Adaptive Learning, Endogenous Inattention, and Changes in Monetary Policy*

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Abstract

This paper develops an adaptive learning formulation of an extension to the Ball, Mankiw and Reis (2005) sticky information model that incorporates endogenous inattention. We show that, following an exogenous increase in the policymaker's preferences for price vs. output stability, the learning process can converge to a new equilibrium in which both output and price volatility are lower.

JEL Classifications: E52; E31; D83; D84

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1   Introduction

A focus of recent research has been on the apparent change in the stance of monetary policy from the 1970's to the 1980's. A particularly striking finding is that the monetary authorities were 'passive' in reacting to inflation during the 1970's but aggressive during the 1980's and 1990's (Clarida, Gali, and Gertler (2000), Lubik and Schorfeide (2004)). In the applied literature, there is interest in whether these findings are related to empirical evidence of a decline in output volatility in the US (McConnell and Quiros (2001)) and to the finding of

Blanchard and Simon (2001) that inflation and output volatility are positively correlated. The decline in economic volatility is a finding of such paramount importance it has been given the moniker 'The Great Moderation' by Bernanke (2004). Table 1 illustrates the decline in output and price volatility for the United States over 1947:1-2004:1.

Table 1.

	Standard Deviation in %		
	1947:1-2004:1	1947:1-1983:4	1984:1-2004:1
y	1.70	2.00	0.95
p	0.98	1.16	0.48

Note: Standard deviation in percent of log real GDP, y, and implicit price deflator p. Data have been HP-detrended.

The cause of the Great Moderation is an open question. Some authors have attributed the decline in economic volatility to a fundamental shift in the focus of monetary policy.[1] Orphanides and Williams (2005b) maintain that monetary authorities concerned themselves primarily with output stabilization ('activist policy') during the late 1960's and 1970's and then switched their emphasis to price stability in subsequent years. Bernanke (2004) contends that monetary policy during the 1970's exhibited 'output optimism' and 'inflation pessimism'. According to Bernanke's hypothesis, an overplaced emphasis on exploiting a (perceived) Phillips curve trade-off, and a mistaken belief that monetary policy was unable to control inflation, led to higher volatility in both output and inflation – confirming the positive correlation in Blanchard and Simon (2001).[2] Bernanke conjectures that a movement away from activist monetary policy anchored inflation expectations and produced lower volatility in *both* inflation and output.

In many models, however, there is a trade-off between inflation and output volatility: a renewed focus on inflation stabilization will lead monetary policy to produce higher output volatility.[3] Although Bernanke (2004), Svensson (2003), and others, conjecture that if policymakers can more tightly pin down inflation expectations then they will achieve economic stability, the specific channels for this effect are left open.

A few possible mechanisms consistent with the Bernanke hypothesis have appeared in the literature. In Orphanides and Williams (2005a) the trade-off disappears when agents engage in 'perpetual learning' and policymakers have the appropriate preferences on inflation and output volatility. In their model inflation expectations persistently deviate from

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[1]The evidence for a one-time permanent shift in monetary policy, and for a similar shift in macroeconomic volatility, is open to other interpretations. Cogley and Sargent (2005) and Sims and Zha (2006) present evidence of drifting and regime switching over much of the post-WWII period.

[2]Sargent (1999) develops a model where the central bank mistakenly exploits a Phillips curve even though the natural rate hypothesis holds.

[3]See Woodford (2003) for examples.

rational expectations, becoming a source of instability and providing an additional role for monetary policy. An alternative story, given in Clarida, Gali and Gertler (2000), retains rational expectations, but relies on multiple equilibria. In particular they suggest that interest rate rules in the earlier part of the post-WWII period were insufficiently aggressive against inflation and were consistent with the existence of sunspot equilibria.

A potential alternative explanation of the Great Moderation is implied by the model of Branch, Carlson, Evans and McGough (2006) (BCEM). In that paper, we extend the sticky information model of Ball, Mankiw and Reis (2005) (BMR) by endogenizing the rate of information acquisition, λ. Then, letting ω measure the weight in the policymaker's loss function placed on price variance relative to output variance, we study the joint determination of monetary policy and the equilibrium rate of λ. The principle insight of that paper is that by reducing price volatility, policymakers can induce an endogenous response in λ that lowers overall economic volatility – thereby avoiding the usual trade-off between price and output stability.

Since attentive readers may have noticed that we have referred to both inflation and price volatility, before continuing we comment on how we treat this distinction. There is a debate among experts in monetary policy about the precise form of the price stability objective that is appropriate for policymakers to pursue.[4] Although there are several specific issues, the one that is most relevant is whether the central bank should attempt to stabilize the inflation rate or instead stabilize the price level around a deterministic path.

This question, though of considerable importance, is essentially orthogonal to the issue under study, and we therefore take a pragmatic approach. Empirically, looking for example at the US Consumer Price Index, there was a substantial fall in the standard deviation of the quarterly inflation rate from the 1950:1 - 1983:4 period to the 1984:1 - 2003:4 period. Measuring inflation as the change in the log(CPI), the ratio of the standard deviation in the former period to the latter period is 2.45. Alternatively, if one detrends the log(CPI) using the Hodrick-Prescott filter and computes the standard deviation of the price level separately for the two periods, there is again a substantial fall: the ratio for the former period compared to the latter period is 2.28.

Because our analysis is most conveniently developed as an extension to the Ball, Mankiw, and Reis (2003) model of "sticky information," in which the optimal monetary policy is formulated in terms of the variability of the price level around an arbitrary trend, we will perform our analysis in terms of price stability rather than inflation stability.

In Branch, Carlson, Evans and McGough (2006), we found that a renewed emphasis on price stability may reduce equilibrium volatility of both prices and output. An example of this simultaneous reduction is provided in Figure 1, which we have extracted from BCEM. Figure 1 plots the unconditional variances of the equilibrium price and output processes as ω is increased from zero: we call this graph "the policy frontier." The arrows indicate the direction of movement along the frontier as ω increases. Here one should not think of policymakers as able to choose among the points on the frontier; rather, a point on the

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[4]See, for example, Woodford (2002) for a discussion and references.

frontier represents an equilibrium outcome for a given policymaker preference specification ω. For details on the construction of this figure, see BCEM. Finally, notice that, at least initially, higher ω corresponds to lower volatility in both price and output.

Figure 1: Policy Frontier
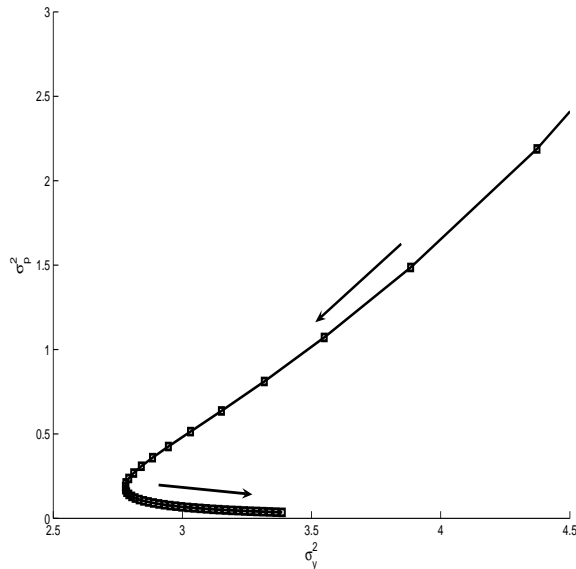
The possibility of a downward sloping policy frontier provides an alternative theoretical explanation for the Great Moderation: in the late seventies and early eighties policymakers became increasingly concerned with price stability. This induced a reduction in the information acquisition rate λ and the economy moved down along the policy frontier. The plausibility of this explanation lies in the details of the frontier's construction, and specifically, the timing of the "game" between policymakers and private agents. The structure of the BCEM model assumes a simultaneous move game with the private agents' strategy captured by the information acquisition rate, the government strategy captured by monetary policy, and with ω parameterizing the preferences of the government. This timing assumption can result in a prisoner's dilemma in which the economy is trapped in an inefficient outcome. The Great Moderation obtains in this game given an exogenous increase in preferences ω. As an alternative, we could specify the structure as a Stackelberg game with the government as the large player who moves first. In such a setting, policymakers could announce a policy consistent with preferences less activist than their own, and thereby choose their preferred point on the frontier. The Great Moderation could then be explained by assuming that until 1983 policymakers believed λ was exogenous, as in the BMR model, and that after 1983 the government became aware of the endogeneity of λ and exercised its first-mover status.

