Journal of Economic Dynamics & Control 38 (2014) 184–208

Contents lists available at ScienceDirect

Journal of Economic Dynamics & Control

journal homepage: www.elsevier.com/locate/jedc

Monetary policy for rationally inattentive economies with staggered price setting

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ARTICLE INFO

Article history:
Received 17 October 2009
Received in revised form
20 August 2013
Accepted 24 September 2013
Available online 20 October 2013

JEL classification:
E52
E31
D83

Keywords:
Monetary policy
Information processing constraint
Information dispersion
Nominal rigidities

ABSTRACT

The paper examines the optimal monetary policy when firms are constrained by information processing capability and infrequent price adjustments. Firms' information processing limit gives rise to imperfect knowledge about macroeconomic aggregates and endogenous information learning contingent on the monetary policy. Staggered price setting introduces the observed price duration and additional policy tradeoffs resulting from the interactions between nominal rigidities and imperfect information processing. The integrated model implies an optimal policy that commits to complete price stabilization in response to natural rate shocks but not in response to markup shocks. In the presence of markup shocks, it is optimal for the central bank to focus on price stabilization in the initial periods following markup shocks and shifts the emphasis to output gap stabilization later. Moreover, larger information capacity, stronger complementarities and more persistent shocks require more aggressive price stabilization in the short-run.

1. Introduction

This paper studies the optimal monetary policy in a Taylor staggered-pricing economy in which firms pay limited attention to aggregate variables.

What policy should a central bank follow? It is a classic question in macroeconomics. The answers reflect economists' belief about how the economy works, what should be valued, what monetary policy is feasible, and hence what explicit assumptions and models should be used.

To account for the real effect of monetary policy, the literature mainly focuses on two types for models for monetary policy analysis: imperfect information models and models with short-run nominal frictions. The widely used New Keynesian models, such as Goodfriend and King (1997), and Clarida et al. (1999), assert that firms' price adjustment is infrequent and time-dependent. Despite their ability to generate monetary neutrality and appealing microfoundations, it is found that such models encounter difficulties in generating plausible effects of monetary policy, such as counterfactual costless deflations (Ball, 1994) and failure to generate a delayed and persistent effect on inflation (Mankiw and Reis, 2002). The basic New Keynesian model thus has been modified by incorporating a backward-looking component into the Phillips curve (e.g. Gali and Gertler, 1999). However, the modification is ad hoc, and it has been criticized for not able to explain the

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http://dx.doi.org/10.1016/j.jedc.2013.10.004

lack of inertia in early U.S. monetary regime when the economy operated under a gold standard and for ignoring the Lucas critique similar to the conventional Phillips Curve (Ball et al., 2005).

Another part of the literature focuses on the information structure in monetary models. Slowly disseminating or incomplete information can produce the observed sluggish inflation response to a monetary shock and account for monetary nonneutrality. For example, Lucas (1972) assumes that producers solve a signal extraction problem to infer aggregate prices. However, this idea has been criticized since macroeconomic data is widely available, and such information should be considered by a rational person. Mankiw and Reis (2002)'s sticky information model assumes frictions in updating information rather than updating prices. It successfully generates the inflation-output tradeoff and monetary nonneutrality, but suffers similar problems as Lucas (1972). The main mechanism for generating inertial inflation behavior is firms' price setting decision based on outdated information, but it is puzzling why some firms would use very old information when most macroeconomic variables are publicly available with little delay.

Rational inattention models, as in Sims (2003), may be able to solve this dilemma. The model claims that agents' inability to *process*, not obtain, the data perfectly prevents them from obtaining full information. Economic agents have a limited capacity to process information "attention", and they rationally choose to be less attentive to some available information and fail to incorporate full information in their decision-making. An information processing constraint is an appealing way to model information frictions for monetary models for several reasons. The method, discussed in Sims (2003) and initiated in information theory, is able to approximate information processing procedure while stepping away from the psychological details. Furthermore, optimality with limited information processing resources leads to information endogeneity. Agents' information learning and expectation are policy contingent, making the model robust to Lucas critique.

This paper makes progress towards determining the optimal monetary policy by integrating staggered pricing models with an information friction resulting from limited information processing capability. Firms have multi-period overlapping price contracts as in Taylor (1979), and they optimize their information processing to obtain the most accurate information given their constraints. Both information processing limits and infrequent nominal adjustment are empirically relevant features.[1] The integrated model is capable of generating a delayed price response to shocks and an amplified output response to monetary disturbances.

There are two types of shocks that cause aggregate fluctuations in the model: natural rate shocks, which are driven by technology innovations and change the efficient level of output, and markup shocks, which cause fluctuations without affecting the efficient level of output. The aggregate fluctuations lead to two inefficiencies. First, aggregate output may deviate from the efficient output as the shocks disturb firms' pricing and production process (real effect of shocks). Second, price dispersion arises, which leads to inefficient allocation of the production resources. In the model, the monetary authority solves a Ramsey problem and chooses a money supply rule to minimize these two inefficiencies.

The effectiveness of monetary policy depends on how the nominal and information frictions affect firms' pricing decisions. Monetary policy affect output gap variation through three channels. First, fundamental shocks directly lead to changes in output gap, the magnitude of which can be dampened by policy response. With incomplete information and price adjustment, a change in the money supply leads to a partial adjustment in output gap. Second, staggered pricing introduces an intertemporal link in firms' prices, allowing for any policy response to have a persistent effect on the output gap. Third, variations in economic fundamentals raise uncertainty. Tracking errors arise as firms' information processing is imperfect. A policy that facilitates learning improves the quality of information received by firms and leads to more efficient pricing and production decisions. Furthermore, inefficient price dispersion can also be traced to the two frictions in the model. Staggered price contracts lead to price difference across firms depending on their time of adjustment. Information heteorogeneity also contributes to price dispersion as firms base their pricing decision on their own information set. A monetary policy that emphasizes price stabilization and facilitates information processing thus can minimize the inefficiency caused price dispersion.

I find that an optimal policy implied by this integrated model should fully accommodate natural rate shocks and stabilize prices. However, when markup shocks are present, there are conflicting policy effects. Offsetting the markup shocks leads to price stabilization, which facilitates learning, reduces relative price distortion, and eliminates persistent shock effects. Intuitively, price stabilization allows for better knowledge of the aggregate price overall and more efficient pricing. It also helps firms that lack the ability to update their prices when a markup shock occurs, since the optimal reset price remains unchanged. Therefore, a price stabilization objective serves the tasks of (1) minimizing inefficient price dispersion and (2) minimizing the inefficient output gap variation due to tracking errors and intertemporal transmission of shock effects through staggered prices. However, markup shocks lead to inefficient fluctuations in output, which requires the central bank to accommodate the shock and let prices fluctuate. Therefore, a careful balance between the effects is necessary, and complete price stabilization is no longer optimal.

The tradeoff between the objectives is determined by firms' information processing capacity, strategic complementarities in pricing, and shock persistence. I find that it is optimal for the monetary authority to focus more on offsetting markup shocks and stabilizing prices in the short-run, and shifts to accommodating the shock and stabilizing output in the long-run.

[1] See, for example, Bils and Klenow (2004) and Nakamura and Steinsson (2008) for evidence of infrequent price adjustment and estimates of adjustment frequency; Radner (1992) regarding firms' limited managerial resources towards collecting and processing information and taking the corresponding actions; Coibion and Gorodnichenko (2012) for evidence of information rigidity and imperfect information modeling favoring rational inattention.