Inflation Expectation Decision and Saving Decision in Heterogeneously Endowed Overlapping Generation Model: An Experimental Evidence from Laboratory

Das, Abhishek and Gupta, Gautam

Jadavpur University

12 June 2015

Inflation Expectation Decision and Saving Decision in Heterogeneously Endowed Overlapping Generation Model: An Experimental Evidence from Laboratory[*]

Abhishek Das[†]
Department of economics
Jadavpur University, Kolkata, India

Gautam Gupta
Department of economics
Jadavpur University, Kolkata, India

Abstract

In this paper we use a heterogeneously endowed Overlapping Generation model (OLG) in an experimental framework. . In our experimental OLG economy young subjects are asked either to predict the inflation rate for the next period or to decide his/her savings for the current period. We find that for both the decisions neither higher amount of government expenditure nor the higher amount of money supply by monetary authority will move inflation rate towards equilibrium. We also find that that if there is much uncertainty, Friedman Conjecture will not work.

JEL Classification: C92; E21; E31; E52

Keywords: OLG-model; Expectations; Inflation; Stability; Monetary policy; Experiments

Preliminary version, please do not quote without authors' authorization

---

[*] We would like to thanks Ajitava RoyChoudhury, and Ambar Nath Ghosh for helpful suggestions. Financial support from the Social Science and Cultural Resources programme, UPE II, Jadavpur University made the study possible for which we are grateful.

[†] Corresponding Author: Abhishek Das, Department of Economics, Jadavpur University, India;email: ind.abhishek@gmail.com

Saving Decision and Inflation Expectation Decision in Heterogeneously Endowed Overlapping Generation Model: An Experimental Evidence from Laboratory

1. Introduction

Rules versus Discretion in monetary policy is the classic debate raised by Henry Simon (1936). But Friedman (1948[1], 1960[2]) argued that relatively simple rules may help economic stability as agents can easily understand such rules, and it is easier for them to coordinate their actions. Friedman proposed that a relatively simple rule, such as a k percent rule, can help stabilize the economy. Beside these policy perspectives another important aspect that is closely related to policy is the number of equilibrium in a model.

There are many theoretical papers on this indeterminacy problem, but little work has been done to investigate its empirical basis. In their series of papers Marimon and Sunder (1993) first use Overlapping Generation (OLG) model in an experimental framework to capture the indeterminacy problem. In their 1993 paper they first study indeterminacy of equilibria. They did not found any non-stationary rational expectation path. They observed that path of inflation rate tends to converge close to, or somewhat below, the low inflationary rate stationary state. Marimon Spear and Sunder (1993), provides sunspot equilibria in experimental lab framework. They found that "if agents expect sunspots to matter, they can matter" (Marimon*et al.*, 1993), more specifically if economic agents believe that some random events maters in price determination, such beliefs can be self-fulfilling even if these events are extrinsic to the economy. Their data shows that even though the real source of uncertainty disappears from the economy, agents' behaviour may show enough insistence as to sunspot fluctuations. In another paper (Marimon & Sunder, 1994) test robustness of their previous results under different policy prescriptions. Here they studied agents' behaviour before and after the time of preannounced policy changes. They observed that, after enough

[1] "[the] monetary framework should operate under the 'rule of law' rather than the discretionary authority of administrators."
"It must be granted, however, that the present proposal is less likely to stimulate such a favorable psychological climate than a proposal which has a simpler and more easily understood goal, for example, a proposal which sets a stable price level as its announced goal. If the business world were sufficiently confident of the ability of the government to achieve the goal, it would have a strong incentive to behave in such a way as greatly to simplify the government's task."
[2] Federal Reserve System "should be instructed to keep the rate of growth as steady as it can" (the famous k percent rule).

experience agents learn to anticipate the effects of a preannounced policy change. In this line of experiments Marimon & Sunder (1995) and Bernasconi & Kirchkamp (2000) came up with a Friedman conjecture: Does a (simple) constant money growth rule help stabilize inflation rates compared to a less transparent, or more complex, rule of maintaining a fixed level of real deficit? In Marimon & Sunder (1995) subjects were asked to make one inflation forecast for one period ahead (knowing past realised inflation) and their result did not support the Friedman conjecture. Whereas Bernasconi & Kirchkamp (2000) considered subjects' optimal savings decision with the same theoretical model as Marimon & Sunder (1995) and found the presence of Friedman conjecture.

In the above experimental structure, subjects' wealth are homogeneous or fixed at a particular level. Instead of having same wealth we provide different wealth level according to their ability to both inter-generational and intra-generational agents in this experiment. Here we are studying an overlapping generations (OLG) model where monetary policy is known to everyone. We use money as a unique asset to transfer wealth across the two periods (young stage to old stage) in which they are alive. We compare the effect of two alternative money supply policy rules on inflation rate. We use deficit rule where government can fix the level of real deficit and finance it through seigniorage. In this deficit rule the rate of growth of money supply is endogenous, while the level of (real) seigniorage is predetermined (fixed, and presumably consumed by the government). In contrast to the deficit rule also we use a money growth rule where the government fixes the rate of growth of the money supply and adjusts the level of public expenditures financed through seigniorage so as to satisfy the monetary target. Here the rate of growth of the money supply is predetermined (fixed), while the level of (real) seigniorage is endogenous. We provide different wealth levels according to their ability[3]and agents are asked to provide the next period inflation rate expectation in the OLG framework. Now if we consider the agent is rational then announcement of μ percent money growth rule will lead the μ percent inflation in the economy through agents' learning process, i.e. realized inflation rate is the announced money-growth rate. So the long-run equilibrium can be achieved in the short-run if agents' predictions coincide with the policy announcement.

Section 2 provides a theoretical basis of heterogeneous endowment in OLG model with different monetary policies. Section 3 provides detailed experimental design for the

[3]Detailed structure of the wealth heterogeneity and measurement of ability is provided in the section on experimental design (Section 3.3.1)

heterogeneous endowment in the OLG model. Section 4 provides results and analysis and section 4 provides a conclusion.

2. Theoretical Model of Heterogeneous Endowment in an OLG Model and Monetary policies

Here we study a standard OLG model, in which fiat money is the only financial asset and government revenue is created through seigniorage. Each generation consists of n agents and each agent of each generation lives for two periods and is endowed according to his/her ability. An agent i of generation t, $t = 1,2,\ldots$ has a two period endowment of a unique perishable good $(w_{t,i}^1\ w_{t,i}^2) = (w_i^1, w_i^2)$, $w_{t,i}^1 > w_{t,i}^2 > 0$, and his preference over consumption C are represented by $U_i(C_{t,i}^1\ C_{t,i}^2) = \ln(C_{t,i}^1) + \ln(C_{t,i}^2)$,where the superscript denotes the periods in the agent's life and k denotes the generation . An agent i of the initial generation that exits in period 1 lives for one period only, and is endowed with $w_{0,i} = w_{0,i}^2$ of the consumption good. He has an endowment of fiat money h_0. Given the sequence of consumption goods prices$\{P_t\}_{t=0}^{\infty}$in agent i of generation t, $t \geq 1$, solves the problem,

$$max\ln(C_i^1) + \ln(C_i^2) \tag{1}$$

$$S.t\ \ P_t(C_{t,i}^1 - w_{t,i}^1) + P_{t+1}(C_{t,i}^2 - w_{t,i}^2) \leq 0 \tag{2}$$