While both of these timing structures are consistent with the model, and both are capable in theory of explaining the Great Moderation, they are less plausible as an historical account, since they require that policymakers understood the BMR model, in either its original form or our extension, decades before the BMR model was published, and that they followed the associated optimal policy rule. We find it more plausible to assume bounded rationality on

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the part of policymakers, as well as private agents, and to think in terms of an evolution and improvement over time in the exercise of monetary policy. In this paper we elaborate on the mechanics of this evolution by developing a natural setting in which policymakers, as well as private agents, are neither naive nor fully informed rational, but instead are boundedly rational in the spirit of Marcet and Sargent (1989), Sargent (1999) and Evans and Honkapohja (2001). This modeling environment eliminates the strategic interaction between the government and private agents and avoids the timing dependencies mentioned above; it instead allows us to investigate whether an informationally realistic modeling of agent and government behavior can support the theoretical conclusions of BCEM. In particular, we study whether in an adaptive learning setting the simultaneous decline in economic volatility remains a possibility.

We consider a system initially in equilibrium and analyze the impact of an exogenous increase in ω. Our numerical results track the BCEM theoretical results showing that a simultaneous decline in price and output volatility is possible, but with one significant difference: initially, when the new policy rule is implemented, output volatility rises in line with the "standard" view of a trade-off – this rise reflects the transitional period in which λ adapts over time to its new lower equilibrium level. However, in the long-run, output as well as price volatility decline permanently. Our adaptive learning version of the model provides results that are more hopeful than those of Sargent (1999) in the sense that with appropriate policy a permanent decrease in volatility is possible.

2 BMR Model in Reduced Form

Ball, Mankiw and Reis (2005) develop a simple model, along the lines of Woodford (2003), with monopolistic competition and optimal monetary policy. Their novelty is the information structure: agents update their information with exogenous probability $0 < \lambda < 1$ each period, and each agent sets a price path optimally every period, subject to their information constraint.[5] The equilibrium for the model is represented by two reduced-form equations,

$$p_t \;=\; \lambda \sum_{j=0}^{\infty} (1-\lambda)^j E_{t-j}\left[p_t + \alpha y_t + u_t\right] \tag{1}$$

$$y_t \;=\; \hat{m}_t - p_t, \tag{2}$$

where p_t is the price-level, y_t is aggregate output, and $u_t = \rho u_{t-1} + \varepsilon_t$ are mark-up shocks that follow a stationary AR(1) process.[6] Equation (1) is a Phillips curve and represents the aggregate supply relationship of the economy. The bracketed term is the usual expression for a firm's optimal price where α is the elasticity of the aggregate supply curve under full information.[7] Equation (2) is a quantity-equation theory of aggregate demand and is

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[5]Reis (2006) provides further microfoundations to this approach.

[6]All variables are in log deviations form. BMR and BCEM also include demand shocks. We omit these shocks to ease exposition.

[7]See Woodford (2003) for detailed discussion.

derived from a cash-in-advance constraint. The variable $\hat{m}_t$ is the policy instrument set at time $t-1$ according to a rule that maximizes a second order welfare approximation, given by $Var(y_t) + \omega E(Var_i(p_{it} - p_t))$, where the second term denotes the expected cross-sectional variance of prices. BMR show that the equilibrium has an $MA(\infty)$ representation of the form

$$p_t = \sum_{j=0}^{\infty} \phi_j \varepsilon_{t-j} \text{ and } y_t = \sum_{j=0}^{\infty} \varphi_j \varepsilon_{t-j},$$

for appropriately defined ϕ_j, φ_j. The key insight of Branch, Carlson, Evans and McGough (2006) is that, when λ is endogenous, ϕ, φ depend on λ and vice-versa.

