How can a monetary authority stimulate output? Promise a lot, deliver little.

Pavlo Buryi\(^1\)

Abstract

It is generally accepted that unanticipated inflation can be used as a monetary instrument to stimulate output. The presence of one-period sticky nominal wage contracts (Lucas (1972)) has often been viewed as a foundation for this stance. The present work provides theoretical as well as empirical evidence that contradicts Lucas’ hypothesis. I show that when firms index wages for the loss of purchasing power, unexpected inflation can reduce output. This finding suggests a new monetary policy. If the objective of a monetary authority is to stabilize the economy, it should generate less inflation than expected or even create surprise deflation.

Keywords: Monetary Policy, Indexation, Unanticipated Inflation

\textit{JEL Codes: E52, L2, J3}

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1. Introduction
In light of the recent economic recession a lot of attention has been given to the Federal Reserve System and some economists have questioned the behavior of the central bank and its policies. The debate revolves around two major questions. First, whether a central bank should prescribe the same kind of medicine each time the economy gets “ill”, in other words follow a simple rule, or should the treatment depend on the situation and the severity of the problem, and thus no rule can be applied. Second, whether a central bank should be transparent about its policies, or should it make decisions that are in the best interest of the economy despite the fact that it may require the central bank to deviate from its announced policies and behave in a discretionary fashion.

The rules are easy to follow, and the actions taken by the central banks that follow these rules, are easy to predict. However, if a central bank has some incentive to deviate (Fratianni, M., et al. (1997)) from the rule it might be hard for the government to commit. The game between the public and the central bank, which describes incentives of both parties, was introduced by Barro and Gordon (1983). Their model suggests that a central bank has incentive to produce unexpected inflation that would increase output due to the presence of one-period sticky nominal wages. This hypothesis was proposed by Lucas (1972) and provides an explanation for the permanent positive rates of inflation that have been observed over the last few decades.

I argue that the monetary authority remains useful when firms index wages to compensate for the loss of purchasing power, unlike Fisher (1977) who suggests that monetary policy loses effectiveness when firms index wages. Money are not neutral due to the fact that the demand side responds to indexation in a sluggish fashion while the supply side responds immediately to the higher cost of production. Bronchetti (2012) provides evidence that workers’ compensation does not fully offset a decrease in consumption. He finds that a 10% increase in benefits reduces a drop in consumption by 3% to 5%. This idea is used in my theoretical model to explain the negative effect of unanticipated inflation.

This paper aims to provide a simple, yet concrete analysis of the effect of unanticipated inflation on output. I show that unexpected inflation decreases the growth rate of output in the US. However, the central bank still has an incentive to behave in a discretionary fashion. It should concentrate its efforts on maintaining higher expectations of inflation and then surprise the public with lower and possibly negative inflation rates.

The remainder of this paper is organized as follows. In section 2, we propose a theoretical model to explain the negative effect of unanticipated inflation. Section 3 presents data and methods. Section 4 tests the proposed theory empirically, and Section 5 concludes.

2. Theoretical Model
To analyze the effect of unexpected inflation on output a simple and yet effective theoretical model is developed.

I consider a microeconomic model that consists of one perfectly competitive firm that produces a final good using one factor, labor. The wages are indexed once a year for the loss of purchasing power.

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2 This question, in very similar words, was asked by Lawrence Summers at a discussion panel during 2014 ASSA meeting in Philadelphia, PA.
The game between the firm and the central bank could be summarized as follows. In the first stage the firm hires labor, trains it, and sets nominal wages. In the second stage a monetary authority chooses a level of inflation, and in the third stage actual output is realized\(^3\).

In the first period the firm has to hire and train personnel before it can produce output. The firm chooses how much labor to hire by setting the expected price equal to the expected marginal cost. This condition is described below

\[
E_{t-1}[p_t] = (1 + E_{t-1}[\pi_t])w_{t-1}
\]  

(1)

where \(E_{t-1}[p_t]\) is time \(t-1\) expectation of price at time \(t\), \(E_{t-1}[\pi_t]\) is time \(t-1\) expectation of inflation at time \(t\), and \(w_{t-1}\) is nominal wage that both parties agreed on at time \(t-1\).

If the linear demand function\(^4\) is assumed, then the expected output is described by the following equation

\[
E_{t-1}[y_t] = \frac{\alpha - (1 + E_{t-1}[\pi_t])w_{t-1}}{\beta}.
\]  

(2)

In the second stage the central bank chooses the level of inflation in an attempt to stimulate output.

In the third stage, after \(\pi_t\) is realized, optimal output can be different from what was expected and is equal to

\[
y_t = \frac{\alpha - (1 + \pi_t)w_{t-1}}{\beta}.
\]  

(3)

If actual inflation is greater than what was expected the cost increases and because the firm cannot adjust the price, output goes down, and the opposite occurs if inflation is lower. In other words, inflation increases the costs of inputs and shifts the supply curve to the left. Another effect of inflation is to increase the income of workers that consume the final good. Therefore, the demand curve should shift to the right. Movement of the supply and the demand curves in opposite directions should preserve output at the same level, but at a higher price, implying money neutrality.

What gives rise to the effectiveness of monetary policy is the assumption that the demand for the good that the firm produces is not affected by indexation, while supply of the good decreases to account for the higher price of inputs. In this theoretical model the central bank is the only source of inflation, which directly affects the cost of production.

The difference between actual output and expected output is equal to

\[
E_{t-1}[y_t] - y_t = \frac{(\pi_t - E_{t-1}[\pi_t])w_{t-1}}{\beta}.
\]  

(4)

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\(^3\) The game between the firm and the central bank is beyond the scope of this paper, instead we are interested in analyzing the incentives faced by the firm.

\(^4\) Inverse demand function of the form \(p_t = \alpha - \beta x_t\)
This equation can be rewritten to derive the expression for current output

\[ y_t = E_{t-1}[y_t] - \frac{(\pi_t - E_{t-1}[\pi_t])w_{t-1}}{\beta} = \frac{\alpha - (1 + E_{t-1}[\pi_t])w_{t-1}}{\beta} - \vartheta \frac{(\pi_t - E_{t-1}[\pi_t])w_{t-1}}{\beta} \]  

(5)

where the coefficient \( \vartheta \) represents the degree to which the firm can adjust output. If \( \vartheta = 0 \) then the firm cannot adjust output and produces output at the level expected in the previous period. In other words, they cannot hire or fire any workers. The firm can adjust labor demand if \( \vartheta > 0 \).

Comparative static analysis suggests that unanticipated inflation decreases output

\[ \frac{dy_t}{d(\pi_t - E_{t-4}[\pi_t])} = -\frac{\vartheta w_{t-1}}{\beta} < 0 \]  

(6)

In the next section, we use OLS and GMM methods to derive the parameters of the theoretical model.

3. Data and Methods

3.1 Data

To test my theoretical model I use US data obtained from the St. Louis Federal Reserve web-site. I use the following quarterly data series: Real GDP (percentage change from year ago) seasonally adjusted, CPI: Total All Items (percentage change from year ago) seasonally adjusted, Average Hourly Earnings of Production and Nonsupervisory Employees: Total Private. To measure unexpected inflation I interchangeably use two variables: “University of Michigan Expected Inflation”, and “Consumer Opinion Surveys: Consumer Prices: Future Ten Year Index for the United State Constructed”. The constructed data set covers the period of time from 1948Q1 to 2014Q1.

The University of Michigan Expected Inflation series provides estimates of expected inflation at time \( t \) for the next 12 months. In order to find what inflation was expected a year ago to be now, one has to look at the value of the variable at time \( t-4 \), because we use quarterly data. The same is true for Consumer Opinion Surveys, \( E_{t-4}[\pi_t] = Cos_{t-4} \).

The reason why I use annual growth rates rather than percentage changes from period to period is because in the theoretical model the firm indexes wages once a year, and not each quarter. It is also reasonable to assume that the economy consists of more than just one firm and in each quarter, there is at least one firm that indexes wages. Therefore, the use of quarterly percentage change from a year ago data seems logical for our purposes. It is worth mentioning that although actual inflation is sometimes negative, expected inflation is always positive.

3.2. Methods

To test whether proposed theory is valid I estimate the following regression.

\[ y_t = \Gamma + E(1 + E_{t-4}[\pi_t])w_{t-4} + Z(\pi_t - E_{t-4}[\pi_t])w_{t-4} + \varepsilon_t \]  

(6)
where $\Gamma = \frac{\alpha}{\beta}$, $E = \frac{1}{\beta}$, and $Z = \frac{\vartheta}{\beta}$. We expect $E < 0$ and $Z < 0$, because as the cost of production goes up the quantity produced should go down. Once we know $E$ and $Z$ we can find $\vartheta$, the effect of unexpected inflation on output. Augmented Dickey-Fuller test is conducted to conclude that all series are stationary. The only series for which I cannot reject the null hypothesis of the unit root at 10% is $(1 + Mich_{t-4})w_{t-4}$, Wage series is known to be highly persistent and has the distinct upward trend which causes the unit root concerns. I will proceed by assuming that this series is stationary.

4. Empirical Estimation

I use OLS, and GMM methods to estimate the parameters of the model. To account for autoregressive nature of the growth rate of real GDP I control for its first lag. The final equation that is estimated takes the following form

$$y_t = \Gamma + E(1 + E_{t-4}[\pi_t])w_{t-4} + Z(\pi_t - E_{t-4}[\pi_t])w_{t-4} + \Theta y_{t-1} + \varepsilon_t. \quad (7)$$

The results from the estimation of the theoretical model are presented in Table 3.

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<tr>
<th>Table 3. Estimation the Theoretical Model</th>
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<tr>
<td>Model and Method</td>
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<tr>
<td>Dependent_Variable</td>
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<tr>
<td>Growth_Rate_of_GDP</td>
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<td>Independent_Variable</td>
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<td>Constant</td>
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<td>$(1 + COSt_{t-4})w_{t-4}$</td>
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<td>$(1 + Mich_{t-4})w_{t-4}$</td>
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<td>$R^2$</td>
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*** reject at 1%, ** reject at 5%, * reject at 1%; t-statistics in brackets

High $R^2$ statistics suggests good fit of the model, and all coefficients are of expected sign and are statistically significant. The results of estimation of the extended model provide strong evidence that the proposed theoretical model is valid, and indeed, unanticipated inflation reduces the growth rate of real GDP.

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5 First lag of each independent variable are used as instruments
Conclusion
When the monetary authority attempts to facilitate the growth rate of real GDP by creating unexpected inflation it should carefully consider the possible negative effect of such a policy. Indeed, the positive relationship between output and unexpected inflation due to the presence of one period nominal wage contracts, as proposed by Lucas, might not be the only effect of this monetary instrument. This article provides evidence that it is in the government’s best interest to maintain high expectations of inflation while keeping the actual inflation rate at or below zero, and proposes a new policy tool such as unexpected deflation that can be used, under certain circumstances, to stimulate growth of output.

Reference: