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Abstract

This paper studies the dynamics of inflation if monetary policy is transparent only to part of the population. We find that average long-run inflation decreases in the proportion of agents with naive expectations and, because of tradeoffs between speed of adjustment and long-run inflation, central banks prefer a higher proportion of agents who form informed expectations in high inflation periods but not so in lower inflation periods. We use survey data on expectations of inflation from Bulgaria collected at the time a currency board was introduced in that country to test for influences on the heterogeneity of expectations across agents.

JEL Classification: E58 - Central Banks and Their Policies
E65 - Studies of Particular Policy Episodes

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Expectations Formation and Inflation Persistence

1. Introduction.

Policy credibility is defined as agents' assessment of the likelihood that announced policies will indeed be carried out. To what can we attribute any lack of full credibility? First, agents may be uncertain about the true "type" of the policy-maker (Backus and Driffill (1985a, 1985b)). Second, even if agents are certain that the true intention of the policymaker is to carry out the announced policy, there might be some probability that the policymaker is faced with an environment where he/she has no choice but to abandon the policy (Drazen and Masson (1994), Obstfeld (1997)). However, having a well-defined policymaker and a very low probability of abandoning the policy may not be sufficient for a quick adjustment to a low inflation target. To illustrate, consider a currency board.

Currency boards are institutions that replace central banks and ensure that domestic currency can be purchased on demand at a fixed exchange rate.[1] The fixed level of the exchange rate can be altered only by the Parliament and, in addition, domestic money is fully backed by foreign exchange reserves held by the government. In its Orthodox form, a currency board has no responsibilities regarding the provision of liquidity to the banking system, financing the budget deficit or unemployment.

In other words, to reduce uncertainty as to the "type" of the policy-maker, a currency board aims to remove discretion over monetary policy. To address the second

[1] See Schwartz (1993) and Williamson (1995) for a discussion on the history and operation of currency boards.

factor for low credibility, sufficient foreign exchange reserves, political consensus and international support are secured, and programs for structural reform are drawn to ensure that the currency board will remain in place for the foreseeable future.

With the two factors for low credibility minimized, will expected inflation fall to a rate close to the inflation of the reserve currency when the new regime is introduced? In survey data collected at the introduction of a currency board in Bulgaria, expected inflation is affected by the new regime but does not decline to low levels immediately.[2] Why is that the case? In other words, what factors, other than credibility, influence the degree to which expectations are affected by the new regime? One potential factor is how well-versed agents are in the implications of a currency board. The data from Bulgaria support the hypothesis that "transparency" and credibility of the regime have separate and significant influences on expected inflation.

More generally, what are the long-run properties and short-term dynamics of inflation if monetary policy is transparent to only part of the population? Are there incentives for the central bank to try to influence the distribution of agents? In the theoretical part of the paper, we address these and related questions.

In spirit, we follow Haltiwanger and Waldman (1989) in assuming that some agents form more informed (rational) expectations and the rest form less informed

[2]Studies of exchange-rate-based stabilization have revealed a number of stylized facts: rapid convergence of inflation from high to moderate levels but, in some cases, slow convergence from moderate to low levels, and an initial increase in real activity. See Sargent (1982), Bruno (1993), Calvo and Vegh (1994a, b), Calvo (1986), Fischer (1986), Pazos (1972), Roldos (1995).

(adaptive) expectations. We analyze the implications of such heterogeneity in a simple Barro-Gordon (1983) model of monetary policy.[3]

We find that long-run average inflation is lower the higher the proportion of agents who form naïve expectations. Intuitively, adaptive expectations have a "disciplining" effect on central banks as higher current inflation is built into expectations of future inflation. We also find that in high inflation periods the central bank will prefer a higher proportion of agents who form more informed expectations but not so once inflation is lower.[4]

The rest of the paper is structured as follows. In sections 2 and 3, we develop a model with heterogeneous agents in a Barro-Gordon (1983) framework. In sections 4 and 5, we discuss the survey data and present our findings. Section 6 summarizes the results.

2. A model of monetary policy with heterogeneous agents.

Output y_t (all variables in logarithms) differs from its natural level by an amount determined by the real wage (w_t-p_t):

$$y_t = \bar{y} - (w_t - p_t) - u_t \tag{1}$$

where u_t is an i.i.d. supply shock with mean zero and variance σ^2. Inflation π_t is defined by:

$$\pi_t = p_t - p_{t-1} \tag{2}$$

[3] Sethi and Franke (1995) and Crettez and Michel (1992) develop models which endogenize the decision of agents to form rational versus adaptive expectations. Because forming rational expectations is costly and agents face different costs, the two groups emerge naturally. Conditional on lagged inflation dynamics, the proportion of naive agents changes over time. However, given variability in inflation, it is shown that both types of expectation formation generally persist over time.