In BCEM individual agents are assumed to choose their information acquisition rate λ, given aggregate $\bar{\lambda}$, according to the best-response function

$$T(\bar{\lambda}) = \arg \min_{0 \le \lambda \le 1} \left(E \left(\hat{p}_t(\lambda) - p_t^*(\bar{\lambda}) \right)^2 \right) + C\lambda^2 \right) \tag{3}$$

where $C\lambda^2$, $C > 0$, is the cost to updating and utilizing information at rate $0 \le \lambda \le 1$. Here $p_t^*(\bar{\lambda})$ is the optimal full information price at t and $\hat{p}_t(\lambda)$ is the agent-specific stochastic process for the price set at t by a firm with information acquisition rate λ. Like BMR, we interpret broadly the costs of information updating, to include not just the cost of obtaining but also the cost of processing the information. That agents seek to minimize a quadratic loss function is motivated by the learning literature (e.g. Evans and Honkapohja (2001)) which models expectation formation as a statistical problem distinct from full utility maximization. Moreover, firms' profit maximization necessarily implies minimization of mean square forecast errors. An *Endogenous Inattention* equilibrium is defined by the fixed point $\lambda^* = T(\lambda^*)$. This is a symmetric Nash equilibrium, between the continuum of private agents and also the policymaker. In this "game" private agents choose λ and the central bank chooses its policy.

In BCEM we considered the following thought experiment: ω exogenously increases. According to the BMR model which takes λ as fixed, price variance decreases and output variance increases and the usual trade-off is implied; however, with endogenous λ, higher ω implies that equilibrium λ will decrease, reducing both price and output volatility. Economic volatility declines with decreases in λ^* since firms do not pass on distortionary mark-up shocks to prices as often. Our thought experiment provided the following conclusion: an increase in ω directly increases output volatility as variation in prices is shifted to variation in output; and it indirectly reduces output volatility through the endogenous response of λ^*. The overall impact on output variance depends on the relative strengths of these effects, and Figure 1 shows that a simultaneous reduction in both price and output volatility is indeed possible.

3   Adaptive Learning and Changes in Monetary Policy

As indicated in the Introduction, the result of the thought experiment discussed above depends on the timing of the game between policymakers and private agents. Rather than

consider the different implications of alternate game structures and debate their plausibility as theoretical explanations for the Great Moderation, we find it more natural to extend the bounded rationality viewpoint to policymakers, as well as private agents, and to think in terms of an evolution of monetary policy.[8] We model the expectations of both policymakers and private agents using the adaptive learning approach described in Evans and Honkapohja (2001). Least squares learning allows policymakers and private agents to learn how to make optimal forecasts, given their information sets, without knowing structural parameters, and also allows them to appropriately track structural change. This makes policy and λ time-dependent. A natural question arises: to what type of equilibrium will this adaptive version of the economy converge (if any)? If, after removing the strategic interaction of the model, the economy converges to the Nash equilibrium/endogenous inattention outcome, then additional support for the BMR/BCEM model is provided. This approach also allows us to consider the output-price volatility trade-off in terms of stability under adaptation. If the relevant equilibria are stable then an exogenous change in policymaker preferences could cause the economy to move to a lower point on the upward sloping section of the policy frontier, thus resulting in reduced volatility in both prices and output.

3.1   Real-time Learning Version of the Model

In BMR, policymakers choose their policy instrument in order to satisfy the first-order condition $E_{t-1}y_t = -\alpha\omega E_{t-1}p_t$ given their forecast for the price-level. This implies a rule

$$\hat{m}_t = (1 - \kappa)E_{t-1}p_t, \tag{4}$$

where $\kappa = \alpha\omega$, for setting the policy instrument $\hat{m}_t$, at time $t - 1$. Such a rule is close to the one studied, for example, by Taylor (1980), who refers to $1 - \kappa$ as the "degree of accommodation" (to price shocks).[9] In the numerical simulations below, it is convenient to report the effects of the policy shift in terms of an increase in ω, but the policy change can equivalently be interpreted simply in terms of a reduction in activism or in the degree of accommodation. In particular, our results do not require that we associate policy with the welfare function of BMR: no knowledge of the structure of the economy on the part of policymakers is needed. Implementation of this rule still requires forecasts of prices. Since we do not want to assume full knowledge of the structure by policymakers we replace $E_{t-1}p_t$ by an econometric forecast $\hat{E}_{t-1}p_t$ based on a reduced form time-series model.[10] In equilibrium, the price process is $MA(\infty)$ and it is natural to assume that policymakers approximate this

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[8]In his comments on Orphanides and Williams (2005), Evans (2005, pp. 241-2) stresses the advantages of models with "cognitive consistency" between private agents, policymakers and economists.

[9]The F.O.C. is a "specific targeting rule" of the type advocated and discussed in detail by Svensson (2003). As stressed by Svensson (2003), one of the advantages of this type of rule is that its specification does not require knowledge of the full structure of the economy. We note, however, that Svensson does not advocate money supply rules.

[10]Other implementations of bounded rationality are possible in which policymakers make use of their knowledge of the structure. For a discussion of optimal monetary policy with structural parameter learning see Evans and Honkapohja (2003). The key qualitative results of the current paper are unlikely to depend on the detailed implementation of learning.

process using an ARMA(r, q) specification. In addition we assume that the exogenous shocks ε_t are observable at t, so that policymakers can use recursive least squares (RLS) to update the estimates of their ARMA model's parameters.[11] Policymakers thus set $\hat{m}_t$ according to (4) with $E_{t-1}p_t$ replaced by $\hat{E}_{t-1}p_t$.

In BMR, firms are price setters and would prefer to set price to

$$p_t^* = p_t + \alpha y_t + u_t$$

each period. However, there is a cost to processing new information. We assume that firms do not know the full economic structure and are thus unable to form fully rational expectations or to compute the optimal λ, given their costs. Instead, firms hire consultants to provide real-time estimates of both optimal price forecasts and of the optimal λ, given the costs to the firm $C\lambda^2$ of updating prices at frequency λ. We think this set-up is a reasonable stylized description of actual agent behavior.[12]

Consultants act as information gatherers, providing to firms forecasts of future optimal prices as well as the optimal rate of information processing.[13] Consultants, like the policymakers, are assumed not to know the full structure of the economy and to forecast using a reduced form ARMA model. Each period consultants forecast the value of p_t^* using an ARMA(r, q) specification, with ε_t observable.[14] We could instead have the consultants forecast p_t, y_t and u_t separately, and then combine them to construct the forecast of p_t^*. The impact on our results of this alternative set-up would be minimal. As before, the ARMA(r, q) can be estimated using RLS. Consultants are willing to provide $\hat{E}_t p_{t+k}^*$, for $k = 0, 1, 2, \ldots$, either free of charge or for a fixed fee willingly paid by all firms; however, the consultants are aware that firms incur a cost of information processing. The consultants therefore also provide to firms an estimate of the optimal rate of information accrual, λ_t, by solving the firm's optimization problem (3) using an estimate of the mean-square forecast error in (3), based on their estimated ARMA(r, q) process for p_t^*. Note that $E\left(\hat{p}_t(\lambda) - p_t^*\right)^2$ can be directly computed for any given λ given any assumed time-series process for p_t^*.

It is worth emphasizing that although the consultants know the value of λ_t and have memory of the conditional forecasts $\hat{E}_{t-j}p_t^*$, the consultants do not know the full structural equations and so do not know how this translates into actual prices and, hence, actual optimal prices. This learning set-up is constructed specifically so that none of the agents know how λ_t affects the actual dynamics. Convergence to a Nash Equilibrium then provides additional theoretical support for the endogenous inattention equilibrium concept.

The following system, written in recursive causal ordering, describes the evolution of the

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[11]See Evans and Honkapohja (2001) for a detailed discussion of least-squares learning in dynamic macroeconomics.

[12]For example, Carroll (2003) provides evidence that consumer expectations follow a distributed lag of professional forecasters.

[13]The notion of a consultant is a descriptive device designed to remove the explicit strategic interaction between agents. Some of the roles of consultant could be served by newspapers, business publications, Central Bank forecasts or the forecasting community more generally.

[14]We could instead assume that policymakers forecast with an ARMA(r', q') with (r', q') possibly different from (r, q). However, this would not change the results below.

economy under adaptive learning (and summarizes the preceding discussion):

$$\hat{E}_{t-1}p_t = \{\text{ARMA(r, q) Policy Maker Forecast}\}$$

$$\hat{m}_t = (1 - \kappa)\hat{E}_{t-1}p_t, \text{ where } \kappa = \alpha\omega.$$

$$\hat{E}_t p_{t+k}^*, \ k = 0, 1, \ldots = \{\text{ARMA(r, q) Consultant Forecast}\}$$

$$\lambda_t = \{\text{Consultant Computed}\}$$

$$p_t = \sum_{j=0}^{\infty} \lambda_{t-j} \prod_{i=0}^{j-1}(1 - \lambda_{t-i})\hat{E}_{t-j}p_t^*$$

$$p_t^* = \alpha\hat{m}_t + (1 - \alpha)p_t + u_t,$$

where the last equation is obtained using the AD relation and the definition of p_t^*.

We now address two questions: First, will this economy converge to the equilibrium associated with a Nash equilibrium of the BCEM model? Second, suppose that ω increases exogenously. Will the economy converge to a new, more "moderate" Nash equilibrium?

3.2   Numerical Results

We first start with what BCEM term the benchmark case, specified to remain consistent with the values chosen in BMR.[15] We set $\alpha = .1, \sigma_\varepsilon^2 = .1, C = 5, \rho = .85$. Woodford (2003) emphasizes the case $\alpha \leq 1$ where goods are strategic complements. The cost parameter C is measured in terms of MSE units and so does not have a natural utility interpretation. The value $C = 5$ was found to be a moderate value in the sense of not leading to extreme results, though similar qualitative findings arise for other values of C. We set the ARMA parameters to $r = 1, q = 5$ as these provide a good approximation to the actual stochastic process. This parameterization yields an upward sloping policy frontier. Figure 2 illustrates the results from a typical simulation when $\omega = 15$.

As indicated by Figure 2, λ_t converges to its Nash equilibrium value, marked by the horizontal line in the top panel. In the bottom two panels, the time t estimates of the unconditional variances of price and output are plotted. These estimates were obtained using a moving average with window length 500; thus the horizontal scales in these figures do not include the transient period. The horizontal lines in these panels correspond to the theoretical variances of output and price at the associated Nash equilibrium.

The results of Figure 2 strongly suggest that the Nash outcome is stable under our adaptive model. The intuition for this stability is as follows. For fixed λ, the ARMA models are approximations to the true MA(∞) equilibrium price process. Since the true process depends on the underparameterized ARMA models – through policy and λ_t – the equilibrium here is similar to the Restricted Perceptions Equilibrium (RPE) defined in Evans and Honkapohja (2001). Moreover, the RPE in models with an expectational structure

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[15]These parameter values are chosen for illustrative purposes and are not calibrated in any serious sense.

Figure 2: Stability of Endogenous Inattention under Learning
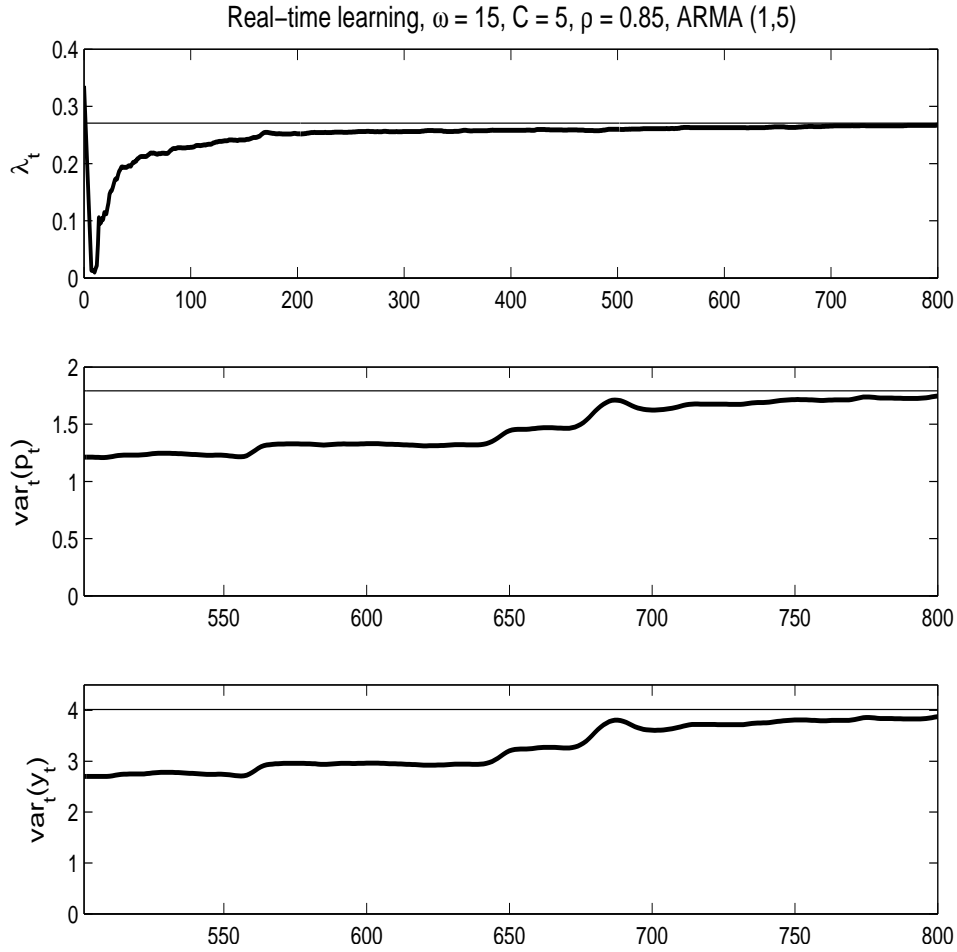
similar to the one presented here are stable under adaptive learning. Furthermore, for a fixed price process we restrict attention to Nash equilibria that are stable fixed points of our T-map in the sense that $T'(\lambda^*) < 1$. Thus, it is not surprising (though not obvious) that these two stable mechanisms imply convergence.

We now turn to examining the simultaneous decline in output and price volatility in real-time. The conjecture is that as policy becomes less activist, there is a tendency for price variance to decrease, resulting in an eventual decrease in equilibrium attentiveness, λ, that induces lower output variance. We thus now assume that during the simulation there is an exogenous increase in ω from $\omega = 15$ to $\omega = 30$. The increase in ω could be due to a shift in policy stance accompanying the appointment of a conservative central banker, and could be thought of either as exogenous or as a response by the government to a series of adverse price shocks.

Figure 3 illustrates the results from a typical simulation. Initially, (after a transient period of length 600), the economy is near the equilibrium corresponding to $\omega = 15$. At time $t = 800$, ω increases abruptly from 15 to 30. Figure 3 demonstrates that, prior to the

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change in policy, the real-time learning dynamics are near their Nash equilibrium values. Immediately following the policy change, price volatility plummets as predicted, but output volatility rises. This reflects the fact that though λ_t is falling from its pre-shock level, it has not yet reached its new equilibrium level; thus, temporarily, the usual trade-off exists. As λ_t gets close to its new equilibrium level, however, both volatility time-series converge to levels lower than those of the pre-shock equilibrium, and the economy exhibits a "Great Moderation."

Figure 3: Changes in policy preferences in real time. At time 800, ω increases to 30.

$C=5$, $500 \leq t \leq 800$: $\omega=15$; $t \geq 800$: $\omega=30$, $\rho=.85$, ARMA(1,5)
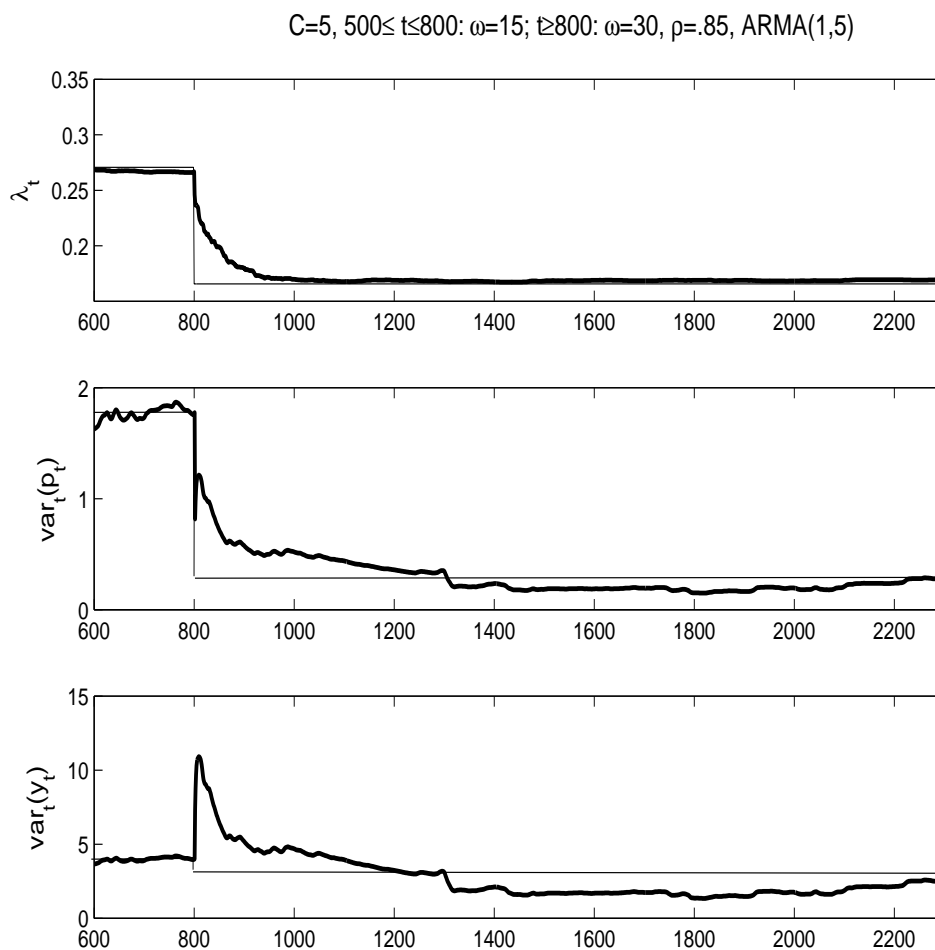
We emphasize that we have not attempted to calibrate our model to provide a description of the actual historical experience. Any serious exercise along these lines would require significantly more detail for both the aggregate demand and the aggregate supply sides of the model. Nonetheless, the finding that a Great Moderation is possible in the model, with a boundedly rational policymaker and adaptive learning by all agents, is significant. These results suggest that a possible application of the theoretical approach taken in this paper would be an empirical examination of the Great Moderation, allowing for policy change and an endogenous response in the attentiveness of economic agents.

4   Conclusion

This paper formulates an adaptive learning version of the endogenous inattention model of Branch, Carlson, Evans and McGough (2006). In this formulation policymakers set policy in order to satisfy their first order optimality condition but replace expectations based on the structural model with recursively updated ARMA forecasts. Similarly, private sector agents use an ARMA model to forecast their optimal price, given their rate of information acquisition. It was shown that this economy converges to the Endogenous Inattention equilibrium of Branch, Carlson, Evans and McGough (2006). Moreover, with a change in policymaker preferences, the central bank and the private-sector can eventually learn a new equilibrium with both lower price and output variance, thus providing an explicit mechanism for explaining the Great Moderation – a mechanism that is consistent with the Bernanke hypothesis. These results provide additional support for the theoretical results in Branch, Carlson, Evans and McGough (2006), Ball, Mankiw and Reis (2005) and others, since they show that the interaction of optimal policy and limited attention on the part of private sector agents has important practical policy implications that are not sensitive to the particular timing protocol of these models.

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