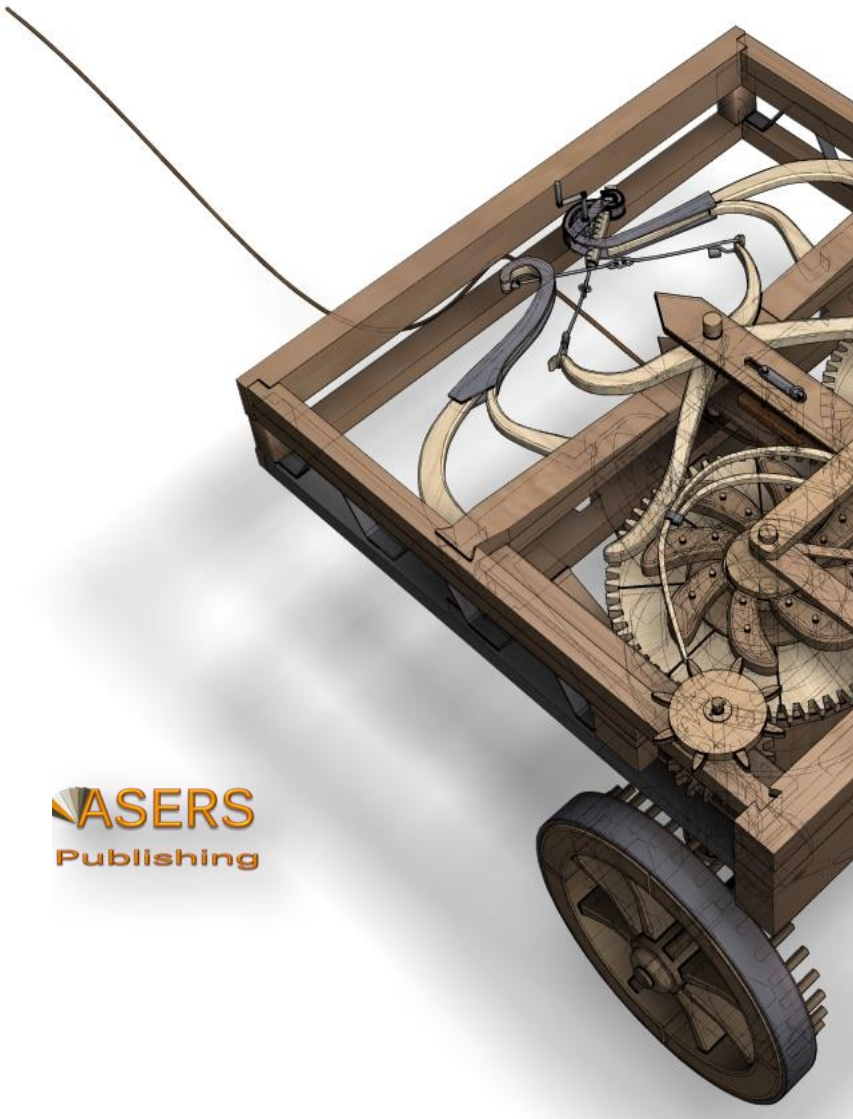
Theoretical and Practical Research in Economic Fields



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Does Economic Literacy Affect Inflation Expectations? An Experimental Survey Approach

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Abstract: *This study investigates the effectiveness of the information treatment in the inflation expectations on individuals with varying levels of economic literacy. In this regard, we conducted an experimental survey that provided participants with information related to inflation and other macroeconomic variables. The study reveals that the information treatment was effective in assisting the participants revise their expectations closer to actual inflation. Notably, this was especially effective for those without an economics background as they revised it to align with the actual inflation. Additionally, we found that formal economics learning is insignificant in the formation of inflation expectations given that the relevant information is accessible. Results of the study shed light on the importance of addressing information friction, focusing on financial education and effective communication from central banks.*

Keywords: economic literacy; experimental survey; inflation expectations; information friction.

JEL Classification: A20; C91; E31; E37.

Introduction

Inflation expectations are heterogeneous. A considerable amount of literature cited information friction as the major factor leading to heterogeneous expectations (Cavallo, Cruces, and Perez-Truglia 2017; Coibion and Gorodnichenko 2012; 2015). Gnan *et al.* (2011) finds that inflation expectations vary across countries and demographic groups due to differences in information sets and models used by individuals.

Information friction is often not clearly revealed through the aggregate survey data especially to address specific questions such as the significance of access to information and financial literacy on the formation of inflation expectations and the expectation updating (Hubert 2015; Maule and Hubert 2016). Controlled laboratory experiments have examined various macroeconomic models and theories in the last few decades. This growing body of literature is driven by changes in macroeconomic modeling, which now focuses on how institutional changes or policies affect aggregate time series data and the choices made by decision-makers such as households and firms (Duffy 2016). Many studies concerning the formation of inflation expectations in the experimental setup were conducted in developed countries; see, for example (Armantier *et al.* 2016; Zafar *et al.* 2012).

This study uses an information-based experimental survey to examine the impact of information treatment on subjects that have varied levels of economic literacy. In the context of India, this study represents a pioneering effort in experimental approach in eliciting inflation expectations. Therefore, this study fills an important gap in the existing literature.

The paper proceeds as follows. Section 2 reviews the relevant literature. Section 3 presents the experimental design and describes the data and methodology of empirical analysis. Section 4 discusses the results, and the final section concludes.

1.Theoretical Approach

A pre-requisite for understanding inflation expectations is the extant of its heterogeneity. A significant amount of literature addresses heterogeneity from the perspective of information friction. Theoretical underpinnings for this

research primarily rise from the framework of information friction. Coibion and Gorodnichenko (2012) and Reid (2015) have addressed the issue of information friction as a possible reason for heterogeneity in expectations, leading to different levels of central bank credibility, forecast errors, and more. Along this line, earlier research, such as Mankiw and Reis (2002), formulates a sticky information model, which assumes infrequent updating of expectations, leading to predictions based on outdated data. Further, Sims (2003) proposed the rational inattention model based on the constrained information processing capacity. Similar to the differences in access to information and the ability to process it in the context of life decisions faced by agents, inflation expectations are formed heterogeneously (Ueno and Namba 2014).

This paper primarily makes use of the rational expectations hypothesis along with the sticky information framework for the modelling of our experiment. Let the time at which the expectations are formulated be *t*, and the expectations at time *t* is denoted as π_t^e. Let I_{t-1} is the given the set of information available at the end of period *t* - 1, then the existence of rational expectations implies the following assumptions:

$$E(\pi_t | I_{t-1}) = \pi_t^e \quad (1)$$

$$\pi_t - \pi_t^e = \pi_t - E(\pi_t | I_{t-1}) = \varepsilon_t \quad (2)$$

where ε_t is a random variable with $E(\varepsilon_t) = 0$. The first assumption states that the expected inflation depends on the relevant information that is available up to the end of $t-1$. The second assumption recognizes the existence of error term in the REH model. However, the estimation error $\pi_t - E(\pi_t | I_{t-1})$ cannot contain a systematic component as it is supposed to produce unbiased estimate of the future values of inflation expectations. In our experimental set up, we test systemic heterogeneity essentially based on economic literacy.

However, in the presence of information friction, the agents are not supposed to act rationally, and the expectations are supposed to be biased. It suggests that due to lack of updating information, the forecasts are inefficient and biased. In such a scenario, the expectation of inflation becomes

$$\pi_t^e = E(\pi_t) + \varepsilon_t \quad (3)$$

The treatment in our experiment deals with the problem of information updating and expecting the subjects to act rationally. Eventually, we assume that the expected inflation approaches actual inflation in the rational expectations estimator in equation (1), and the error term in the equation (3) disappears.

2. Literature Review

The literature in the field of information friction and inflation expectations grows further in different directions in lines to the theoretical underpinnings. A stream of literature argues that the friction may arise from education and financial literacy. Burke and Manz (2014) suggest that a significant portion of demographic heterogeneity in inflation expectations observed in survey data may be driven by heterogeneity in economic literacy. One among the recent studies argue that the very less frequent updating of information by general public leading to less accurate forecasts compared to the professional forecasters and policy makers(Cornand and Hubert 2022). Studies have found lower education is associated with higher rates of expected inflation (Bruine de Bruin *et al.* 2010; Bryan and Venkatu 2001). Literature also indicates that rational inattention and cognitive limitations play a major role in information friction; see, (Cavallo, Cruces, and Perez-Truglia 2017).

The population's financial literacy level and the degree of interaction with financial instruments also contribute to information friction, especially in a developing country like India. Factors such as availability and use of information, cognitive skills, and the influence of past experiences in the formation of inflation expectations are studied in the literature. Bruine de Bruin *et al.* (2010) study the formation of expectations in the light of demographic variables and financial literacy to determine which contributes to the heterogeneity of survey expectations in the US. Similar to many other studies, individuals who are female, poor, single, less educated, and those with less financial literacy reported higher expectations.

Furthermore, the literate subjects could focus on the overall inflation, while the less literate ones focused more on inflation experiences or price memory of market purchases. Armantier *et al.* (2016) find that individuals with higher financial literacy and numeracy skills tend to have more accurate inflation expectations. Madeira and Zafar (2015) and Malmendier and Nagel (2016) affirms that the past experiences with inflation rates of individuals can significantly impact their expectations about future inflation.

Other factors that have been identified contributing to heterogeneity in inflation expectations; such as the accuracy of individuals' forecasts (Xu *et al.* 2016), and the influence of public information and media coverage on expectations (Madeira and Zafar 2015). A seminal paper by Carroll (2003) postulated the role of news information

in the formation of inflation expectations. He put forward an epidemiological model of expectation formation, according to which consumers update their expectations from the media.

Another stream of literature discussed the ability to process the available information. Coibion *et al.* (2020) explored how individual expectations are formed and highlighted the importance of economic agents' capacity or limitations in processing information about inflation. Cognitive abilities are essential in forming subjective economic expectations and choices (Falk *et al.* 2018). It is understood that it helps economic agents gather information regarding the economy and allocate the available resources according to the needs and utilities within individual budget constraints.

A study using exclusive data from Finland's male population is taken up by D'Acunto *et al.* (2019) to assess the relationship between intelligence quotient (IQ) and expectation formation. The panel data, which surveys the same individual every 6 months, focuses on the assumptions of learning and updating the information for the same. The results suggest that the men with higher IQ report lower forecast errors and vice versa. Furthermore, the Higher IQ respondents overreact to the macro news but update their forecast towards a lesser forecast error. The effect of macro shocks on the lower IQ men does not go with this rule. Also, they deduce that inflation is the changes in the prices of specific goods rather than general prices in the economy.

It is also argued that more literate subjects choose more relevant information and use it more effectively (Burke and Manz 2014). Cavallo *et al.* (2017) conducted experiments and discovered that respondents assign less significance to historical inflation when anticipating future inflation, in a low-inflation country like the US. Moreover, they seem to assign a higher weight to less accurate sources of information, such as their memories of the price changes of the supermarket products they purchased. At the same time, respondents assign a comparatively higher weight to the historical inflation in a high-inflation economy such as Argentina. Furthermore, the 'cost of inflation' plays an important role in deciding the horizon of updating information in the process of inflation anticipation. The study also identifies rational inattention as an important source of information friction.

Carroll (2003), using the survey data, found a percentage of the US population (λ) who acquires the news from professional forecast/ newspaper articles can 'rationally' anticipate inflation for the next period. In fact, he shows that higher dissemination of news narrows the gap between the mean forecast from the Michigan Survey and that of professional forecasters. Pfajfar and Santoro (2013) test Carroll's theory of epidemiology by using the direct measure of the flow of news on prices that consumers have heard and find that most consumers who update their expectations do not revise them towards the mean of professional forecasters survey. Furthermore, they reveal that 75% of the population revise their expectations, contrary to Carroll's 25%. Lein and Maag (2011) also reveal that the λ is not fixed, and the share of the population who updates the expectations is not a constant fraction. Also, it is not the same people who are updating the expectations.

Following Pfajfar and Santoro (2010), Das *et al.* (2018) conduct an experimental study on expectation formation in a New Keynesian macroeconomic framework, finding heterogeneity in expectation formation and model switching behavior. The subjects of the experiment were students of economics at Jadevpur University, India. The authors conclude that the expectation formation process is adaptive and heterogeneous. They also find high heterogeneity in expectation formation and model switching nature by the subjects. Saakshi and Sahu (2019) used a panel data and identified the heterogeneity in household inflation expectations in India are due to the city level information friction developed from differences in economic activities.

To sum up, according to the literature, the formation of inflation expectations exhibits heterogeneity, mainly from information asymmetry or friction. Various methods, such as the sticky price and rational inattention models, are employed to model information friction. In addition, demographic variables such as education, access to information, information processing abilities, and the cost of updating expectations also significantly impact the heterogeneity of expectations.

Based on the theoretical underpinnings and literature survey, this study undertakes an experimental study to find the interaction between information friction and economic literacy. This paper adds to the literature of experimental studies for identifying the formation of inflation expectations in the presence of information friction.

3. Data and Methodology

This study is aimed to shed light into the process of the formation of inflation expectations and how it varies with subjects' understanding of economic concepts. Following Burke and Manz (2014), an experimental survey approach in this regard will allow us not only observe the forecasting process, but also the revision of forecasts based on the information treatment. It is different from the regular survey method as it has narrow possibility to address the information friction and heterogeneity. Adding to it, surveys cannot readily gain insight into how individuals select and process information when forming inflation expectations. Given these considerations, our

experiment serves as a valuable addition to the existing research based on survey data about inflation expectations.

The data is from the original survey conducted by the author between 5th July 2020 to 17th August 2020 among young, educated respondents across India with a special focus on financial literacy. It used a purposeful sampling method and employed the survey via social media platforms such as WhatsApp, Facebook, Telegram and direct emails to ids collected from sources as a data collection method.

3.1. Survey Design

The survey was conducted online, and the respondents were asked to complete a Google Form. The questionnaire used for the study is in Appendix 5A. The survey contained a brief introduction about the aim of the survey and the confidentiality of their responses. The survey was strictly voluntary. They were also asked to refrain from taking help from any sources to keep the survey's integrity.

Stage 1: *eliciting initial expectations*

After beginning the survey, participants were immediately prompted to provide their inflation expectations for two-time horizons: 3 months ahead, corresponding to September 2020, and 12 months ahead, corresponding to June 2021. The options for their responses were presented as brackets ranging from 0% to 16%, with each bracket representing a 1% range. For example, a "4%-5%" response would indicate an expectation of inflation within the range of 4% to 5%.

Further, they were then directed to fill out demographic details, including gender, age, employment, annual income of the family, educational qualification, marital status, state of residence, category of place of residence, religion, and caste.

A separate section of questions was assigned to record their knowledge of economics at their educational level. Specific questions related to the know-how of inflation and the targeting policy of the central bank are also asked. To tinker more with their inflation knowledge, we asked specific open short-answer questions to recall any past inflation rate with a date they remembered. We also give them the option to reveal the media/ source they refer to while forming inflation expectations in general.

Stage 2: *information treatment*

After this, they were provided with a set of information regarding inflation. Specifically, we defined inflation and displayed graphs to inform them about historical data related to inflation, inflation target, food inflation, and professional forecasters' expectations. These graphs were explained in words to make it easier for respondents from both economic and non-economic backgrounds.

Stage 3: *eliciting informed expectations*

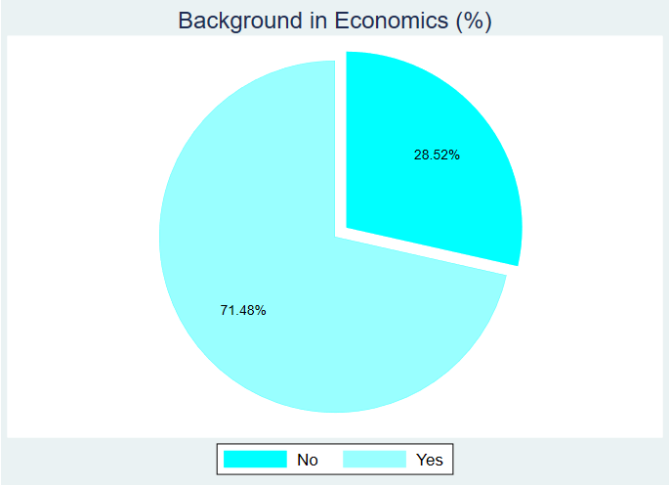
Finally, they were asked to reveal their expectations again with the same set of questions as in Stage 1.

We hypothesize that the information provided to the respondents to be useful so that the individuals revise their expectations closer to the actual inflation corresponding to the horizons or the RBI inflation target. We also expect that the information is more useful for those who do not have a background in economics and those who do not know about the RBI inflation-targeting policy.

