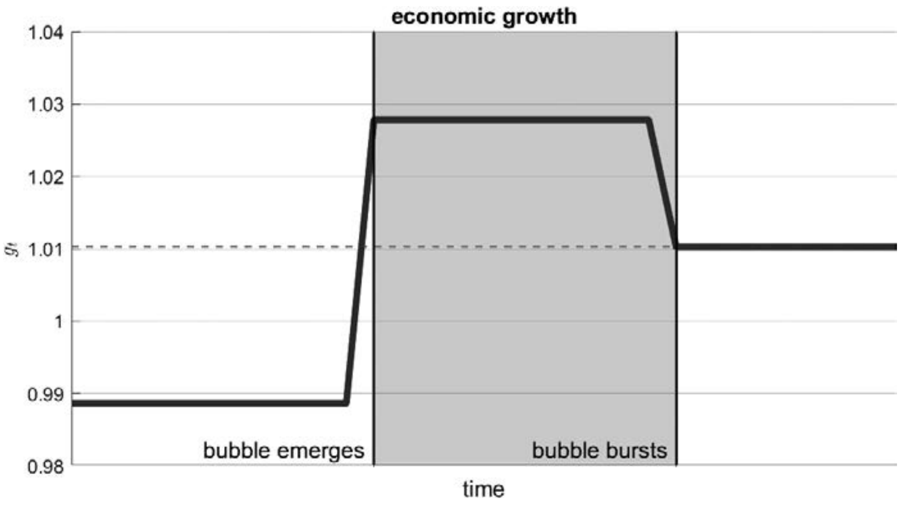
In this case, the economic growth rate would be as shown in Figure 1.[6] The horizontal axis shows time, and the vertical axis shows the economic growth rate. On the right side of the figure, the economic growth rate after the bubble burst is depicted. In the middle of the figure, shaded area, the economic growth rate during the bubble period is plotted. This growth rate is higher than the growth rate after the burst of the bubble. The mechanism for this has already been discussed.

Notice the left side of the highlighted area. At this point, the bubble has not yet occurred. However, households are expecting that a bubble may occur. Interestingly, the economic growth rate before the bubble is not only lower than the economic growth rate during the subsequent bubble period, but it is also lower than the economic growth rate after the bubble burst. The pre-bubble period and the post-bubble period are objectively not different since neither has bubbles. What does create the difference in economic growth rates is expectations. In the pre-bubble period, the expectation of a bubble pushes down the rate of economic growth.

The mechanism is quite simple. Households know that the rate of economic growth will increase when a bubble occurs. Correctly expecting this, households increase their consumption levels even before the bubble period. Although this costs them some of their current investment, they will be willing to increase their current consumption levels because they will be able to "make up" for the low investment once the bubble occurs.

When a bubble is expected to occur, economic growth rates fall. This is the crowding-out effect of future bubbles' expectations on investment. Bubbles themselves have a crowd-

Figure 1. Growth rate in a recurrent bubble model



[6] For a detailed analysis, see Guerron-Quintana et al. (2022).

ing-in effect, so the rate of economic growth increases during a bubble period. However, if we also take into account that the economic growth rate is pushed down before the bubble occurs, it is not clear whether bubbles increase the economic growth rate in the long run or are good for social welfare. In fact, Guerron-Quintana et al. (2022) analyze the impact of recurrent bubbles on economic growth and social welfare in more general situations and report that bubbles can be good or bad, depending on the state of the economy and the nature of the bubbles. According to the analysis, the degree of development of financial markets and the frequency of bubbles seem to be important factors for the impact of recurrent bubbles on social welfare.

VI. Policy Implication

To consider the policy implications of the theory of recurrent bubbles, let us recall the lean versus clean debate. The two positions seem in opposition, but on closer examination, the claims are not so different. Instead, they even agree on some important points.

First, neither position believes that bubbles themselves are costly. They believe that the “crisis” occurring after bubble bursts is the essence of the cost of the bubble. Even with this consensus, they still disagree because they have different views on how serious the crisis is and whether the severity of the crisis can be mitigated through policy responses. Those who believe that the crisis is not that serious will argue that the bubble has some positive aspects and should basically be left alone (FED view), while those who believe that the costs of the crisis are enormous will argue that the bubble, even if it has positive aspects, should be eliminated as soon as possible (BIS view).

The theory of recurrent bubbles adds a new perspective to this debate. That is, the viewpoint that the expectation of bubbles’ appearance is also a cost of bubbles. This perspective has been missing from the traditional lean versus clean debate. This is because the debate is a confrontation of opinions on whether bubbles that have already occurred should be burst earlier (lean) or not (not lean = clean). In the sense that the occurrence of a bubble is given, the policy debate is fundamentally based on the stochastic bubble model.

VII. Conclusion

This paper discusses research on asset price bubbles. The author has wanted to convey three points through this paper. The first is that research on rational bubbles is fruitful. A major research achievement in this field is clarifying that irrationality and enthusiasm are theoretically not necessary conditions for creating bubbles and that a low-interest rate environment is a necessary condition for creating rational bubbles. Second, the theory of rational bubbles is still developing. In particular, with regard to the lean versus clean debate, it has yet to be able to provide convincing answers to the questions raised by policymakers. This is because of the difficulty of conducting empirical research on bubbles and the difficulty of theoretically formulating the costs of bubbles. Third, research on rational bubbles is moving forward. As an example, the theory of recurrent bubbles, which the authors of this paper are working on, has been presented. The author sincerely hopes that further research advances will bridge the gap between policymakers and researchers.

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