If the agent knew today's and tomorrow's prices then he would optimally save;

$$s_{t,i} = 0.5(w_{i,t}^1 - \frac{P_{t+1}}{P_t}w_{i,t}^2) \tag{3}$$

Assuming rational expectations and considering $\pi_{t+1} = \frac{P_t}{P_{t+1}}$and $\pi_{t+1}^e = E_{t-1}\pi_{t+1}$, the optimum saving decision becomes

$$s_{t,i} = 0.5(w_{t,i}^1 - \pi_{t+1}^e w_{t,i}^2) \tag{4}$$

Therefore total savings:

$$S_t = \sum_{i=1}^n 0.5(w_{t,i}^1 - \pi_{t+1}^e w_{t,i}^2) \tag{5}$$

Now the per capita savings is;

$$s_t = \frac{S_t}{n} = \frac{1}{n}\left[\sum_{i=1}^n 0.5(w_{t,i}^1 - \pi_{t+1}^e w_{t,i}^2)\right] \tag{6}$$

$$s_t = 0.5(\overline{w}_{t,i}^1 - \pi_{t+1}^e \overline{w}_{t,i}^2)$$

Where, $\frac{1}{n}\left[\sum_{i=1}^n(w_{t,i}^1)\right] = \overline{w}_{t,i}^1$ and $\frac{1}{n}\left[\sum_{i=1}^n(w_{t,i}^2)\right] = \overline{w}_{t,i}^2$

$$s_{t-1} = 0.5(\overline{w}_{t-1,j}^1 - \pi_t^e \overline{w}_{t-1,j}^2) \tag{6/a}$$

Now $h_t$is per capita money supply in period t. Here we consider two policy regimes;

1. **Real Deficit Regime:** Government finances a constant per capita level of deficit d through seigniorage.
2. **Money Growth Regime:** The monetary authority allows money to grow by a constant factor of μ and adjusts the level of seigniorage to satisfy the monetary target

Now for the first money supply policy regime:

$$h_t = h_{t-1} + P_t d \tag{7}$$

And for the second money supply policy regime:

$$h_t = \mu h_{t-1} \tag{8}$$

By setting$\mu = 1$, when $d \neq 0$ and $\mu \neq 1$ when $d = 0$, the per capita money supply in real terms, $m_t = \frac{h_t}{P_t}$ is given by

$$m_t = \frac{\mu m_{t-1}}{\pi_t} + d \tag{9}$$

The equilibrium price for any period $t$is such that the per capita aggregatesupply s_t equals the per capita aggregate (real) money supplym_ti.e.:

$$s_t = m_t \tag{10}$$

Following Marimon and Sunder (1995) and Bernasconi and Kirchkamp (1999), equation (6), (6/a), (9) and (10) give the equilibrium map

$$\Phi(\pi_{t+1}^e, \pi_t^e, \pi_t) = 0 \tag{11}$$

$$\text{i.e.}\pi_{t+1,i}^e - \left(b_{t,i} - de\right) + \mu \frac{\left(b_{t-1,j} - \pi_{t,j}^e\right)}{c_{i,j}\pi_t} = 0 \tag{12}$$

Where, $b_{t,i} = \frac{\overline{w}_{t,i}^1}{\overline{w}_{t,i}^2}$, $e = \frac{2}{\overline{w}_{t,i}^1}$ and $c_{ij} = \frac{\overline{w}_{t,i}^2}{\overline{w}_{t-1,j}^2}$

Now the actual inflation rate can be expressed as a function of expected inflation rate in the current and following periods

$$\pi_t = \mu \frac{\left(b_{t-1,j} - \pi_{t,j}^e\right)}{c_{i,j}(b_{t,i} - de - \pi_{t+1,i}^e)} \tag{13}$$

Equation (13) describes the equilibrium dynamics of the economy. This is known as *actual law of motion* for π_t given the expectations and the monetary regime. Now assuming rational expectation hypothesis$\pi_t = \pi_{t,j}^e$ and $\pi_{t+1} = \pi_{t+1,i}^e$ coincides with the equilibrium of the economy.

$$\pi_t = \mu \frac{(b_{t-1,j} - \pi_t)}{c_{i,j}(b_{t,i} - de - \pi_{t+1})} \tag{14}$$

Now at equilibrium $\pi_t = \pi_{t+1}$

Therefore it becomes

$$\pi_t^2 - \left(b_{t,i} - de + \frac{\mu}{c_{i,j}}\right)\pi + \frac{\mu b_{t-1,j}}{c_{i,j}} \quad (15)$$

For $\left(b_{t,i} - de + \frac{\mu}{c_{i,j}}\right)^2 > 4\frac{\mu b_{t-1,j}}{c_{i,j}}$ there are two solutions that satisfy the stationarity condition $\Phi(\pi_{t+1}^e, \pi_t^e, \pi_t) = 0$. Where the roots are

$$\frac{\left(b_{t,i} - de + \frac{\mu}{c_{i,j}}\right) \pm \sqrt{\left(b_{t,i} - de + \frac{\mu}{c_{i,j}}\right)^2 - 4\frac{\mu b_{t-1,j}}{c_{i,j}}}}{2} \quad (16)$$

Here we can define two equilibra as π^L (Low Inflation Stationary State or Low ISS) and π^H (High Inflation Stationary State or High ISS). One important point is that irrespective of the regime both π^L and π^H are monetary equilibria.

3. Design of Experiment

Experiments were conducted at Jadavpur University, Kolkata, India. In the first phase of our experiment we generate heterogeneous endowment for subjects, and in the second phase of our experiment we run the main OLG model experiment.

Details of the instructions are in Appendix A.

First Phase:

In our main experimental environment (second phase) we are dealing with agents with heterogeneous endowment. To calculate the endowment for each subject, in this phase we test the subjects' ability to identify and count simple symbols through a questionnaire. According to the score of the game we provide endowments to the subjects. (Sample Questionnaire in Appendix B)

At first subjects are asked to mention their name and department. On doing so, everyone was given a unique code number. In the next phase this unique code number is used as an identification number. Now the participants are asked to complete a questionnaire comprising of 10 tasks within 1 minute and for each correct answer the subject scores 1 point. Hence each of them can get a maximum of 10 points from a questionnaire. This game is played 34 times. So, one at a time the participants completed 34 questionnaires. The points earned from each questionnaire determined the endowment level for each round (generation) for the next phase. We announce, in this phase, that higher the number of correct answers from each questionnaire, higher will be the endowment for each round but we did not explain what will happen in the next phase.

Second Phase:

In our experimental market subjects can buy and sell a commodity (we call it a chip) in a sequence of market periods. There is a fixed number, $N, (N \geq 3n)$ of participants in each session. In our experiment we consider 15 subjects. At the beginning of each market period subjects are assigned their specific role:

Young: n subjects enter the market as a young consumer. In our experiment we consider 5 subjects as young$(n = 5)$.

Old: n subjects act as old consumers and leave the market at the end of the period. In our experiment we consider 5 subjects as old $(n = 5)$.

Reserve: $N - 2n$ $(\geq n)$subjects stay outside for their turn to enter as young consumers. .In our experiment we consider 5 subjects as reserve, $(N - 2n = 5)$. Moreover one may consider more than 5 subjects as reserve and take randomly 5 subjects as young.

After entering as a young consumer at period t subject$i$ received an endowment of $W_{t,i}^1$ units, where superscript 1 represent young therefore $W_{t,i}$ represents the score of$i\ th$ subject at $t\ th$ questionnaire of first phase. As the chips are perishable in nature, young subject cannot move with chip to the next period for their old age. Therefore young only may consume some of these chips instantly (C^1) and sell the remaining chips to old consumers and to the government $(S = W_{t,i}^1 - C^1)$. In return to selling the chips they receive experimental money which a subject can carry to their old age for next period. In the old age consumer consume C^2 amount of chips $(C^2 = W^2 + S(P_t/P_{t+1})$. Where $W^2 = W_{t,i}^1/6$. We use this proportion to make the difference between young age endowment and old age endowment higher. Subjects have to consume all of their endowment in the old age as there is no bequest effect of endowment in the model.

In case where the first period itself is the exit period subjects will receive the exit period endowment (W^2). In addition, to this endowment each of the first exit period subjects received an amount of rupees (h_0) from the experimenter at the beginning of this period. These participants have to use all these money to buy chips during the exit period because the money they hold at the end of an exit period are worthless as there is no bequest effect in the model;

The number of chips consumed in both the young (C^1) and old age (C^2) determine the payoff of the subjects.

After completion of a period, say t, a young consumer becomes an old consumer in the next period i.e. for $t + 1$ period, old consumers become reserve subjects and n subjects are randomly selected from the reserve subjects of $t-1$ period as a young consumer for $t+1$ period. This process continues for34 periods. Therefore a subject re-enters the market as a young with memory and experience of the game as a bequest effect[4] but they do not have access to the accumulated earning from previous periods.

The history of prices and optimum savings (in percentage form) are also displayed on every subject's computer screens.

3.1 Trading Rules

Standard OLG models are silent on the mechanism of trading process between old and young. Lim, Prescott, and Sunder (1994) started with single-unit double auction process but that was error-prone[5]. Marimom and Sunder (1995) and Bernasconi and Kirchkamp (2009) used a very simple process to calculate the supply of chips from young agents.

Depending on the treatments at the beginning of tth period young subject are asked to submit either a price ratio of the following period or to submit their optimal savings decision for the period. In case of Inflation rate expectation treatments following formula determines the individual supply decision.: $s_{i,t} = 0.5(w_{i,t}^1 - \pi_{i,t+1}^e w_{i,t}^2)$, $s_{i,t} \geq 0$.

The individual supplies from young agents are summed to determine the economy's chip supply for the current period.

Depending on the treatments, all subjects other than the young (old and reserve) are also asked to submit either a price ratio for the following period or optimal savings decision at the same time as the young. In this time they are endowed with corresponding period's earnings from phase 1. Subjects are rewarded for prediction in a way such that the more accurate the prediction, greater will be the prize. They are awarded in next period when actual price is generated. In case of saving decision treatments savings decision of the current period determined the price ratio for the next period

$$s_{t,i} = 0.5(w_{t,i}^1 - \pi_{t+1}^e w_{t,i}^2) \tag{4}$$

Therefore $\pi_{i,t+1}^e = \frac{2s_{i,t} - w_{i,t}^1}{w_{i,t}^2}$ (4a)

[4]For more detail see Mrimon and Sunder (1993), Lemma 1.

[5]Lim, Prescott, and Sunder (1994) started out using single-unit double auction with the provision that the last transaction of an old subject in any period could be for a fractional unit to enable him or her to use up all the cash for consumption. This mechanism was awkward, slow, and error-prone, with many old subjects carrying money to their "graves". Cash balances left in the hands of the old caused unintended variations in the supply of money in the experimental economy. This is explained in Marimon& Sunder (1995)

And $\quad (\pi_{t+1}^{e} = \frac{\tilde{P}_{t+1}}{\tilde{P}_t})$. (4b)

In period t, only the young agents' savings were added to determine the "chip" supply. The aggregate money was generated by the sum of the real cash balance in the hands of the old, plus the expenditure policy of the government. Under the fixed deficit regime, experimenter (acting as government) buys $D = nd$(where d is per capita deficit) chips every period at market clearing price to increase the amount of money circulation. Government's demand is added to the demand of the old to arrive at the market demand function. Under the money growth regime market demand is adjusted for growth in the amount of money in circulation at a constant factor μ in each period.

The market clearing price is determined by the point of intersection between these supply and demand functions. Actual price is public information. But the amount of money earned by the young agent is strictly private information. The history of prices is also displayed on their computer screens.

3.2Terminal Condition

Standard OLG model is an infinite horizon model, termination condition may affect the equilibrium. Therefore it is very difficult to run OLG model in an experimental setup[6]. Marimon & Sunder (1993) showed that with no announcement in advance, if at the end of some period of the experimental session participants are informed that was the last period of the session, then this does not hamper the Nash Equilibrium condition. Here we also use this terminal condition.

3.3 Payoff

First phase:

For participation in the first phase of the experiment we have paid a flat payment of Rs.50. Participations were informed that irrespective of their score they will be paid Rs.50 for their participation. We also informed them that lower the score lower is the opportunity to earn higher payment in second phase.

[6] Aliprantis and Plott (1993) implement a finite period OLG model.

Second Phase:

The combination of entry-exit period consumption determines the amount of money they earn which implies the subjects are paid for their choice of $C_1\ and\ C_2$ according to the following payment rule;

$$\max\{0, e(logC_1 + \ logC_2)\} \tag{17}$$

Where e is a constant term.This payoff mechanism indicates that multiplicative product (product of entry level and exit level) of chips consumption and amount of their money earning are proportional i.e. the higher is the multiplicative product of chips consumption, higher is the amount of their money earning.

The participants for whom the first period is the exit period the amount of money earned is:

$$e(logC_2) \tag{18}$$

Since the young have incentive to earn more in the next period, therefore we need not provide further incentive for taking a savings decision. But, to induce the old and the reserve to take optimal savings decisions we have to provide an incentive. Therefore, the old and reserve players can also earn by providing their optimum savings decisions for each period. When subjects take decisions on their optimal savings (saving decision treatments) they are also indirectly making the inflation expectations decision through equation (4a). We pay subjects according to the optimal inflation expectation decision generated by their saving decision. Therefore the following formula is used for payment

$$\max\{0, e\left(1 - \left|\left[\frac{(P_{t+1}/P_t)-(\tilde{P}_{t+1}/\tilde{P}_t)}{(P_{t+1}/P_t)}\right]\right|\right)\} \tag{19}$$

Where e is a constant term and $(\tilde{P}_{t+1}/\tilde{P}_t)$ is the prediction of price ratios.

3.4 Treatments

To maintain proper experimental control in the lab we take one group per experimental session. Our two main objectives are (i) to test for the existence of the Friedman conjecture (1948, 1960) in heterogeneous wealth framework both in saving decision and Inflation rate expectation decision and (ii) to test the nature of equilibria in OLG framework. To test for the Friedman conjecture we asked subjects' either to take a decision on inflation rate expectation (IE) or to take decision on saving (S) and used two types of money supply policy namely Real Deficit rule (RD) and Money Growth rule (MG). We also change the per capita deficit (d)value and money growth parameter(μ) as a treatment variable.Details of the treatments are in following Table 1.

Table 1 about here

4. Results and Discussion

Twelve experimental sessions were run for 24 independent groups of 15 subjects each for over 31-34 rounds. We have generated 23176 data points[7] from 360 subjects. Though we had run the experimental session for 31 to 34 rounds but for our analysis we have considered only the first 30 periods.

4.1 Basic Results

The main focuses of this paper are to test the nature of the equilibrium and the existence of the Friedman conjecture. Before that we first see the basic statistics of the two decisions. One important point is that irrespective of the monetary policy rule as money supply increases inflation rate also increases. Another important point is that mean actual inflation rate and expected inflation rate is (almost) equal to the money growth parameter in case of money growth rule treatments. In case of inflation expectation decision treatments we directly get the inflation rate expectation data but in case of saving decision we calculate subjects' inflation expectation from their saving decision data using equation (4a).

Detail results are in the following Table 2.

Table 2 about here

Now we turn to savings behavior. In case of inflation expectation decision treatments we calculate subjects' saving decision using equation (4) but in case of saving decision treatments we directly get the optimal savings rate decision. Detail results are in the following Table 3.

Table 3 about here

4.2 Nature of Equilibrium

In our experiment we are using both inter and intra generational endowment heterogeneity which is a novelty over existing literature. Now if we closely go through the equilibrium of the model given by

---

[7]Data points on actual inflation: 736; Data points on expected inflation: 11040; and Savings Decision: 11400

$$\pi_t = \frac{\left(b_{t,i} - de + \frac{\mu}{c_{i,j}}\right) \pm \sqrt{\left(b_{t,i} - de + \frac{\mu}{c_{i,j}}\right)^2 - 4\frac{\mu b_{t-1,j}}{c_{i,j}}}}{2}$$

We find the following two important properties:

a. Due to this heterogeneity in endowment model's equilibrium varies over time.

b. Irrespective of the regime (Real deficit rule regime or money growth rule regime) both the equilibrium (High ISS and Low ISS) are monetary in nature.

Now we move to our experimental results. Figure 1, Figure 2, Figure 3 and Figure 4 show the time series of both the equilibrium values of inflation rates and realized inflation rate for both the regimes (for both decision).

Figure 1, Figure 2, Figure 3 and Figure 4 about here

It is well established (Marimon and Sunder (1993, 1994, 1995) and Bernasconi and Kirchkamp (2009)) that in this setup subjects converge closely to the low ISS. Our experiment shows that realized inflation is converging to low ISS in case of money growth rule regime for all the treatments. But in case of real deficit rule regime we find only treatment 1 and treatment 7 (low deficit, d=0.20; Fig 1: S_1, S_2 and Fig 3: S_13 and S_14) is converging to the low ISS. In case of high deficit treatment (Fig 1: S_3, S_4, S_5 , S_6 and Fig 3: S_15, S_16, S_17, S_18) in this regime realized inflation is not only lower than the low ISS but also the divergence increases as deficit increases. Therefore our experimental result shows that as the deficit increases low ISS moves towards high ISS.

To confirm this fact we consider the absolute difference between actual inflation and low ISS ($diff$) and regress it on deficit parameter (d) in case of real deficit regime and on growth parameter (μ) incase of money growth regime along with a constant. Detail regression results are shown in the following Table 4

Table 4 about here

In the regression we see that coefficient of policy parameter comes out positively significant, which indicates that higher the value of the policy variable higher will be the divergence. Therefore from the policy perspective we can say that neither higher amount of government expenditure nor the higher amount of money supply by monetary authority will anchor towards equilibrium.

4.3 Inflation rate Volatility and the Friedman Conjecture

Friedman conjecture (1948, 1960) is one of the research questions of our experimental analysis in the two monetary regimes. Here we want to check whether a constant growth of the money supply stabilizes inflation better than a constant real deficit rule. To study this conjecture, we look at three different measures for volatility. Among them two are objective type: an absolute one ($V_{oa} = ln|\pi_t - \pi_{t-1}|$) and a relative one ($V_{or} = lnln^2(\pi_t/\pi_{t-1})$); and one is subjective, ($V_s = \ln(\sigma(\pi^e)/\bar{\pi}^e)$), where $\sigma(\pi^e)$is the standard deviation of a subject's inflation rate expectation and $\bar{\pi}^e$ is the mean expectation of the subject. In all cases we take logs to reduce skewness. The cumulative distributions are shown for the two regimes in the following Figure 5.

Figure 5 about here

In case of subjective variance measurements of these forecasts are centered very closely around a single level, the individual might be in a relatively stable situation. If, however, forecasts are scattered over a large interval, an individual is apparently less certain about the situation of the economy, which we interpret as the perception of a more volatile situation.

In case of inflation expectation decision all the three types of volatility measure show that money growth regime is much steeper than real deficit regime. This indicates that, the individuals are apparently less certain about the condition of the economy in case of real deficit regime. Thus we can infer that under real deficit regime, the perception of individuals appears to be more volatile. Where as in case of saving decision, The first and the third types of volatility measure show that real deficit regime is much steeper than money growth regime. This indicates that, the individuals are apparently less certain about the condition of the economy in case of money growth policy regime. Thus we can infer that under money growth regime, the perception of individuals appears to be more volatile. And second volatility measure we find that partly real deficit regime is steeper and partly money growth regime is steeper. Therefore we cannot come to any certain conclusion on the basis of this measurement.

To see the effect of policy regimes in our experimental economies we ran regressions, with volatility measure as a dependent variable and policy regime as an independent variable. Table 5 summaries the regression results.

Table 5 about here

In case of inflation rate expectation decision treatments we found that, regardless of what indicator we consider, the constant real deficit rule always leads to more inflation volatility than the constant money growth rule. Thus, in contrast to Marimon and Sunder (1995), our evidence apparently gives some support to the Friedman's conjecture. Where as in case of saving decision treatments, we found that, except for the second measure of volatility, the money growth rule always leads to more inflation rate volatility than the real deficit rule. This result indicates that existence of Friedman Conjecture (1960) is not verified. Thus, in contrast to Bernasconi and Kirchkamp (2009), our evidence apparently gives some support to Marimon & Sunder (1995).

5. Conclusion

In our experimental economy we incorporate the wealth heterogeneity in both inter and intra generation according to their ability, which is a novelty of this experiment over existing literature. In our model economy we consider two types of policy regime; namely real deficit regime and money growth regime. In our model there are two types of monetary equilibrium arising for both the regimes. Within these two regimes we also consider the variation of the regimes by incorporating different values of policy parameters. And as these equilibrium is dependent on the wealth, therefore the equilibrium varies over time. Along with these monetary policies we consider two types of decisions. In our experimental OLG economy young subjects are asked either to predict the inflation rate for the next period or to decide his/her savings for the current period. From their predictions on inflation we calculate how much of his wealth he want to save for his old time and from their decision on savings, we calculate his/ her predicted inflation rate for the next period. The interaction between old and young determine the current price of the chip.

Main focuses of this experiment are to explain the nature of equilibrium and investigate the Friedman conjecture.

We find that for both the decisions neither higher amount of government expenditure nor the higher amount of money supply by monetary authority will move inflation rate towards equilibrium.

In inflation expectation decision treatments we found that a constant growth of the money supply stabilizes inflation better than a constant real deficit rule. Therefore our experimental result support the Friedman conjecture. Where as in saving decision treatments we found that constant real deficit rule stabilizes inflation rate better than constant growth of the money supply. Therefore our experimental results do not support the Friedman Conjecture. More specifically when people are taking decision on savings, they are more uncertain about the future than when predicting inflation rate for next period and we find that in savings decision, Friedman Conjecture is not validated. Thus we may conclude that if there is much uncertainty, Friedman Conjecture will not work.

Reference

Bernasconi, M. and O. Kirchkamp (2000): Why do monetary policies matter? An experimental study of saving and inflation in an overlapping generations model, Journal of Monetary Economics, 46(2), 315–343

Friedman, M. (1948): A Monetary and Fiscal Framework for Economic Stability, The American Economic Review, 38(3), 245–264.

Friedman, M. (1960): A Program for Monetary Stability. Fordham University Press, New York.

Marimon, R., and S. Sunder (1993): Indeterminacy of Equilibria in a Hyperinflationary World: Experimental Evidence. Econometrica 61, 1073-1107.

Marimon, R., and S. Sunder (1994): Expectations and Learning under Alternative Monetary Regimes: An Experimental Approach. Economic Theory 4, 131-62.

Marimon, R., and S. Sunder (1995): Does a Constant Money Growth Rule Help Stabilize Inflation?. Carnegie-Rochester Conference Series on Public Policy 43, 111-156.

Table 1: Treatments

No	Session	Policy	Periods	Subjects (N, n)	Decision	Deficit per Capita (d)	Money Growth Parameter(μ)
1	1-2	RD	30,33	(15,5)	IE	0.20	1
2	3 - 4	RD	32,34	(15,5)	IE	1	1
3	5 - 6	RD	33,30	(15,5)	IE	1.5	1
4	7- 8	MG	32,30	(15,5)	IE	0	1.1
5	9-10	MG	33,31	(15,5)	IE	0	1.5
6	11-12	MG	30,32	(15,5)	IE	0	2
7	13-14	RD	30,33	(15,5)	S	0.20	1
8	15-16	RD	32,34	(15,5)	S	1	1
9	17-18	RD	33,30	(15,5)	S	1.5	1
10	19- 20	MG	32,30	(15,5)	S	0	1.1
11	21-22	MG	33,31	(15,5)	S	0	1.5
12	23-24	MG	30,32	(15,5)	S	0	2

Table 2: Basic Results on Inflation Rate Expectation

	T1 $d = 0.20$		T2 $d = 1.00$		T3 $d = 1.50$		T4 $\mu = 1.10$		T5 $\mu = 1.50$		T6 $\mu = 2.0$		T7 $d = 0.20$		T8 $d = 1.00$		T9 $d = 1.50$		T10 $\mu = 1.10$		T11 $\mu = 1.50$		T12 $\mu = 2.0$	
	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_9	S_10	S_11	S_12	S_13	S_14	S_15	S_16	S_17	S_18	S_19	S_20	S_21	S_22	S_23	S_24
	Inflation Rate Expectation Decision												Saving Decision											
Only for Experimental Economy																								
Mean Actual Inflation Rate	1.01	1.03	1.09	1.08	1.09	1.13	1.09	1.10	1.50	1.50	2.00	1.99	1.14	1.10	1.07	1.09	1.09	1.09	1.10	1.10	1.50	1.50	2.00	2.01
SD of Actual Inflation Rate	0.17	0.18	0.19	0.09	0.05	0.11	0.05	0.10	0.08	0.07	0.19	0.07	0.27	0.23	0.10	0.13	0.06	0.05	0.11	0.12	0.13	0.10	0.21	0.19
Mean Inflation Rate Expectation	1.01	1.04	1.09	1.07	1.09	1.09	1.11	1.10	1.49	1.48	2.00	1.99	1.13	1.07	1.07	1.09	1.08	1.10	1.08	1.12	1.49	1.49	1.99	1.99
SD of Inflation Rate Expectation	0.20	0.20	0.21	0.13	0.07	0.09	0.13	0.15	0.15	0.14	0.26	0.19	0.28	0.25	0.11	0.14	0.08	0.06	0.14	0.13	0.15	0.10	0.21	0.20
For All Subjects in a Session																								
Mean Inflation Rate Expectation	1.02	1.05	1.10	1.07	1.11	1.10	1.11	1.11	1.49	1.50	2.00	1.14	1.14	1.08	1.09	1.07	1.09	1.10	1.11	1.52	1.48	1.96	1.96	1.14
SD of Inflation Rate Expectation	0.21	0.23	0.22	0.16	0.11	0.13	0.17	0.19	0.18	0.17	0.28	0.25	0.21	0.13	0.14	0.12	0.11	0.27	0.28	0.39	0.39	0.50	0.49	0.25

Table 3: Basic Results on Saving Behavior

	T1 $d = 0.20$		T2 $d = 1.00$		T3 $d = 1.50$		T4 $\mu = 1.10$		T5 $\mu = 1.50$		T6 $\mu = 2.0$		T7 $d = 0.20$		T8 $d = 1.00$		T9 $d = 1.50$		T10 $\mu = 1.10$		T11 $\mu = 1.50$		T12 $\mu = 2.0$	
	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_9	S_10	S_11	S_12	S_13	S_14	S_15	S_16	S_17	S_18	S_19	S_20	S_21	S_22	S_23	S_24
	Inflation Rate Expectation Decision												Saving Decision											
Only for Experimental Economy																								
Mean Saving	33.35	32.74	31.88	32.10	31.83	31.85	31.55	31.72	25.20	25.27	16.68	16.86	31.14	32.19	32.20	31.89	32.07	31.67	31.98	31.37	25.15	25.21	16.84	16.83
SD of Saving	3.26	3.36	3.41	2.10	1.27	1.51	2.19	2.58	2.44	2.30	4.32	3.09	6.57	4.83	2.32	2.70	1.62	1.46	2.84	2.45	3.01	2.59	3.65	4.01
For All Subjects in a Session																								
Mean Saving	38.74	38.34	37.81	38.07	37.76	37.80	37.66	35.81	33.42	33.39	27.80	27.70	37.36	37.50	38.04	37.92	38.14	37.82	37.62	37.63	33.19	33.55	28.13	28.16
SD of Saving	4.49	4.70	4.89	4.54	4.36	4.41	4.67	9.84	6.15	6.04	8.49	8.03	5.87	4.78	4.43	4.63	4.48	4.52	5.09	5.15	6.73	6.87	9.20	9.24

Table 4: Role of policy parameter on difference between actual inflation and low ISS

	Inflation Expectation Decision		Saving Decision	
	$diff = \beta d + c$	$diff = \beta d + c$	$diff = \beta \mu + c$	$diff = \beta \mu + c$
β	0.5258*** (0.0275)	0.4833*** (0.0301)	0.4354*** (0.0404)	0.3045*** (0.0382)
C	-0.0027*** (0.0288)	0.0488 (0.0315)	-0.4582*** (0.0637)	-0.32032*** (0.0604)
Adj. R^2	0.6787	0.5972	0.3999	0.2646

c is a constant included in the regression. Standard errors are in parentheses. ***/**/* denotes significance at 1/5/10 percent level.

Table 5: Inflation volatility and the Friedman Conjecture

	Inflation Expectation Decision			Saving Decision		
	$V_{oa} = \beta deficit + C$	$V_{or} = \beta deficit + C$	$V_s = \beta deficit + C$	$V_{oa} = \beta deficit + C$	$V_{or} = \beta deficit + C$	$V_s = \beta deficit + C$
$\boldsymbol{\beta}$	0 .2625* (0.1448)	1.2041*** (0.2867)	0.1739*** (0.0394)	-0.2839* (0.1504)	0.0546 (0.2961)	0.6120*** (0.0364)
$\boldsymbol{C}$	-3.0169*** (0.1024)	-6.8268*** (0.2028)	-2.0274*** (0.0278)	-2.3733*** (0.1062)	-5.5416*** (.2094)	-1.3983*** (0.0257)
Adj. $\boldsymbol{R^2}$	0.0068	0.0473	0.0938	0.0106	-0.0029	0.6112

$deficit$ is a dummy variable that is 1 for the real deficit rule and 0 for money growth rule, C is a constant included in the regression. Standard errors are in parentheses. ***/**/* denotes significance at 1/5/10 percent level.

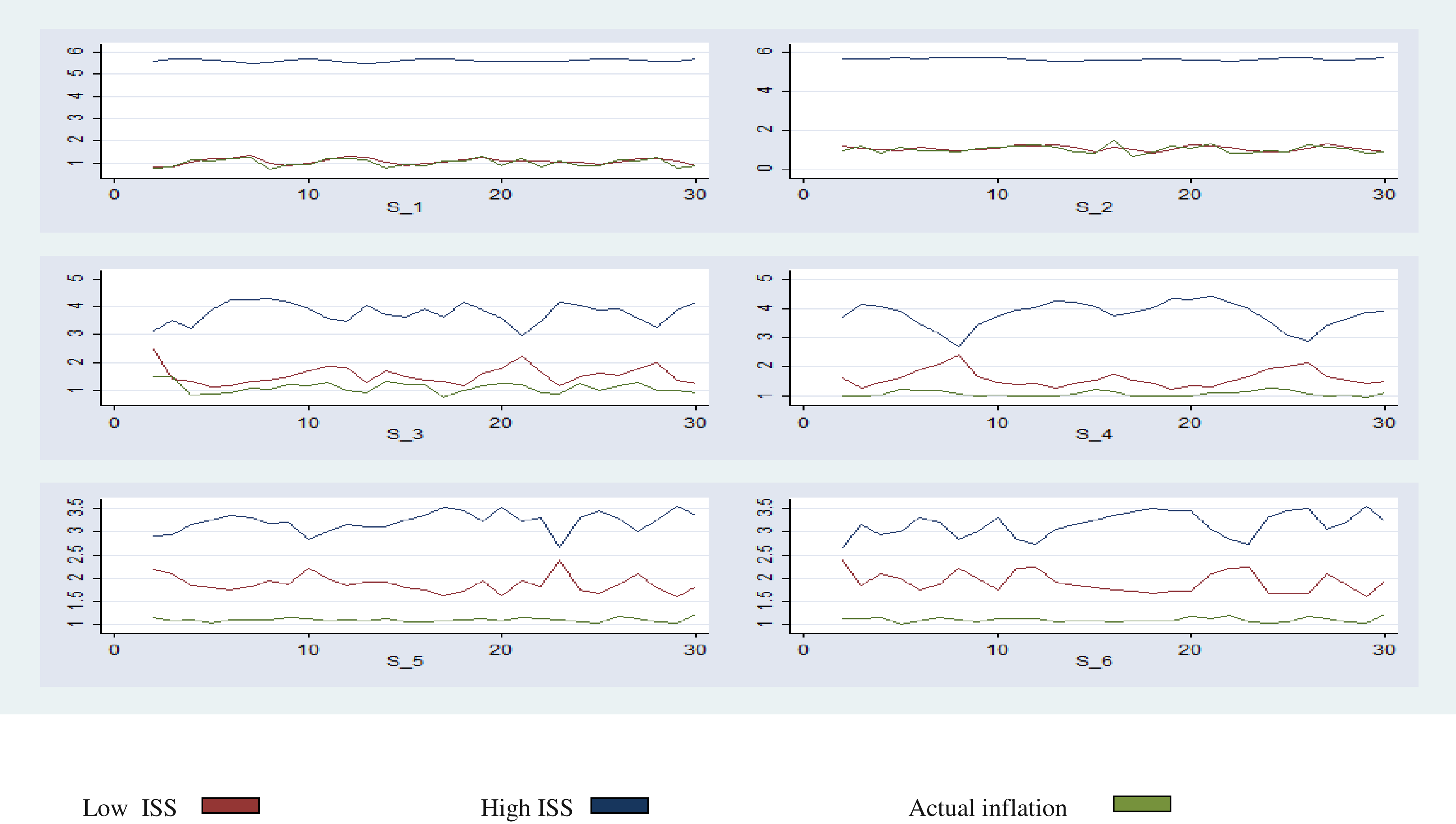


Fig 1: Time series of equilibrium values and actual inflation rate in a real defecit regime. (inflation expectation decision)

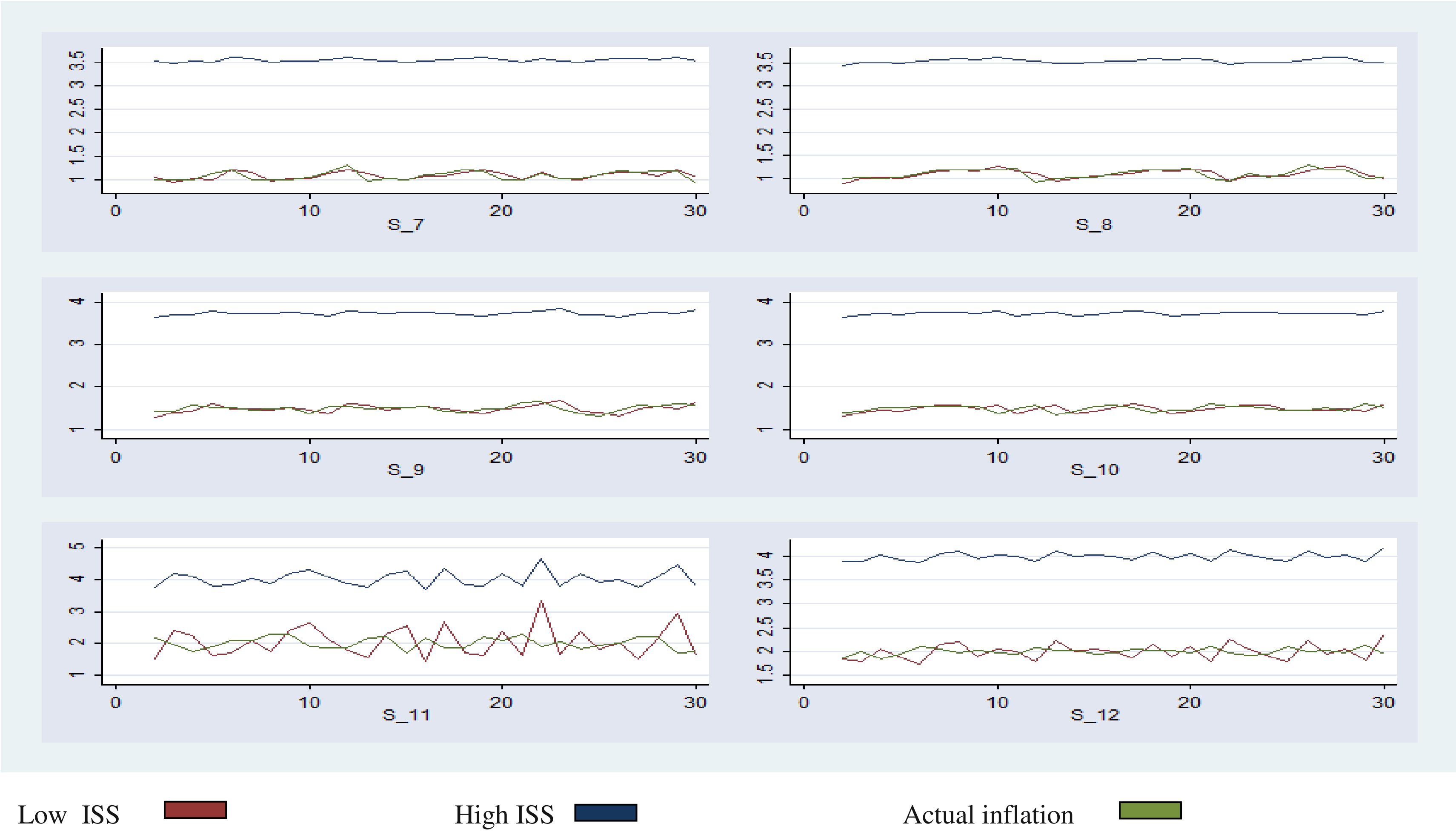
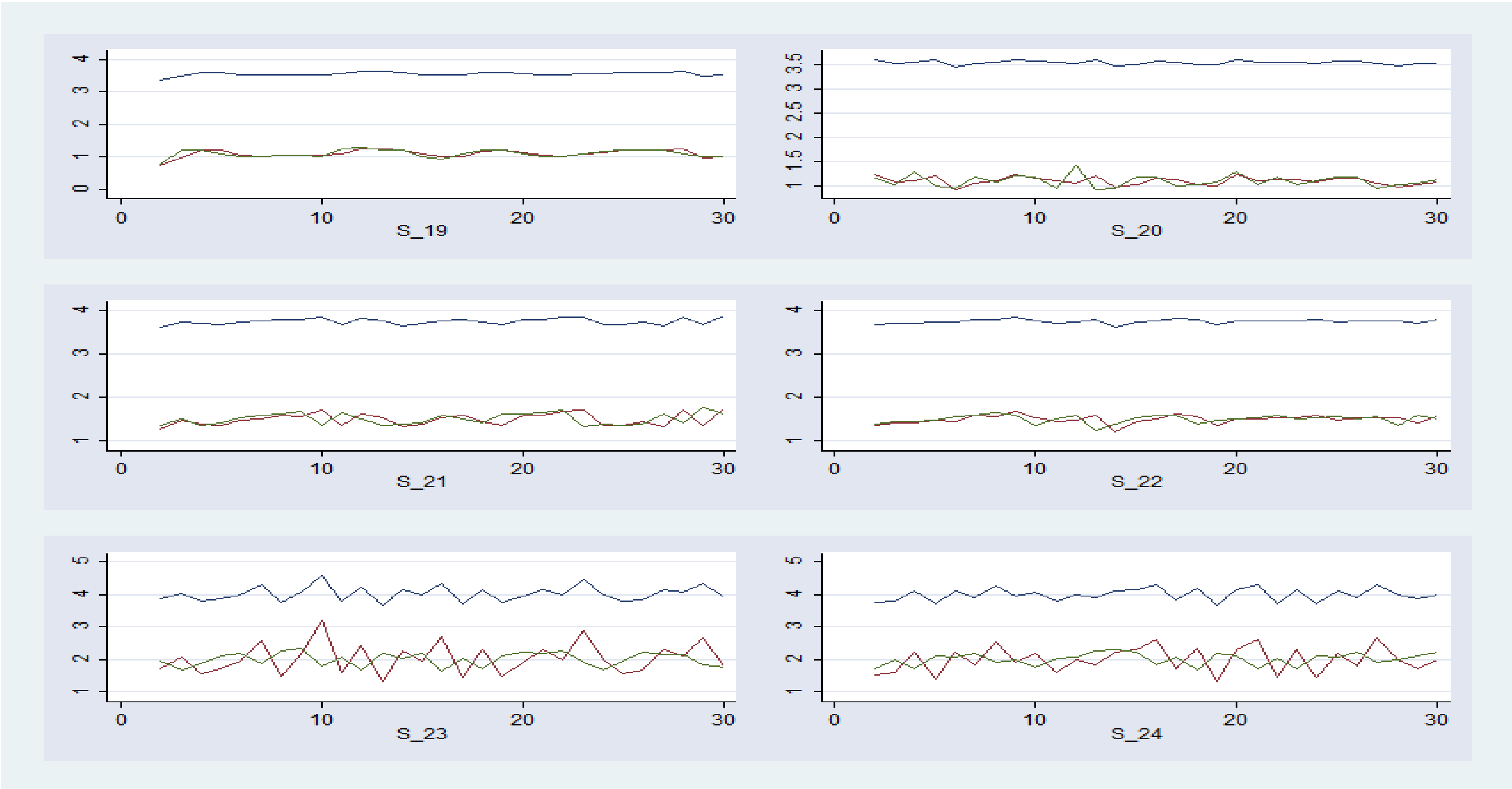


Fig 2: Time series of equilibrium values and actual inflation rate in a money growth regime. (inflation expectation decision)

LowISS High ISS Actual inflation rate

Fig 3: Time series of equilibrium values and actual inflation rate in a real defect regime. (Saving decision)



LowISS High ISS Actual inflation rate

Fig 4: Time series of equilibrium values and actual inflation rate in a money growth regime. (Saving decision)

Appendix A

Instruction for Participants

(This instruction is used for inflation expectation decision experiment)

Overview of the Experiment

Thank you for agreeing to participate in this experiment being conducted by the Centre for Experiments in Social and Behavioral Sciences, Department of Economics, Jadavpur University. This is an experiment in decision making. The instructions are simple, please follow them carefully.The money you earn depends on the decisions you and others make. You will make decisions with the help of the computer. This money will be paid to you in cash at the end of the experiment.

Now imagine you are a citizen of an imaginary economy. The imaginary economy will be created by a computer programme. This experiment is divided into many periods. Your role may change from period to period. You will have the opportunity to buy and sell chips. Your main task is to predict the next period price ratio on the basis of previous price. The currency used in this market is rupee. The only use of this currency is to buy and sell chips. It has no other use. The procedures for determining the amount of rupee you take home with you is explained later in these instructions.

You will participate in a market for two consecutive periods at a time. Let us call the first of these periods your entry period (because you begin your participation in the market), and the-second your exit period (because you end your participation in the market). Different individuals may have different entry and exit periods. You may enter and exit more than once depending on the number of periods for which the market is operated.

Trading and Recording Rules

1. All entry-period players are sellers and all exit-period players (and possibly the experimenter) are buyers. At the beginning of the entry or exit period you will receive an amount of chips (endowment; depending on the points gained in the first part). This endowment will be always greater in your entry period, when you are young than your exit period (one sixth of the young age) as old. You cannot carry the chips from one period to the next. You can sell your savings at young age and earn money. This money will be carried forward in the old age. On the other hand you have to exhaust all of your earnings by consuming chips in the exit period.

2. Every exit period player (old) pays his entire money to entry-period players (Young) in exchange for chips at a market price determined in the manner explained below.
3. At the beginning of each period the young must state the prediction of price ratio for the following period ($\frac{\tilde{P}_{t+1}}{\tilde{P}_t} = 1 + \text{inflation rate}$). Predictions will be used to determine the number of chips they wish to sell according to the following formula.

   $$s_{t,i} = 0.5(w_i^1 - (\tilde{P}_{t+1}/\tilde{P}_t)w_i^2) \quad (1)$$

   Notice that higher the price ratio when you enter, the fewer the number of chips you will sell. Where w_i^1 is endowment for young age and w_i^2 is endowment for old age.
4. After considering the rupee available from the exit player (old), offers made by entry players(young)and experimenter's policy (government)about financing the debt with rupee and/or incrementing the quantity of, rupee in circulation, the market clearing price is computed and announced. Exit players (old) and the experimenter pay this price for each chip they buy. Each entry player (young) will be informed of the number of chips he/she has been able to sell at the market price and each exit-period player (old)will be told of the number of chip that he/she has been able to buy with his/her money on hand.
5. Old and reserve players can also earn. For that you have to submit the price ratio of the following period at the same time as the young. In this time you are endowed with corresponding period's earnings from phase1. Each exit (old) and reserve players receives a reward one period later, depending on how close his/her, prediction of price ratio is to the actually observed price ratio. At the end of that period, the experimenter announces the most accurate, predicted price ratio and the market price ratio.
6. After transaction information is received, through the computer each entry player (young) can compute the chips remaining on hand (consume). The rupee received from sale will be used to buy chips in the exit period which follows immediately.
7. Each exit player (old) records the number of chips purchased on their record sheet. Then the experimenter computes the rupee earned by using formula (2) or (2') given below.
8. The experimenter may terminate the market at any time. Without any announcement in advance, the participants will be informed which is the last period of the experiment; rupee held by all entry-period players (young) are converted into chips using the market-clearing price of the following period.

9. At the end of the experiment, add up the earnings and prediction rewards columns of your Information and Record Sheet. The experimenter will pay you the sum of these (your cumulative earnings) in rupees.

Payoffs

The amount of rupee you will earn to take home with you for any pair of entry-exit periods will be:

$$\max\{0, e(log\, C_1 + log C_2)\} \quad (2)$$

Where e, the conversion rate, is set to 10.

This means that the greater the product of chips you consume at the end of your entry and exit periods, the greater amount of money you earn to take home with you.

For some of you, however, this first period itself will be an exit period and you will receive the exit period endowment (w_2). In addition, each of you for whom the first period is an exit period will receive an amount of Rs.5 from the experimenter at the beginning of this period. These participants have to use these entire rupees to buy chips during the exit period because the rupees you hold at the end of an exit period are worthless;

The payoff of such first exit period individuals at the end of Period 1 will be:

$$e(log c_2) \quad (2')$$

All the money you earn by predicting $\tilde{P}_{t+1}/\tilde{P}_t$ will be added after all the rounds and will be paid to you at the end of the session.