3.2. Descriptive Statistics

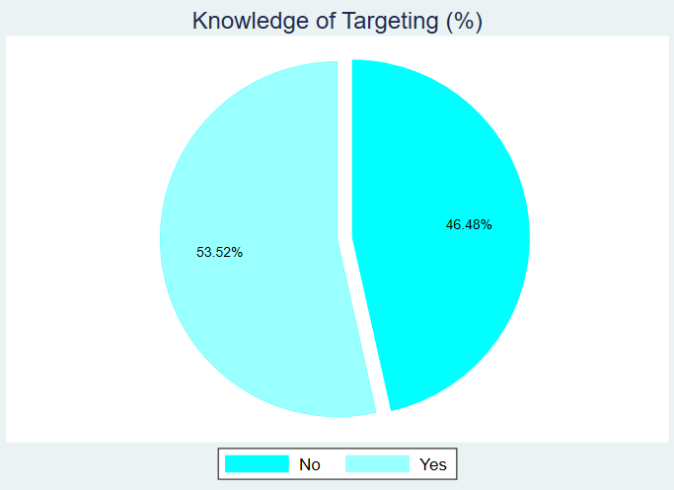
A total of 256 people participated in the survey. 76.95% of them were male, 67.19% were unmarried, and 71.88% of them had educational qualifications as post-graduation and above. Respondents with a background in economics (RBE) and those with knowledge about targeting (RKT) are 71.4% and 53.5% of the total respondents, respectively (Figure 1 and 2). RKT denotes those who have true knowledge of targeting wherein it takes the value 1 (Yes) if they quoted the number between 2% and 6%, and 0 otherwise. Similarly, RBE takes a value 1, if the respondent has a background in economics, and 0 otherwise. 23.83% of the respondents claimed to 'know exactly' about inflation (Figure 3).

Figure 1. Participants with background in economics



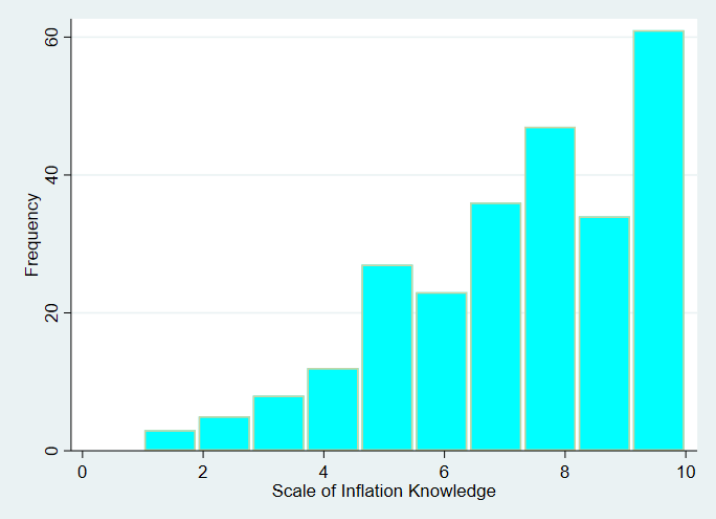
Source: Author's calculation from the experimental survey

Figure 2. Participants with true targeting knowledge



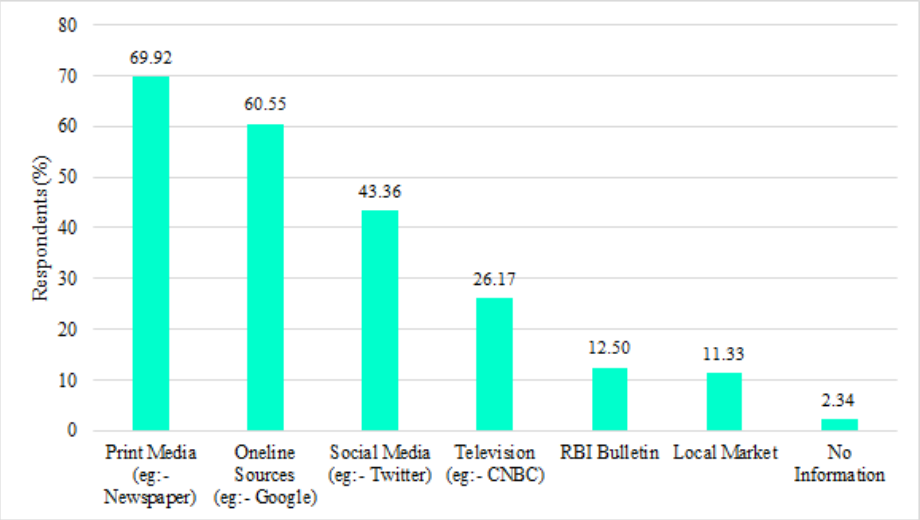
Source: Author's calculation from the experimental survey

Figure 3. Participants' knowledge about inflation in Likert scale



Source: Author's calculation from the experimental survey

Figure 4. Information sources of respondents



Source: Author's calculation from the experimental survey

The frequency of people referred to various sources for information on inflation is displayed in Figure 4. The respondents were free to select multiple sources. The most referred is the print sources including newspapers and magazines, followed by online search engines and social media. The least referred ones are the RBI bulletin and the local market price information.

As can be observed from Table 1, average expectations were below the realized inflation for both horizons – 3 months and 12 months. After the information treatment, respondents revised their expectations upwards. Furthermore, the standard deviation declined following the treatment, perhaps due to the information pass-through.

Table 1. Descriptive Statistics

Variable	Mean	Median	SD
Inflation Expectations 3 months ahead – Pre-treatment	5.08	4.5	3.28
Inflation Expectations 3 months ahead – Post-treatment	5.24	5.5	2.97
Inflation Expectations 12 months ahead – Pre-treatment	5.42	4.5	3.64
Inflation Expectations 12 months ahead – Post-treatment	5.79	5.5	3.23

Source: Author's calculation from the experimental survey

3.3. Empirical Methodology

The primary analysis involves assessing how the expectations of individuals about the future are influenced by the information provided to them. As inflation targeting focuses on long-term expectations, we only consider the 12 months ahead expectations in the analysis.

As the expectation data is not normally distributed, we take up the Wilcoxon signed-rank test to compare the medians pre and post information treatments. A one-sample test is used to determine whether a sample median significantly differs from a known or hypothesized population median, which in our case will be the corresponding realized inflation rate. Two sample test is similar to the one-sample test, rather determines whether there is a significant difference between the medians of two independent groups.

Further, an OLS regression is run to examine whether economic literacy is significant in expectation formation. The model can be depicted as:

$$\pi^{e}_{t,t+12} = \beta_0 + \beta_1 X_1 \quad (4)$$

Where in $\pi^{e}_{t,t+4}$ is the expectations about t+12 (12 months ahead) forecasted at time t. A significant β_1 would suggest that the expectations are affected by the background in economics. This regression is estimated with both the expectations before and after the information treatment. The OLS regression in this analysis is not intended to express causal relationship rather association of the variables. This model also evades adding other determinants of inflation expectations into consideration for two reasons. Primarily the regression doesn't address the question of determinants of inflation expectations. Secondly, the survey data doesn't allow us to consider

other macroeconomic variables in to the regression for it is an experimental study. However, the treatment process has included macroeconomic variables and thus can be considered that the information provided takes care of such concerns.

4. Results

This section discusses the results. Initially, we checked whether the respondents revised their expectations following the information treatment. The CPI inflation rate during the survey (July 2020) was 6.67%. The actual inflation rate corresponding to (12 months ahead) June 2021 was 5.59%. We use the one-sample test for the hypothesis (H_0: Median Expectation = Inflation).

Table 2. Inflation Expectations Pre and Post-treatment

Treatment	Inflation expectation	Actual inflation	*z*	*p*
Pre	4.5	5.59	-2.26	0.02
Post	5.5	5.59	-0.42	0.67

Source: Author's calculation from the experimental survey

Table 2 suggests that the 12 months ahead forecast post-treatment is closer to the actual inflation while the pre-treatment is not, indicating effectiveness of information treatment. Furthermore, it is noted that the expectation increased by 1% owing to the treatment, which is a step closer to the realized inflation leading to a lesser forecast error.

4.1. Background in Economics and Formation of Expectations

We found that, primarily, the treatment is effective for the overall population of the survey with significant revision in the expectations. In this section we particularly look in to whether the expectations of the RBE and non-RBE are aligning towards the actual inflation post-treatment? The results for tests of equality based on the hypothesis (H_0: Median Expectation = Target) are tabulated in Table 3.

The expectations of Non-RBE have increased from 3.5% to 5.5% due to the treatment. While the median RBE expectations are left without change even with the treatment. On this note we can assume that the RBE didn't find the information provided useful, as their expectations are already aligned with the actual inflation. Hence, they didn't meet the expectations at all.

Table 3. Test for equality based on economic literacy

Economic Literacy	Treatment	Inflation expectation	*z*	*p*
Non-RBE	Pre	3.5	-3.21	0.00
RBE	Pre	5.5	-0.46	0.64
Non-RBE	Post	5.5	-1.26	0.21
RBE	Post	5.5	0.35	0.72

Source: Author's calculation from the experimental survey

Table 4. Influence of economic literacy on expectations

Economic Literacy	Pre - treatment	Post - treatment
Non-RBE	-	-
RBE	1.35**	0.73
	(0.52)	(0.46)
Constant	4.45***	5.27***
	(0.45)	(0.40)
N	256	256
R^2	0.03	0.01

Note: *, ** and *** represent significance at 10%, 5% and 1%, respectively. Robust standard errors are in the parenthesis.

Source: Author's calculation from the experimental survey

Further, to check the effect of treatment, we run an OLS regression. Table 4 presents the results suggest that the average expectations of RBE are higher than the non-RBE. It also reiterates that the background in economics did not have an effect in the forecast post-treatment, indicating that once the information is passed, background in economics was not a significant factor in explaining expectations formation.

4.2. Knowledge of Targeting and the Formation of Expectations

In this section, we analyze whether the median expectations of the RKT and non-RKT are aligning towards the prescribed upper bound of inflation target (6%) post-treatment. This analysis will inform us how true knowledge regarding inflation targeting plays a role in formulating expectations. In doing so, we take up the compare the medians of expectations categorised by the RKT and non-RKT. Results of the hypothesis tests (H_0: Median Expectation = Target) are tabulated below.

Table 5. Test for equality based on knowledge of targeting

Targeting Knowledge	Treatment	Inflation expectation	*z*	*p*
Non-RKT	Pre	4.5	-1.85	0.06
RKT	Pre	5.5	-2.76	0.00
Non-RKT	Post	5.5	-0.81	0.42
RKT	Post	5.5	-1.50	0.13

Table 5 suggests that the expectations before treatment was significantly different from the RBI inflation target regardless of the categorization based on targeting knowledge. However, the median expectations post targeting aligned towards the target and thus not significantly different from the target. It is also noted that the non-RKT revised their expectations owing to the treatment while the RKT did not.

Conclusions

This study used an experimental survey method to address the question of information friction in the formation of inflation expectations. In doing so, we tested the effectiveness of information treatment on updating inflation expectations of respondents with a background in economics study and those who have knowledge about central bank inflation targeting. Our results found that the treatment is significantly effective as the respondents updated their expectations based on the information provided, leading to a lesser forecast error.

Specifically, we found that the information treatment is effective for those who didn't have a background in economics as they revised it to align with the actual inflation. However, after the information is provided the background in economics is insignificant in the formation of inflation expectations. The treatment is also found effective in aligning the expectations towards the inflation target regardless of the targeting knowledge. This result also implies that the information treatment is helpful even for those who have comparatively better knowledge about targeting. Similar results are found in (Burke and Manz 2014) wherein, an improved economic literacy was associated with improved forecasting scores. However, they also found that the more literate subjects could make the most out of the information provided. In our case, the more literate subjects did not have much room for improvement of forecast and thus the results cannot be counted contradictory. Bruine de Bruin *et al.* (2010) also reports the financial literacy variable associated with better inflation forecasts, which corroborates our findings.

Results of the study shed light on the importance of addressing the information friction that adds to the heterogeneity in expectations formation. Better financial education and effective central bank communication can help decrease forecast errors. Based on our findings, the most preferred source of information on inflation is print media, followed by online search engines and social media. In the wake of the rise of influential social media platforms, central banks can opt for mechanisms that reach the public easily and effectively so that economic agents can easily update information regarding inflation and thus reduce information friction.

This study is conducted based on a survey that was fielded online in the presence of the COVID-19 outbreak. In effect, the survey caters to an internet community, those who can read and write the English, and those with an internet connection. However, it perfectly caters our objective of studying learned individuals' expectations. Further research can be carried out using a field survey to overcome these limitations. The prospective study may also employ more sophisticated difference indifference methodology to better the results.

Note: Questionnaire of the survey will be provided up on reasonable request.

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Declaration of Competing Interest

The author declares that he has no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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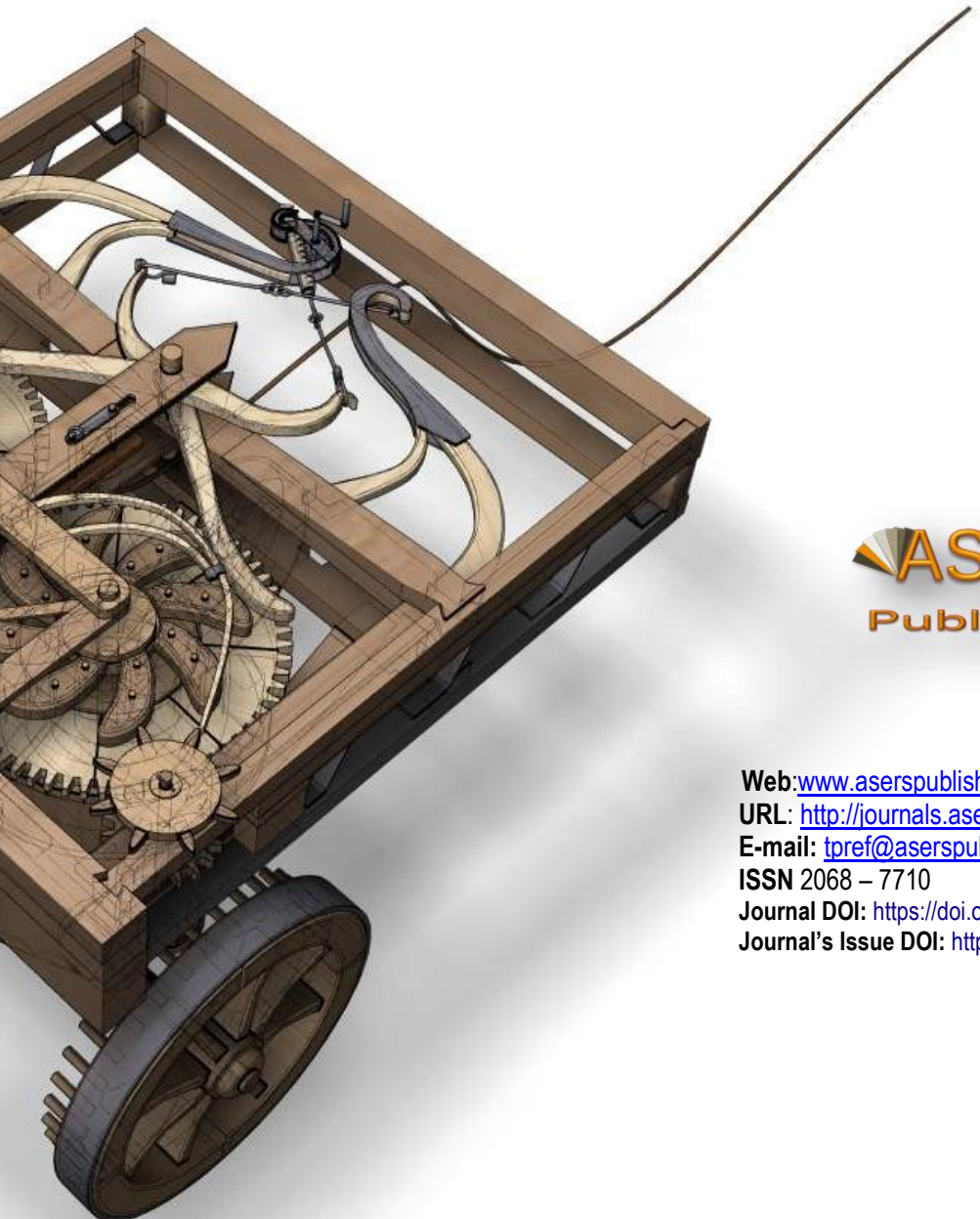

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