[4] Cukierman an Meltzer (1986) discuss a model, which accounts for central bank secrecy, in which the central bank may prefer that the private sector is uncertain of currenct objectives of monetary policy.

Agents are heterogeneous in the way they form inflationary expectations. A proportion θ of all agents form adaptive expectations:

(3) $$E^A_{t-1}\pi_t = \pi_{t-1}$$

which yields:

(4) $$E^A_{t-1}p_t = p_{t-1} + \pi_{t-1}$$

The remaining (1-θ) agents form rational expectations. Denote their expectations of the price level by $E^R_{t-1}p_t$.

Before the shock u_t has been observed, the nominal wage is set at the average expected price:

(5) $$w_t = \theta\left(p_{t-1} + \pi_{t-1}\right) + (1-\theta)E^R_{t-1}p_t$$

Define the monetary authorities' loss function L_t as:

(6) $$L_t = \left[y_t - \tilde{y}_t\right]^2 + \alpha\pi_t^2$$

where $\tilde{y}_t$ is the level of output targeted by the policymaker. By substituting (5) into (1) and (1) into (6), we write the loss function as:

(7) $$L_t = [\pi_t - (1-\theta)E_{t-1}\pi_t - \theta\pi_{t-1} - k_t - u_t]^2 + \alpha\,\pi_t^2$$

where $E_{t-1}\pi_t = E^R_{t-1}p_t - p_{t-1}$ is expected inflation by agents with rational expectations and $k_t = \tilde{y}_t - \bar{y}_t > 0$ is the difference between the target and the natural level of output.

After observing the nominal wage and the shock u_t, the government chooses inflation π_t to minimize:

(8) $$\min_{\pi_t} \sum_{i=0}^{\infty} \beta^i E_t L_{t+i}$$

where $\beta \in [0,1]$. Substitute from (7) into (8) and assume $k_{t+i}=k$, all i. The objective can

then be written:

$$(8') \qquad \min_{\pi_t} V_t = \left[\pi_t - (1-\theta)E_{t-1}\pi_t - \theta\pi_{t-1} - k - u_t\right]^2 + \alpha\pi_t^2 + \\ + \sum_{i=1}^{\infty}\beta^i E_t\left[\pi_{t+i} - (1-\theta)E_{t+i-1}\pi_{t+i} - \theta\pi_{t+i-1} - k - u_{t+i}\right]^2 + \alpha\sum_{i=1}^{\infty}\beta^i E_t\pi_{t+i}^2$$

Provided that some agents form adaptive expectations ($\theta > 0$) inflation in period t is built into expectations of inflation for period $t+1$ and beyond. Monetary authorities choose inflation to balance their current and future inflation and output objectives.

The first order condition with respect to π_t and using certainty equivalence yields:

$$(9) \qquad \beta\theta^2 E_t\pi_{t+1} - \left(1+\alpha+\beta\theta^2\right)\pi_t + (1-\theta)E_{t-1}\pi_t + \theta\pi_{t-1} = -(1-\beta\theta)k - u_t$$

Then taking expectations of both sides of (9) as of time $t-1$ and collecting terms yields the following difference equation:

$$(10) \qquad E_{t-1}\pi_{t+1} - \frac{\alpha+\theta+\beta\theta^2}{\beta\theta^2}E_{t-1}\,\pi_t + \frac{1}{\beta\theta}\,\pi_{t-1} = -(1-\beta\theta)\frac{k}{\beta\theta^2}$$

As shown in the Appendix, the solution for (10) can be written:

$$(11) \qquad E_{t-1}\pi_t = \lambda_1\,\pi_{t-1} + (1-\lambda_1)\overline{\pi}$$

where λ_1 $(0 < \lambda_1 < 1)$ is the smaller root of the characteristic equation and

$$(12) \qquad \overline{\pi} = (1-\beta\theta)\frac{k}{\alpha}$$

In the absence of future shocks, inflation is expected to gradually approach a long-run equilibrium level of $\overline{\pi}$. Note that $\overline{\pi}$ will be lower the higher the proportion (θ) of naïve agents. The effect is magnified if the central bank places more weight on the expected value of its future losses as indicated by greater values for β. Intuitively, naïve agents have a "disciplining" effect on the central bank in terms of raising inflation. Higher current inflation is built into the expectations of naïve agents and, thus, implies

greater future expected losses to the central bank.[5] Also, from (12), long-run inflation decreases in the resolve of the monetary authorities to fight inflation (α) and increases in the magnitude of their output objectives (k).

2.1 Inflation Dynamics

The λ_1 parameter is shown in the Appendix to be:

$$\lambda_1 = \frac{\alpha + \theta + \beta\theta^2 - \sqrt{(\alpha + \theta + \beta\theta^2)^2 - 4\beta\theta^2}}{2\beta\theta^2} \tag{13}$$

The anticipated speed of adjustment toward the long run inflation rate is given by $(1-\lambda_1)$ or, put differently, the degree of persistence in inflation is given by λ_1. We are interested in the effect of the resolve of the central bank to fight inflation (α), the discount factor (β), and the proportion of naïve agents (θ) on this inflation persistence.

First, note that λ_1 is a decreasing function of α. The greater the relative weight that the central bank puts on inflation in its objective function, the more rapidly it will try to bring down inflation to the long-run level, as well as having a lower long-run inflation target.

A similar intuition applies to the fact that λ_1 is a decreasing function of β. If the monetary authority puts relatively more weight on future losses, it wants to get high inflation out of the system more quickly.

Somewhat surprisingly there is an ambiguity in the effect of θ on λ_1. Intuitively we expected that a greater proportion of naïve agents who base their inflation

[5]Note that without naive agents (θ=0) or with a myopic policymaker (β=0), long run inflation is k/α, the solution to a one-period Barro-Gordon problem.

Figure 1.1 Inflation persistence, Low Beta

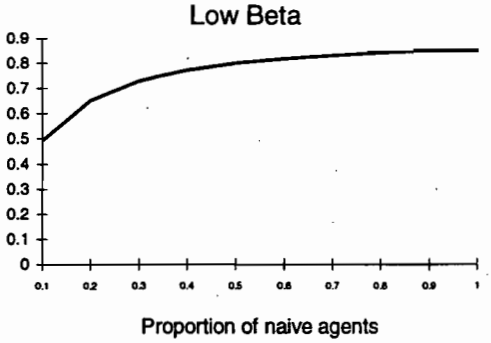
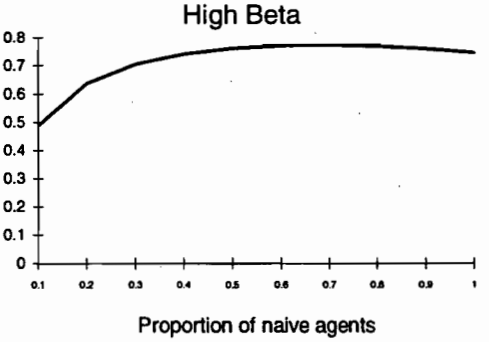


Figure 1.2 Inflation persistence, High Beta



expectations on past inflation would increase the persistence of inflation. This is the case if β is not too high. However, when β is high, λ_1 attains an interior maximum as θ varies from 0 to 1. These cases are depicted in Figures 1.1 and 1.2. In both figures, α=0.1 and k=1. In Figure 1.1, β=0.5 and in Figure 1.2, β=0.95. With higher β, the costs in future periods from not reducing inflation now may outweigh the persistence effect of higher θ.

Next we consider how responsive the monetary authority is to a supply shock. As shown in the Appendix, with $u_t \neq 0$, current inflation is:

$$\pi_t = \lambda_1 \pi_{t-1} + (1-\lambda_1)\bar{\pi} + \frac{1-\beta\lambda_1^2}{(1-\beta\lambda_1^2)(1+\alpha)+\alpha\beta\lambda_1^2+\beta\theta^2(1-\lambda_1)^2} u_t \tag{14}$$

The rather complicated coefficient on u_t is unambiguously positive, so that a negative shock to output will call for an increase in inflation. How large that response will be depends on the parameters α, β, and θ. In terms of the effect of more naïve agents on the responsiveness of inflation to a supply shock, we can distinguish two opposing effects. First, a higher value of θ means that the central bank can more effectively offset the output effect of a supply shock. Second, with more naïve agents any shock-induced

deviation from steady state inflation may persist longer, so that the central bank's response to shocks in terms of inflation will be smaller because of the future cost of current inflation. That second effect is stronger when the authorities put more weight on future periods, *i.e.*, have a higher β.

2.3. Optimal proportion of agents with adaptive expectations.

In this section we ask whether the central bank has any preference regarding the distribution of agents in the two groups -- with rational and with adaptive expectations. In particular, the bank may choose to adopt a monetary regime characterized, among other features, by more or less transparency. Formally, we write the value function (8) as (see Appendix):

$$(8'') \qquad \begin{aligned} V_t = &\left[\pi_t - (\lambda_1 - \lambda_1\theta + \theta)\pi_{t-1} - (1-\lambda_1)(1-\theta)\pi_t - k\right]^2 + \alpha\pi_t^2 + \\ &+ \sum_{j=1}^{\infty} \beta^j \left\{\left[\theta(\lambda - 1)\lambda_1^{j-1}(\pi_t - \bar{\pi}) - k\right]^2 + \alpha\left[\lambda_1^j \pi_t + (1-\lambda_1^j)\bar{\pi}\right]^2\right\} \end{aligned}$$

and we are interested in the value of θ that minimizes (8″) given π_{t-1}.

Figures 2.1, 2.2 and 2.3 show three examples in which the value function (8″) is calculated for θ in the interval between 0 and 1. In all examples, $\alpha = 0.2$ and $k = 1$ so that long term-inflation in the absence of naïve agents (with $\theta = 0$) would be 5, and $\beta = 0.9$. We calculated the value function with three different values for π_{t-1} chosen to proxy for high, moderate and low inflation. In Figure 2.1, $\pi_{t-1} = 30$ (high compared to equilibrium inflation with no naïve agents), in Figure 2.2, $\pi_{t-1} = 15$ ("moderate" but still higher than equilibrium inflation with no naïve agents), and in Figure 2.3, $\pi_{t-1} = 5$ (equal to equilibrium inflation with no naïve agents).

Figure 2.1 Value Function, high inflation

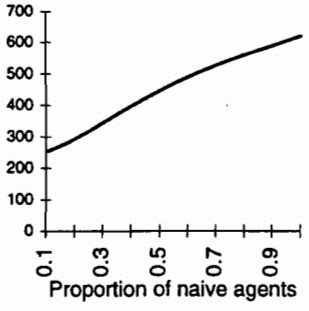


Figure 2.2 Value Function, moderate inflation

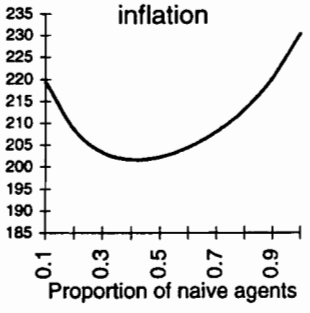
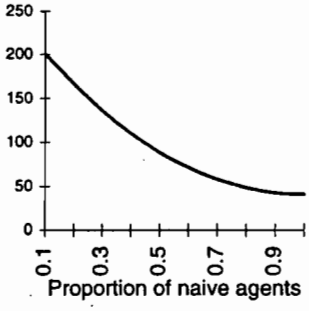


Figure 2.3 Value Function, low inflation



There are two considerations here. More agents with adaptive expectations means a lower long run inflation. At the same time more agents with adaptive expectations also generally have the effect of slowing down the speed with which the inflation target is approached. Thus, when inflation is very high, the central bank prefers more informed agents since this will reduce inflation more quickly. However, at lower initial inflation rates, long-run inflation becomes relatively more important and the central bank will prefer fewer informed agents.

One interesting implication is that reducing moderate inflation will occur at a slower rate compared to reducing high inflation to the extent that the central bank can manage to be more transparent and have more rational agents when initial inflation is high.

3. Empirical hypotheses

In this section, we derive hypotheses regarding differences in expected inflation between the two types of agents if a new monetary rule consistent with lower long-run inflation is introduced. In particular, let the new monetary rule be summarized by a greater value for α, adopted at time T:

(15) $$\alpha_t = \begin{cases} \alpha & \text{if } t < T \\ \alpha^* & \text{if } t \geq T \end{cases}$$

where $\alpha^* > \alpha$. As a result, steady-state inflation from equation (12) will be lower under the new regime: $\bar{\pi}(\alpha^*) - \bar{\pi}(\alpha) < 0$

Assume that prior period inflation is at the old steady state level, $\pi_{T-1} = \bar{\pi}(\alpha)$. Hence, from (11), just before the new policy is implemented expected inflation by agents with rational expectations is a weighted average of the old and the new levels of long-run inflation:

(16) $$E_{T-1}\pi_T = \lambda_1 \pi_{T-1} + (1 - \lambda_1)\bar{\pi}(\alpha^*)$$

Subtract π_{T-1} from both sides of (16):

(17) $$E_{T-1}\pi_T - \pi_{T-1} = (1 - \lambda_1)[\bar{\pi}(\alpha^*) - \pi_{T-1}] < 0.$$

This establishes Hypothesis 1. *Immediately after the new lower inflation policy is announced, agents with rational expectations hold expectations of lower inflation than agents with adaptive expectations.*

Next subtract $\bar{\pi}(\alpha^*)$ from both sides of (16):

(18) $$E_{T-1}\pi_T - \bar{\pi}(\alpha^*) = \lambda_1[\pi_{T-1} - \bar{\pi}(\alpha^*)] > 0.$$

This establishes Hypothesis 2. *Immediately after the new lower inflation policy is announced, agents with rational expectations expect inflation to be above the new target inflation rate.*

Finally if monetary policy is unchanged and inflation is approximately at its old long-run level, it is rational to expect the current rate of inflation π_{T-1}. Thus, we have Hypothesis 3. *If there is no change in regime, then agents with rational and adaptive expectations will expect the same rate of inflation.*

The introduction of a new monetary rule consistent with lower inflation will thus drive a wedge between the expectations of those who are informed and those who are naive about its implications. The new currency board in Bulgaria in July 1997 is one instance in which people were asked about their inflation expectations after the currency board was announced and before it went into effect.

4. Description of the survey.

A national survey was conducted in Bulgaria during the last two weeks of June 1997 immediately before the introduction of a currency board on July 1st. By mid June, the fixed level of the exchange rate and the members of the currency board were announced. The survey (with 1022 respondents) is considered representative for the country. It was conducted as part of a larger survey on political attitudes and current economic conditions. We used two of the questions from the survey. In the first, each respondent was asked about her/his expectation of the average monthly inflation over the following year if a currency board is introduced and, in the second, about her/his expectation of the average monthly inflation over the following year if a currency board were not introduced. Monthly rather than annual rates of inflation were chosen because at that time, after a period of high and unstable inflation, price movements were generally discussed and quoted in the media in terms of monthly rather than yearly changes.

The study is unique in the sense that it captures a very specific moment. First, the introduction of a currency board is an event with very low frequency. Second, the survey was carried out immediately before the introduction of the currency board but after the legislation and all parameters of the board were publicly announced. In that sense, there

was no uncertainty about the level at which the nominal exchange rate was to be fixed or about the members of the board.

Respondents also indicated their age, education level, gender, and political attitudes. Income data were provided by too few respondents to be usable in the estimations.

4.1. *A brief background on the economic conditions in Bulgaria.*

The currency board was introduced in Bulgaria on July 1, 1997 after the idea was first made public in late 1996. Following a period of financial stability, the domestic currency depreciated by 570 percent during 1996 along with the failure of several major banks representing some 20 percent of the total assets in the banking system. The beginning of 1997 was characterized by further devaluation and price increases resulting in close to 40 percent average monthly inflation for the year before the currency board was introduced. [6]

The *lev* was fixed at approximately its then current market price of 1 lev = 1,000 German marks. There was substantial debate about the choice of the German mark over the US dollar as the currency to which the *lev* was to be pegged. Germany is a traditional major trading partner of Bulgaria and most of the regional trade is in marks. However, energy sources, traded in US dollars, account for some 30 percent of the imports to the country. Presumably for reasons of transparency, a peg to a trade-weighted basket of currencies was not adopted. The level of the peg was considered inappropriate by some institutions who preferred that the *lev* should be devalued further to provide a "cushion" against possible inflation persistence after July 1. At the introduction of the board, the

[6]See Valev (1998).

problems in the banking system, the bulk of which is still state-owned, were partially resolved and a commitment was made to speed the privatization process in the real and financial sectors.

In the last few months before July 1st, a considerable debate about what is a currency board and whether it is appropriate in Bulgaria occupied the media. The opinions expressed were often conflicting but, in general, the amount of information appeared sufficient for a lay person to understand what a currency board implies at least for the near future.

5. Results.

At the introduction of a low-inflation regime, different expected inflation across agents can be explained, among other factors, by different perceptions of the true intentions of the policy-maker as well as by agents' understanding of the regime's operation and implications. We use political affiliation to distinguish agents by their perceptions of the policymaker, and we use level of education to distinguish respondents in terms of their information about the currency board.[7] Hence, the central hypotheses we test are that political supporters of the government and more educated agents will expect lower inflation compared to the rest of the population given that a currency board is introduced. Such differences are not expected to arise if a currency board is not introduced.

Table 1 shows mean and median expected inflation with and without a currency board for the overall sample and for subsamples defined by education, political

[7] More educated agents have greater contact with the media where discussions of the policy shift take place. Another potential reason is that more educated agents occupy positions which require them to form more-informed expectations and offer them better resources to do so.

affiliation, gender and age. Average expected monthly inflation with a currency board is 25 percent, and without a currency board, 50 percent. Note however that median expected inflation is 10 percent if a currency board is introduced and 25 percent if it is not. Because of the positive skewness of the answers, the median may be a better measure of central tendency. Clearly, the introduction of a currency board is consistent with lower expected inflation but does not by itself lower expectations to desired levels (the inflation of the German mark).

Table 1 also reports the mean and the median of expected inflation in subsamples. Again, the mean may not be an appropriate measure for differences in expected inflation because of different skewness across subsamples. Less obviously, differences in medians across subsamples may not serve that purpose well either. The reason is that most answers are clustered around certain numbers with fairly large jumps between different answers. Hence the median values of two subsamples could differ greatly while the difference results from just a few observations. Similarly, two subsample medians could be the same despite significant differences in the distribution of answers.

To resolve the problem, we take the following path. First, we divide the overall samples (with and without a currency board) into high and low expected inflation groups relative to the respective median.[8] Second, we test if there is a significant difference in the proportion of political supporters or more educated agents across the two groups. Note that this approach also conforms better with the theory where we discuss agents' heterogeneity in terms of two groups of expectation formation. The results are reported in

[8] Note that for the overall sample, for both inflation with and without a currency board, the median expected inflation separates the sample at points which is a natural cut in the data.

Table 2.1 for expected inflation with currency board, in Table 2.2 for expected inflation without a currency board.

In Table 2.1 we find that more educated agents and political supporters of the government represent a significantly greater proportion in the group of agents with lower inflationary expectations than in the group with higher inflationary expectations given that a currency board is introduced. Gender and age do not appear to be associated with high or low expected inflation. In Table 2.2, if a currency board is not introduced, none of the variables have significantly different representations in the two groups. The lack of effect of political affiliation on expected inflation if a currency board is not introduced coupled with the significant effect with a currency board suggests that the credibility of the government to reduce inflation is related to a specific policy, in this case the introduction of a currency board.

Approximately 30 percent of the respondents did not provide a forecast. With few exceptions, they provided either both forecasts, with and without a currency board, or none at all. It is likely that the selection process is not random and that respondents self-selected on the basis of observable factors. Hence, estimation of the effect of political affiliation and education may produce biased results.

We employ Heckman's (1979) procedure to correct for self-selection bias. It involves the maximum likelihood estimation of participation equation which explains the decision to provide a forecast and a regression equation relating expected inflation to education and political affiliation. The procedure produces consistent and asymptotically efficient estimates by taking into account the correlation of the error terms in the two

equations. [9] The results are reported in Table 3. The dependent variable is 1 if expected inflation is above the median and 0 otherwise.[10] The reported estimates of λ in Table 3 indicate the degree of selection bias. There is evidence of significant selection bias in the case of expected inflation with a currency board but not so without a currency board. [11]

The significant negative coefficients on both education and political affiliation given that a currency board is introduced indicate that they do have separate and distinct influences on expected inflation.

6. Conclusion.

In this paper, in the spirit of Haltiwanger and Waldman (1989), we trace the implications of heterogeneity among agents in terms of expectation formation. In particular, we solve a simple Barro-Gordon (1983) model where some agents form more informed (rational) expectations and others form less informed (adaptive) expectations

We find that steady state inflation decreases in the proportion of naïve agents. Intuitively, adaptive expectations have a "disciplining" effect on central banks in view of the fact that higher current inflation is built into expectations of future inflation. We also analyze the incentives of the monetary authorities to publicly communicate and discuss policy objectives and methods and, thus, potentially affect the distribution of agents into the two groups. We find that, in high inflation periods, the central bank will prefer a higher proportion of agents who form more informed expectations but not so in moderate and low inflation periods.

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[9] For information on the procedure see Heckman (1979), Greene (1991), and Stata Corporation (1997).
[10] Qualitatively, the same results were obtained using levels of expected inflation.
[11] We estimated specifications including age and gender in the regression equation and did not find evidence of significant relationships between these variables and expected inflation. On average women

We use data from a survey conducted in Bulgaria immediately before the introduction of a currency board in that country to examine influences on expected inflation and to test some of the predictions of the model. Agents do hold different expectations and these differences can be partially attributed to factors that proxy for the degree to which agents are informed of the workings of monetary policy. Party affiliation can be viewed as a proxy for a belief in the credibility of the new monetary regime (currency board), and we use education to proxy for the exposure agents have to discussion about the implications of the new regime. We find that supporters of the party in power and more educated agents do expect significantly lower inflation than those not supporting the party in power and those with less education.

reported lower expected inflation than men but this did not show up after correcting for selection bias in a multiple regression specification.

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Table 1
Summary statistics of expected inflation.
Survey results. June 1997, Bulgaria

		Mean	Median	Coeff. of Variation (a)	Obser-vations
Whole Sample	Inflation with currency board	24.96	10	1.75	691
	Inflation without currency board	50.36	25	1.46	701
More education	Inflation with currency board	22.4	10	1.77	460
	Inflation without currency board	51.8	25	1.47	475
Less education	Inflation with currency board	29.9	15	1.57	231
	Inflation without currency board	47.2	25	1.38	226
Political supporters	Inflation with currency board	21.6	10	1.72	339
	Inflation without currency board	51.6	20	1.46	339
Political opponents	Inflation with currency board	28.1	15	1.66	352
	Inflation without currency board	49.1	30	1.42	362
Female	Inflation with currency board	21.07	10	1.09	341
	Inflation without currency board	47.64	25	1.42	342
Male	Inflation with currency board	28.74	10	1.96	347
	Inflation without currency board	53.25	20	1.45	356
Older	Inflation with currency board	23.2	10	1.16	256
	Inflation without currency board	44.7	20	1.30	260
Younger	Inflation with currency board	26.0	10	1.90	435
	Inflation without currency board	53.7	30	1.49	441

Note: Each respondent was asked to provide a forecast of the average monthly inflation rate over the following year conditional on introducing or not introducing a currency board. Education: more educated if respondent has high school or higher education. Political affiliation: supporter if today would vote for the party currently in office. Age: older if respondent is more than 50 years old.

Table 2.1

Agents are divided into two groups -- with high and with low inflation expectations relative to the median given that a *currency board is introduced.* The table gives the proportion of political supporters, educated, female and older agents in the two groups. Survey data, Bulgaria. June, 1997.

	Agents with lower than the median expected inflation	Agents with higher than the median expected inflation	Difference
	(1)	(2)	(1) - (2)
Proportion of more educated respondents	.71	.62	.09**
Proportion of supporters of the government	.55	.42	.13**
Proportion of female respondents	.49	.49	.00
Proportion of older respondents	.37	.37	.00

Note: Education: more educated if respondent has high school or higher education. Political affiliation: supporter if today would vote for the party currently in office. Age: older if respondent is more than 50 years old. **(*) indicates significance at the 1(5) percent level.

Table 2.2

Agents are divided into two groups -- with high and with low inflation expectations relative to the median given that a *currency board is not introduced.* The table gives the proportion of political supporters, educated, female and older agents in the two groups. Survey data, Bulgaria. June, 1997.

	Agents with higher than the median expected inflation	Agents with lower than the median expected inflation	Difference
	(1)	(2)	(1) - (2)
Proportion of more educated agents	.67	.68	-.01
Proportion of supporters of the government	.51	.46	.05
Proportion of female respondents	.48	.49	-.01
Proportion of older respondents	.39	.35	.04

Note: Education: more educated if respondent has high school or higher education. Political affiliation: supporter if today would vote for the party currently in office. Age: older if respondent is more than 50 years old. **(*) indicates significance at the 1(5) percent level.

Table 3
The effect of political affiliation and education on expected inflation.
Heckman's procedure. Survey data. June 1997, Bulgaria

	Expected inflation with currency board	Expected inflation without currency board
	Dependent variable: 1 if expected inflation is greater than the median	Dependent variable: 1 if expected inflation is greater than the median
Education	-0.11**	-0.01
	(0.04)	(0.04)
Political affiliation	-0.12**	-0.06
	(0.04)	(0.04)
Constant	0.72	0.59
	(0.08)	(0.09)
λ	-0.21*	-0.14
	(0.11)	(0.12)
	Dependent variable:1 if respondent provided an answer, 0 otherwise	Dependent variable:1 if respondent provided an answer, 0 otherwise
Education	0.17*	0.31**
	(0.09)	(0.09)
Political affiliation	0.13	0.06
	(0.08)	(0.08)
Gender	-0.15*	-0.20**
	(0.08)	(0.09)
Age	-0.29**	-0.26**
	(0.09)	(0.09)
Constant	0.50	0.49
	(0.10)	(0.10)
Model Chi2(7)	31.22	42.41
Number of observations	1022	1022

Note: MLE. Mill's ratio estimates used as starting values. Standard errors in parentheses. **(*) indicates significance at the 1(5) percent level. Education: 1 if respondent has high school or higher education. Political affiliation: 1 if today would vote for the party currently in office. Gender: 1 if female. Age: 1 if respondent is more than 50 years old.
A significant value for $\lambda=\rho\sigma$, where σ is the estimated standard error of the residuals of the regression equation and ρ is the estimated correlation of the residuals from the participation and the regression equations, indicates evidence of self-selection bias.

Appendix

In the absence of any shocks, the first-order condition can be written as the following second-order difference equation:

$$\text{(A.1)} \qquad \pi_{t+1} - \frac{\alpha + \theta + \beta\theta^2}{\beta\theta^2}\,\pi_t + \frac{1}{\beta\theta}\,\pi_{t-1} = -(1-\beta\theta)\frac{k}{\beta\theta^2}$$

or in lag-operator notation:

$$\text{(A.2)} \qquad (1-\lambda_1 L)(1-\lambda_2 L)\pi_{t+1} = -(1-\beta\theta)\frac{k}{\beta\theta^2}$$

where λ_1 and λ_2 are the roots of the characteristic equation

$$\text{(A.3)} \qquad f(\lambda) = (\lambda - \lambda_1)(\lambda - \lambda_2) = \lambda^2 - \frac{\alpha + \theta + \beta\theta^2}{\beta\theta^2}\lambda + \frac{1}{\beta\theta} = 0$$

Note that

$$\text{(A.4)} \qquad f(0) = \frac{1}{\beta\theta} > 0$$

$$\text{(A.5)} \qquad f(1) = (1 - \lambda_1)(1 - \lambda_2) = -\frac{\alpha}{\beta\theta^2} < 0$$

These imply that the smaller root lies between 0 and 1 and the larger root is greater than 1. The smaller root can be written explicitly as

$$\text{(A.6)} \qquad \lambda_1 = \frac{\alpha + \theta + \beta\theta^2 - \sqrt{(\alpha + \theta + \beta\theta^2)^2 - 4\beta\theta^2}}{2\beta\theta^2}$$

One can use (A.4) and (A.5) to show that an increase in α or in β, with $0 < \theta < 1$, lowers λ_1.

If one multiplies (A.2) through by $(1 - \lambda_2 L)^{-1}$, the result assuming no bubbles is:

$$(1-\lambda_1 L)\,\pi_{t+1} = \frac{1-\beta\theta}{\lambda_2 - 1}\frac{k}{\beta\theta^2}$$

Then after substituting for $(\lambda_2 - 1)$ from (A.5):

$$\text{(A.7)} \qquad \pi_{t+1} = \lambda_1\,\pi_t + (1-\lambda_1)\,\bar{\pi}$$

where

(A.8) $$\bar{\pi} = (1-\beta\theta)\frac{k}{\alpha}.$$

(A.7) also implies that

(A.9) $$E_{t-1}\,\pi_t = \lambda_1\,\pi_{t-1} + (1-\lambda_1)\,\bar{\pi}$$

and that

(A.9) $$E_t\,\pi_{t+n} = \bar{\pi} + \lambda_1^n(\pi_t - \bar{\pi})$$

When these substitutions are made in the objective function, we have

(A.10)
$$V_t = \left[\pi_t - (\lambda_1 - \lambda_1\theta + \theta)\pi_{t-1} - (1-\lambda_1)(1-\theta)\pi_t - k\right]^2 + \alpha * \pi_t^2 + \\ + \sum_{j=1}^{\infty}\beta^j\left\{\left[\theta(\lambda-1)\lambda_1^{\,j-1}(\pi_t - \bar{\pi}) - k\right]^2 + \alpha\left[\lambda_1^{\,j}\pi_t + (1-\lambda_1^{\,j})\bar{\pi}\right]^2\right\}$$

From the first order condition, we can then determine how much π_t will differ from $E_{t-1}\pi_t$ when u_t is not equal to zero. The result is:

(A12) $$\frac{\partial\pi_t}{\partial u_t} = \frac{1-\beta\lambda^2}{(1-\beta\lambda^2)(1+\alpha) + \alpha\beta\lambda^2 + \beta\theta^2(1-\lambda)^2}$$

Hence,

(A.13) $$\pi_t = \lambda_1\pi_{t-1} + (1-\lambda_1)\bar{\pi} + \frac{1-\beta\lambda_1^2}{(1-\beta\lambda_1^2)(1+\alpha) + \alpha\beta\lambda_1^2 + \beta\theta^2(1-\lambda_1)^2}u_t$$

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