Earning for Old and Reserve Players

The following formula is used for payment for trading rule

$$\max\{0, e\left(1 - \left|\left[\frac{(P_{t+1}/P_t) - (\tilde{P}_{t+1}/\tilde{P}_t)}{(P_{t+1}/P_t)}\right]\right|\right)\}$$

Where e, the conversion rate, is set to 10. and $(\tilde{P}_{t+1}/\tilde{P}_t)$ is the prediction of price ratios.

Other Instructions

During the experiment sessions, it is strictly forbidden to speak with other students who participate in the experiment. Doing so can lead to the exclusion from the experiment. In this case, no payment will be made. If you have any questions or problems during the course of the experiment, raise your hand and the experimenter will come to you. Please do not ask aloud.

If you have any questions please ask now!

Instruction for Participants

(This instruction is used for saving decision experiment)

Overview of the Experiment

Thank you for agreeing to participate in this experiment being conducted by the Centre for Experiments in Social and Behavioral Sciences, Department of Economics, Jadavpur University. This is an experiment in decision making. The instructions are simple, please follow them carefully. The money you earn depends on the decisions you and others make. You will make decisions with the help of the computer. This money will be paid to you in cash at the end of the experiment.

Now imagine you are a citizen of an imaginary economy. The imaginary economy will be created by a computer programme. This experiment is divided into many periods. Your role may change from period to period. You will have the opportunity to buy and sell chips. Your main task is to determine your own optimum saving on the basis of previous price. The currency used in this market is rupee. The only use of this currency is to buy and sell chips. It has no other use. The procedures for determining the amount of rupee you take home with you is explained later in these instructions.

You will participate in a market for two consecutive periods at a time. Let us call the first of these periods your entry period (because you begin your participation in themarket), and the second your exit period (because you end your participation in the market). Different individuals may have different entry and exit periods. We shall tell you when you enter and exit the market. You may enter and exit more than once depending on the number of periods for which the market is operated.

Trading and Recording Rules

1. All entry-period players are sellers and all exit-period players (and possibly the experimenter) are buyers. At the beginning of the entry or exit period you will receive an amount of chips (endowment; depending on the points gained in the first part). This endowment will be always greater in your entry period, when you are young than your exit period (one sixth of the young age) as old. You cannot carry the chips from one period to the next. You can sell your saving at young age and earn money. This money

will be carried forward in the old age. On the other hand you have to exhaust all of your earning by consuming chips in the exist period.

2. Every exit-period player (old) pays all his money to entry-period players (young) in exchange for chips at a market price determined in the manner explained below.
3. At the beginning of each period the young must state there saving decision for the current period. This saving decision will be used to calculate the prediction of price ratio ($\frac{\tilde{P}_{t+1}}{\tilde{P}_t} = 1 + \text{inflation rate}$) for the following period. The following formula is used to determine the inflation rate:

   $$s_{t,i} = 0.5(w_i^1 - (\tilde{P}_{t+1}/\tilde{P}_t)w_i^2) \quad (1)$$

   Notice that lowers the chips you sell higher will be the price ratio. Where w_i^1 is endowment for young age and w_i^2 is endowment for old age.
4. After considering the rupee available from the exit players (old), offers made by entry players (young) and experimenter's policy (government) about financing the debt with rupee and/or incrementing the quantity of rupee in circulation, the market-clearing price is computed and announced. Exit players (old) and the experimenter pay this price for each chip they buy. Each entry player (young) will be informed of the number of chips he/she has been able to sell at the market price, and each exit-period player (old) will be told of the number of chips that he/she has been able to buy with his/her money on hand.
5. Old and reserve player can also earn. For that you have to submit their saving decision for current period at the same time as the young. In this time you are endowed with corresponding period's earnings from phase 1. Each exit (old) and reserve players receive a reward one period later, depending on how close his/her prediction of price ratio is to the actually observed price ratio. This price ratio will be calculated through their saving decision (equation a). At the end of that period, the experimenter announces the most accurate, predicted price ratio and the market price ratio.
6. After transaction information is received, through the computer, each entry player (young) can compute the chips remaining on hand (consume). The rupee received from sale will be used to buy chips in the exit period which follows immediately.
7. Each exit player (old) records the number of chips purchased on their record sheet. Then the experimenter computes the rupee earned by using formula (2) or (2') given below.

8. The experimenter may terminate the market at any time. Without any announcement in advance, the participants will be informed which is the last period of the experiment; rupee held by all entry-period players (young) are converted into chips using the market-clearing price of the following period.
9. At the end of the experiment, add up the earnings and prediction rewards columns of your Information and Record Sheet. The experimenter will pay you the sum of these (your cumulative earnings) in rupees.

Payoff

The number of "rupee" you will earn to take home with you for any pair of entry-exit periods will be:

$$mcx\{0, e(logc_1 + logc_2)\} \quad (2)$$

Where e, the conversion rate, is set to 10.

This means that the greater the product of chips you consume at the endof your entry and exit periods, the greater amount of money you earn to take home with you.

For some of you, however, this first period itself will be an exit period and you will receive the exit period endowment (w_2). In addition, each of you for whom the first period is an exit period will receive an amount of Rs.5 from the experimenter at the beginning of this period. These participants have to use these entire rupees to buy chips during the exit period because the rupees you hold at the end of an exit period are worthless;

The payoff of such first exit period individuals at the end of Period 1 will be:

$$e(logc_2) \quad (2')$$

All the money you earn by taking decision on saving will be added after all the round and will be paid to you at the end of the session.

Earning for Old and Reserve Players

The following formula is used for payment for trading rule

$$\max\{0, e\left(1 - \left|\left[\frac{(P_{t+1}/P_t) - (\tilde{P}_{t+1}/\tilde{P}_t)}{(P_{t+1}/P_t)}\right]\right|\right)\}$$

Where e, the conversion rate, is set to 10. and $(\tilde{P}_{t+1}/\tilde{P}_t)$ is the prediction of price ratios.

Other Instructions

During the experiment sessions, it is strictly forbidden to speak with other students who participate in the experiment. Doing so can lead to the exclusion from the experiment. In this case, no payment will be made. If you have any questions or problems during the course of the experiment, raise your hand and the experimenter will come to you. Please do not ask aloud.

If you have any questions please ask now!

Appendix B

Sample Question

Name :...   Code:....................................

Page _1

1	0oo00o00o0o0o00o0o0o00o0o000000o0ooo00 o0o0o0	How many 0 s are there:
2	!!!!IIIII!!II!!!III!!!!IIII!!!!III!!!!!!III!!!II!!!!!IIII!!!III!!I	How many I s are there:
3	$@@@$$@@$$@$@$@$@@@@$@$@$$@$$$$@	How many @ are there:
4	£€€€££€€€€€€££€€€€£££€€€£€£€£€€€€€££€€€£€££€€€£€£€€	How many € s are there:
5	Ɨ++++ƗƗ++ƗƗƗ++ƗƗƗ+++++ƗƗƗ++ƗƗƗƗ++ƗƗƗ+ƗƗ++++ƗƗƗ++ƗƗƗ++	How many + s are there:
6	φϕϕφϕϕφφφφϕϕφφϕϕϕφφφϕϕφϕφϕφϕϕφφφϕϕϕφφφ ϕφϕϕ	How many φ s are there:
7	ϵϵэээєээєєєээєэєэєєээєєєэээээєєэээєєэээєєэ эєэєэ	How many э s are there:
8	ЦШЦЦШШЦЦШЦШЦШЦШШЦЦШШШЦЦШЦЦ	How many Ц s are there:
9	ꙖѨꙖꙖѨѨꙖѨꙖѨꙖѨѨѨꙖꙖѨѨꙖꙖꙖ	How many Ꙗ s are there:
10	ӇӇӇӉӇӉӇӉӉӇӉӉӇӉӉӇӇӇӉӇӉӇӉӉӇӇӉӇӉӉӇӇ	How many Ӈ s are there: