Price Stabilization and Disinflation in the Monetary Policy Model

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Abstract:

In this paper I will compare and contrast the monetary policy of New Zealand in the 1980's and 1990's with the monetary policy of the U.S. in the 1980's. The evolution of the monetary policy model following a shock or series of shocks is thoroughly discussed, using these two countries as concrete examples. The intended purpose of this work is to provide insight into the theoretical framework of the model, sufficient information to understand the process of building the model, and an overview of my findings.

Introduction:

Monetary policy is a set of tools that central banks across the world utilyze to manage inflation, unemployment, and output. Monetary policy gives a central bank the power to stimulate a distressed economy and boost output; while a similar approach can be used to quell extreme inflation in an economy that is expanding too rapidly. Furthermore, monetary policy provides a narrative of the moving parts in an economy following a shock and the nature in which it returns to equilibrium. Without an effective monetary policy, a country loses its ability to respond appropriately to the unpredictable fluctuations of the international economy, posing concerns for the well being of its people and economic stability.

This paper draws from information provided in a monetary policy model memo (Hawkins, 2020); as well as, lecture slide decks published by Doctor R. Hawkins of U.C. Berkeley (Hawkins, 2020). The resources mentioned provide the framework and foundation for further research; explaining key equations, important concepts, and giving real world examples of monetary policy in the macroeconomy. Given this background information, I chose a

particular country and specified time period to further explore and evaluate the response of a central bank employing the methods outlined in these resources.

In this paper we will be analyzing the policies set by the central bank of New Zealand (known as The Reserve Bank of New Zealand) between 1985 and 1995, discussing the rationale behind these decisions, and explaining the interdependence of the variables within the prominent equations of monetary policy. In addition, I will compare the similarities and differences of the monetary policy response in the U.S. during the 1980's under chair of the Federal Reserve Paul Volcker with the response in New Zealand. In general, I will provide the theoretical framework needed to understand the model, an in depth analysis of the monetary policy model used, and discuss the conclusions drawn from my study.

Theory:

Most central banks have a dual mandate to minimize the inflation and output gap. More specifically, the central bank attempts to keep inflation close to target inflation and output close to potential output. This dual mandate of the central bank is observed in the **Loss Function**:

$$L = \left(y_t - y^P\right)^2 + \beta\left(\pi_t - \pi^T\right)^2 \tag{1}$$

In this equation y_t denotes output at time t, y^P denotes potential output, π_t denotes inflation at time t, π^T denotes target inflation, β denotes the weight placed upon inflation, and L denotes the loss resulting from these gaps.

The central bank can control output (y_t) through the policy rate (r_t) using the dynamic IS curve, closing the output gap and making the first term in the loss function equal to zero. However, by closing the output gap the central bank loses influence over inflation via the **Short Run Aggregate Supply Curve**.

$$\pi_t = \pi_{t-1} + \gamma\left(y_t - y^{P}\right) \tag{2}$$

To mitigate this issue, the central bank employs constrained minimization observed in the **Optimal Path Equation**:

$$\left(y_t - y^{P}\right) = -\beta\gamma\left(\pi_t - \pi^{T}\right) \quad \text{or} \quad \tilde{y}_t = -\beta\gamma\tilde{\pi}_t \tag{3}$$

In these equations we see a new variable appear; γ, which is the product of Okun's coefficient found in Okun's law and ω found in the expectations augmented phillips curve. We also introduce the tilde notation denoting a gap, simply for a more concise representation.

The primary tool used in monetary policy is adjusting nominal short term interest rates to achieve the objectives of the central bank. This can mean raising the rate to cool down the economy if inflation is too high, or lowering rates to stimulate economic growth in a struggling economy. In the United States this rate is known as the Federal Funds Rate; in New Zealand the central bank refers to this rate as the Official Cash Rate. The equation used by central banks to determine where the rate should be set is described by the **Optimal Rate Rule**:

$$r_t = r^* + \frac{1}{\zeta_y\left(\gamma + \frac{1}{\gamma\beta}\right)}\left(\pi_t - \pi^{T}\right). \quad \text{or} \quad \tilde{r}_t = \frac{1}{\zeta_Y\left(\gamma + \frac{1}{\gamma\beta}\right)}\tilde{\pi}_t \tag{4}$$

In this equation r_t denotes the interest rate at time t and r* denotes the equilibrium interest rate. We can see from this equation that r*, ζ_y, β, γ, and the inflation gap all play a part in setting the interest rate. In addition, the equilibrium rate r* equation contains components of the **IS Curve** and the **Cobb Douglas Production Function**:

$$r^* = \frac{1}{\zeta_Y}\left(\overline{Y} - Y^{P}\right) \quad \text{with} \tag{5}$$

$$\zeta_Y = \frac{\zeta_C + \zeta_I + \zeta_{NX}}{1 - mpc} \quad \overline{Y} = \frac{\overline{C} + \overline{I} + \overline{G} + \overline{NX} - mpc \times \overline{T} - \overline{S}}{1 - mpc} \quad Y^P = AK^\alpha L^{1-\alpha} = K^\alpha (EL)^{1-\alpha}$$

It is important to include these equations because it shows the interrelationship of the major equations in macroeconomics and their role within the monetary policy model. We see from this equation that an increase in any of the variables within $\overline{Y}$ bar increases r*, ultimately increasing r_t. Similarly, we see that an increase in any of the variables composing Y^P would decrease r* resulting in a decrease of r_t. By this, it becomes evident how an array of factors impact the interest rate.

A large portion of the analysis of monetary policy is to understand the relationship of gaps; i.e., whether a given variable has a positive or inverse relationship with another given variable. An equation that aids us in understanding the relationship between the unemployment gap and output gap is **Okun's Law**:

$$(u_t - u_N) = C_{okun}(y_t - y^P) \tag{6}$$

Here, u_t is the unemployment rate at time t, u_N is the natural rate of unemployment, and C_{okun} is the slope of the linear regression line of the gaps. By this equation we learn that output and inflation have an inverse relationship.

Open market operations (OMO) are the primary way in which central banks control the short term interest rate and is also a means to manipulate the money supply. These are known as **Repo and Reverse Repo** transactions; in which securities are traded between the central bank and commercial banks:

$$r_{\text{repo}} = \underbrace{\left(\frac{p_1 - p_0}{p_0}\right)}_{\text{return}} \underbrace{\left(\frac{365}{t_1 - t_0}\right)}_{\text{annualization}} \tag{7}$$

In this equation $(p_1\text{-}p_0/p_0)$ equals the price a bond is repurchased, $(365/t_1\text{-}t_0)$ represents the time the bond is supposed to be repurchased, and r_{repo} equals the interest rate on the bond.

The half life of an economic shock is another important equation to understand. It provides us with the timeframe in which the given shock will decay halfway back towards equilibrium:

$$t_{1/2} = \frac{\ln(2)}{\gamma^2 \beta} \tag{8}$$

All equations in this section are sourced from a monetary policy memo (Hawkins, 2020). With the major equations of monetary policy presented and explained, we are now equipped with the necessary prerequisites to move forward with the process of analyzing real macroeconomic data and evaluating the underlying narrative of our model.

Analysis:

My first step in building a monetary policy model was to gather the appropriate data. I began with the output gap which I was able to download from (Quandl, 2020). Had the output gap data itself been unavailable, I would have had to find both output and potential output, then calculate the year over year change of these variables $((y_t\text{-}y^P)/y^P*100)$. Next, I found the unemployment rate from (FRED, 2020) and the natural rate of unemployment from (OECD, 2020). With this data I calculated the unemployment gap $(u_t\text{-}u_n)$, and these values were already in terms of percentage. These two values were saved in columns as y-obs and u-obs, meaning the true output gap and the true unemployment gap respectively. Next, I created two scatterplots to find ω and C_{okun} because I needed to find the value of γ (which is the product of ω and C_{okun}).

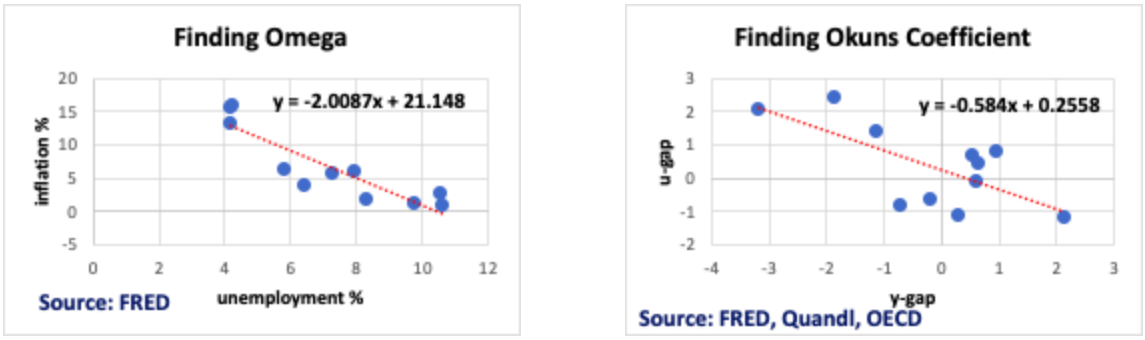

Figure 1: Calculating the needed variables for my model.

By adding a trendline to each chart and its corresponding equation, I was able to find ω which is the slope of the first equation, and C_{okun} which is the slope of the second equation. Multiplying them provided me with the value of γ during this time period. As for β and ζy I was unable to attain the true values from a source, so I simply used values that were reasonable and fit to the observed gaps well. With γ, β, ζy established I entered the rate factor equation $(1/\zeta y(\gamma + 1/\beta\gamma)$ in one cell and the half-life equation $(ln(2)/\gamma^2\beta)$ in an adjacent cell.

With the necessary data and variables established, I entered the values into a calculator built in problem set 7 that outputs the evolution of the gaps in monetary policy following an economic shock or series of shocks. The following table provides the values used in my calculator:

Variables	ω	C_{okun}	$\gamma = (\omega * C_{okun})$	β	ζy	Rate factor	Half-life
Values	-2.009	-0.584	1.173	0.5	0.5	1.251	1.01

Figure 2: Variables used in excel calculator with corresponding values.

I initiated two consecutive positive output shocks; one of **0.5** in 1986 and one of **3** in 1987; corresponding to the stimulating economic reforms during the mid 1980's in New Zealand, which I will discuss in further detail in the following section. I also initiated a positive inflation shock of **3** in 1990 and **4** in 1991 corresponding to the introduction of inflation targeting during the 1990's in New Zealand.

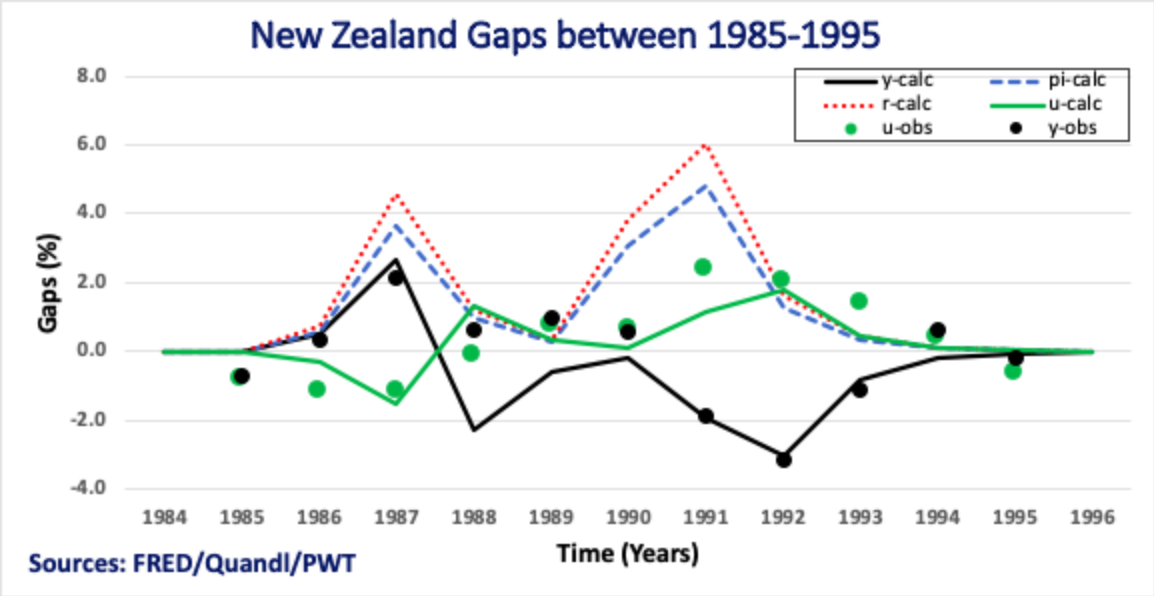

Figure 3: Monetary Policy in New Zealand, modeled using an excel calculator.

All "calc" values represent outputs from the excel calculator responding to the mentioned shocks I initiated. The "obs" values are representative of the gaps found from the real data gathered earlier. When attempting to match the real gaps with the gaps generated in the calculator, I decided it was more important to input shocks that made sense in terms of the historical context in New Zealand as opposed to matching the model perfectly to the data. Before explaining the evolution of my gaps over the time period I will first present two figures; the first showing the various supply and demand shock implications and the second providing insight to the interrelationship of the gaps and their corresponding equations:

Aggregate Supply Shock	$\Delta\pi$	**Positive shock-** $\downarrow \pi$	**Negative shock-** $\uparrow \pi$
Aggregate Demand Shock	Δy	**Positive shock-** $\uparrow y$	**Negative shock-** $\downarrow y$

Figure 4: Summarization of supply and demand shocks.

Gaps	*y and* π	*y and u*	*u and* π	π *and* r_t	r_t and y_t
Relationship	*Positive*	*Inverse*	*Inverse*	*Positive*	*Inverse* (y_t *lagged)*
Equation	SRAS (2)	Okun's Law (6)	$\pi_t = \pi^e - \omega\,(u_t - u_N)$	Optimal rate rule (4)	$\tilde{y}_{t+1} = -\zeta_Y \tilde{r}_t$

Figure 5: The interrelationship of gaps in our monetary policy model.

With a better understanding of the equations that connect these variables, I will now describe the evolution of gaps during the first series of shocks in my model (*Figure 3*). Given the positive demand shocks boosting consumption and investment we observe an increase in output. The inverse relationship of output and unemployment is evident as unemployment decreases due to greater demand in labor to produce, there are more jobs available and employment spikes. Also, with an increase in employment the population has a greater disposable income, increasing demand and thereby increasing prices; i.e. inflation. Although inflation is not inherently problematic; it becomes a concern when it increases too quickly or sharply; as such, interest rates respond to this increase in inflation. For this reason we observe the increase in rates simultaneously with inflation, but the response of output to the interest rate change is lagged. Higher interest rates means borrowing is more expensive; so taking out a loan on a new car or a loan to begin a new business venture is less appealing to borrowers; in turn, decreasing output as these components are correlated. This cycle ultimately causes the economy to slowly evolve back to equilibrium and the gaps steadily close.

The second series of shocks seen in (*Figure 3*) are positive inflation shocks. Inflation is pushed down due to target inflation being set below the rate to drive down and stabilize prices. Lower inflation indicates to the central bank that interest rates should be decreased to incentivize borrowing. When rates are low there is a surge in borrowing because it is cheaper to start a business or buy a new home. This increase in consumption and investment means that output will rise (albeit the rise is a lagged response) and as output increases there is a higher demand for labor to produce goods, causing unemployment to decline. This decline in unemployment means that people have a higher disposable income and are willing and able to pay higher prices,

thereby increasing inflation. Again, this cycle causes gaps to shrink and pushes the economy back towards equilibrium.

Discussion and Summary:

In problem set 7 we evaluated the monetary policy model of the United States in the 1980's using the same approach outlined above; the results are as follows:

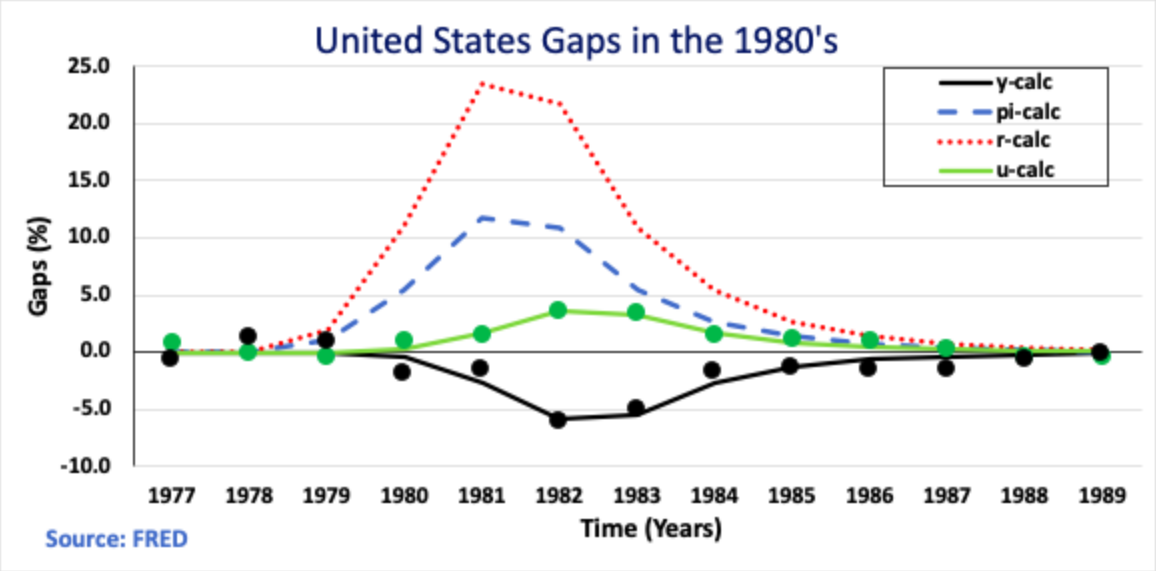

Figure 6: Monetary Policy in the United States, modeled using an excel calculator.

The shock series that were initiated in this calculator were positive inflation shocks of 1,5,9,5 between 1979-1982, respectively. The following table includes the other variables used in the calculator for this model in the United States:

Variables	$\gamma = (\omega * C_{okun})$	β	ζy	Rate factor	Half-life
Values	1	1	0.25	2	0.69

Figure 7: Variables used in excel calculator with corresponding values.

In the late 1970's and early 80's the United States experienced a significant rise in inflation, commonly referred to as "The Great Inflation". Thus, to combat this high inflation, Federal Reserve chair Paul Volcker implemented contractionary monetary policy; nearly doubling the fed funds rate from about 10% to 20% (Amadeo, 2020). This

action of setting absurdly high interest rates ultimately produced the results that Volcker had intended in terms of disinflation; however, it negatively impacted demand to such an extent that the United States experienced a recession in the coming year. After 1983 the economy steadily relaxed back to equilibrium and the gaps evolved towards zero.

While the United States implemented positive inflation shocks as contractionary measures against a booming economy, New Zealand utilized expansionary monetary policies to incentivize borrowing for investments and to increase aggregate demand. The Labour Party came to power in the 1980's and made some major reforms to the current economic layout; these included deregulation of the financial market and businesses, reduction of tariffs, and limited interference over interest rates (Singleton, 2008). These changes were reproduced in our model (*Figure 3*) as the positive output shocks in 1986 and 1987, which reduced the unemployment gap and caused the rate gap, inflation gap, and output gap to rise. Another important part of this evolution to note is the response of the output gap in 1988; as indicated earlier, output has an inverse lagged response to the interest rate, this is why we see the output gap go from positive to negative in the following year.

Another event to note during this timeframe is the international stock market crash known as black monday (black tuesday in New Zealand due to the time difference). My initial research into the economic shocks of New Zealand during this time period led me to believe that this event would send large waves through the economy and would be the ideal event to portray in my model. However, I soon realized after downloading the real economic data that this event did not shock the economic variables in the model in the way I had first predicted. Recollecting an earlier lecture slide deck on business cycles

(Hawkins, 2020) reminded me that the stock market is acyclical in relation to most of the prominent economic variables.

Perhaps the most intriguing monetary policy decision during this time period was the decision to exercise inflation targeting. In the early 1990's the Reserve Bank of New Zealand became the first regime in the world to implement inflation targeting (Singleton, 2008). They aimed to maintain a level of inflation between 1% and 3%, while putting lower priority on other facets of the economy. It should be noted that although I used a β value of 0.5 throughout the model, beta would have increased when the Reserve Bank of New Zealand introduced inflation targeting in 1990 because it represents the weight a central bank sets for inflation in their mandate. Even today, New Zealand focuses heavily on inflation and strives to maintain very stable prices.

In closing, the monetary policy model assists central banks in determining the actions they should take based on the economic forecast of the nation. Oftentimes, shocks come unexpectedly and the monetary policy model gives a central bank the means for a fast and proactive response. In our comparison of New Zealand and the United States, we follow the evolution of gaps following various shocks and the effectiveness of these policies to bring an economy back towards equilibrium becomes transparent. With the provided equations, in depth explanation of concepts, and thorough description of the interdependence between macroeconomic variables; this paper presents the foundation for future research into the forces of monetary policy.

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