Monetary Economics

Neo-Fisherian Monetary Policy

Gerald P. Dwyer

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Literature

- This class and next
  - Crowder,"The Neo-Fisherian Hypothesis: Empirical Implications and Evidence?" 2020, Empirical Economics
  - Lucas, "Econometric Policy Evaluation: A Critique", 1976, Carnegie-Rochester
- Next topic
  - Dwyer and Tkac,"The Financial Crisis of 2008 in Fixed-income Markets", 2009, Journal of International Money and Finance

Outline

1. Theory
   - Friedman"s Critique of Pegging Interest Rates
   - An Alternative Outcome under Rational Expectations
   - Forecast errors in announcement
   - Effect of change in interest rates
2. Some Empirical Evidence
   - Conclusion

Friedman on monetary policy implemented by interest rate I

- Friedman made the classic critique of implementing monetary policy by an interest rate
- Fed does not know equilibrium interest rate – "market rate"
- Suppose the economy is in equilibrium

$$
\begin{aligned}
m_t - p_t &= y_t - \beta i_t + \varepsilon_t \\
\beta &> 0 \\
y_t &= y^f
\end{aligned}
$$

Friedman on monetary policy implemented by interest rate I

- Suppose that the monetary authority sets the interest rate

$$i_t = i_t^{cb}$$

- Ignore ε_t
  - Suppose $\varepsilon_t = 0$
- So initially

$$m_t - p_t = y^f - \beta i_t$$

- Now central bank wants to set $i_{t+1} < i_t$
- Real income fixed
- Prices will not change right away
  - Initial value of price level is p_0
  - Let the initial value of the interest rate be i_0
  - Let the new value be $i_1 < i_0$
  - Initial value of nominal quantity of money is m_0

Friedman on monetary policy implemented by interest rate II

- The central bank must increase m to lower i

$$m_1 - p_0 = y^f - \beta i_1$$

- $i_1 < i_0$ implies $m_1 > m_0$
- Now over time p increases because m has increased and people spend more on goods and services
- As a result i tends to increase back toward i_0
- The central bank, to keep i down, must increase m again
- This tends to raise prices again
- This is not all of the story – things get worse
- Eventually, people will notice that inflation is higher and i will tend to increase more because the equilibrium interest rate now is above initial i, i_0
- The central bank will have to increase m at a more rapid rate to keep i down and inflation will accelerate

Friedman on monetary policy implemented by interest rate III

- Implication: Holding the interest rate down will generate accelerating inflation
- Conversely, raising the interest rate and keeping it there will generate accelerating deflation
- Lesson: Interest rates set by monetary policy are on a knife edge, on which being off a little bit can be disastrous

An Alternative Story I

- An alternative view, which can be called "Neo-Fisherian"
- Suppose, as above,

$$m_t - p_t = y^f - \beta i_t + \varepsilon_t$$
$$i_t = i_t^{cb}$$

- Add

$$i_t = r + \mathrm{E}_t \, \pi_{t+1}$$

- which implies

$$i_t = i_t^{cb}$$
$$i_t = r + \mathrm{E}_t \, \pi_{t+1}$$

- and therefore

$$i_t^{cb} = r + \mathrm{E}_t \, \pi_{t+1}$$
$$\mathrm{E}_t \, \pi_{t+1} = i_t^{cb} - r$$

An Alternative Story II

- This is an equilibrium only if the households respond to announcements of a change in the central bank's policy rate by changing their expected inflation rate by exactly the amount of the change in the nominal interest rate
- This is not so implausible in this economy
  - The real interest rate and real income are constant
  - Everyone knows this
  - If the central bank has a reputation of always producing the inflation the central bank wants
  - And if, as a result, announcements of the nominal interest rate are interpreted as announcements of the inflation rate that will prevail
  - Then $\mathrm{E}_t \, \pi_{t+1} = i_t^{cb} - r$
  - Furthermore,

$$m_t - p_t = y^f - \beta i_t + \varepsilon_t$$

  - implies

$$p_t = m_t - y^f + \beta i_t - \varepsilon_t$$

An Alternative Story III

- and because $\Delta p_t = \pi_t$

$$\pi_t = \Delta m_t + \beta \Delta i_t - \Delta \varepsilon_t$$

- and

$$\pi_{t+1} = \Delta m_{t+1} + \beta \Delta i^{cb}_{t+1} - \Delta \varepsilon_{t+1}$$

- This implies

$$\mathrm{E}_t\, \pi_{t+1} = \mathrm{E}_t\, \Delta m_{t+1} + \beta\, \mathrm{E}_t\, \Delta i^{cb}_{t+1} - \mathrm{E}_t\, \Delta \varepsilon_{t+1}$$

- Now $\mathrm{E}_t\, \pi_{t+1} = i^{cb}_t - r$ which implies

$$i^{cb}_t - r = \mathrm{E}_t\, \Delta m_{t+1} + \beta\, \mathrm{E}_t\, \Delta i^{cb}_{t+1} - \mathrm{E}_t\, \Delta \varepsilon_{t+1}$$

- We have

$$\begin{aligned} \mathrm{E}_t\, \Delta m_{t+1} &= \mathrm{E}_t\, m_{t+1} - m_t \\ \mathrm{E}_t\, \Delta i^{cb}_{t+1} &= \mathrm{E}_t\, i^{cb}_{t+1} - i^{cb}_t \\ \mathrm{E}_t\, \Delta \varepsilon_{t+1} &= -\varepsilon_t \end{aligned}$$

An Alternative Story IV

- and so this is an equilibrium if

$$E_t \, \Delta m_{t+1} = i_t^{cb} - r - \beta \, E_t \, \Delta i_{t+1}^{cb} - \varepsilon_t$$

- If households expect no change in the policy interest rate, then

$$E_t \, \Delta m_{t+1} = i_t^{cb} - r - \varepsilon_t$$

- and because $i_t^{cb} - r = E_t \, \pi_{t+1}$

$$E_t \, \Delta m_{t+1} = E_t \, \pi_{t+1} - \varepsilon_t$$

- and expected inflation is related to expected money as we might expect

- This is fine for expected inflation but what about actual inflation?
- Recall that

$$m_t - p_t = y^f - \beta i_t + \varepsilon_t$$
$$i_t = i_t^{cb}$$

An Alternative Story V

- In assuming complete credibility, we are supposing that announcing a nominal interest rate is the same as announcing an inflation rate
- In terms of an equation

$$\pi_{t+1} = i_t^{cb} - r = \pi_{t+1}^{cb}$$

- and therefore

$$\mathrm{E}_t\, \pi_{t+1} = i_t^{cb} - r$$

- The demand equation

$$m_t - p_t = y^f - \beta i_t + \varepsilon_t$$

- implies

$$\Delta m_{t+1} - \pi_{t+1}^{cb} = -\beta \Delta i_t^{cb} + \Delta \varepsilon_{t+1}$$

- Suppose for simplicity that $\Delta i_t^{cb} = 0$

An Alternative Story VI

- Then

$$\Delta m_{t+1} - \pi_{t+1}^{cb} = \Delta \varepsilon_{t+1}$$

- and

$$\Delta m_{t+1} = \pi_{t+1}^{cb} + \Delta \varepsilon_{t+1}$$

- Note that

$$\pi_{t+1} = \mathrm{E}_t \, \pi_{t+1}$$

Complications I

- What a lovely world!
- What can go wrong?

Deviations from announced inflation I

- Suppose we still have

$$m_t - p_t = y^f - \beta i_t + \varepsilon_t$$
$$i_t = i_t^{cb}$$

- but now we have

$$\pi_{t+1} = i_t^{cb} - r + \eta_{t+1} = \pi_{t+1}^{cb} + \eta_{t+1}$$

- where

$$\mathrm{E}\,\eta_t = 0, \quad \mathrm{E}\,\eta_t\eta_s = \begin{cases} \sigma^2, & t = s \\ 0, & t \neq s \end{cases}$$

- This can be interpreted as a deviation of the ex post real interest rate from the expected rate or a deviation of the inflation rate from the expected inflation rate
  - These are the same thing here

Deviations from announced inflation II

- Therefore
$$E_t\,\pi_{t+1} = i_t^{cb} - r = \pi_{t+1}^{cb}$$
- Because we still have that $E_t\,\pi_{t+1} = i_t^{cb} - r$, we still have that
$$E_t\,\Delta m_{t+1} = i_t^{cb} - r - \beta\,E_t\,\Delta i_{t+1}^{cb} - \varepsilon_t$$
- If $E_t\,\Delta i_{t+1}^{cb} = 0$, then
$$E_t\,\Delta m_{t+1} = i_t^{cb} - r - \varepsilon_t =$$
- and so we have in terms of expected inflation and money growth
$$E_t\,\Delta m_{t+1} = E_t\,\pi_{t+1} - \varepsilon_t$$
- In terms of actual inflation, we are supposing that
$$\pi_{t+1} = \pi_{t+1}^{cb} + \eta_{t+1} = E_t\,\pi_{t+1} + \eta_{t+1}$$

Deviations from announced inflation III

- From the demand for money, we have that

$$\Delta m_{t+1} - \pi_{t+1} = \Delta \varepsilon_{t+1}$$

- where I suppose, as before, that $\Delta i_t^{cb} = 0$
- Now we see that

$$\Delta m_{t+1} = \pi_{t+1}^{cb} + \eta_{t+1} + \Delta \varepsilon_{t+1}$$

- So far, so good
- This is not as good as it could be
- This has just supposed an error term and not built one into the model in a fundamental way

Expected change in interest rates I

- Thus far, we have been looking at the equilibrium with no expected change in interest rates
- Suppose there is an expected change in the interest rate
- What happens? Does inflation change? Presumably yes because the interest rate has changed
- More concerning: Is the expected change in the interest rate and the implied effect on the real quantitgy of money reflected in
  - a temporary change in the inflation rate?
  - a change in the nominal quantity of money?
- Suppose

$$
\begin{aligned}
m_t - p_t &= y^f - \beta i_t + \varepsilon_t \\
i_t &= i_t^{cb} \\
\pi_{t+1} &= i_t^{cb} - r + \eta_{t+1} = \pi_{t+1}^{cb} + \eta_{t+1}
\end{aligned}
$$

Expected change in interest rates II

- With $\Delta i^{cb}_{t+1} \neq 0$,

$$
\begin{aligned}
\Delta m_{t+1} &= \pi_{t+1} - \beta \Delta i^{cb}_{t+1} + \Delta \varepsilon_{t+1} \\
\Delta m_{t+1} &= \pi^{cb}_{t+1} + \eta_{t+1} - \beta \Delta i^{cb}_{t+1} + \Delta \varepsilon_{t+1} \\
\mathrm{E}_t \, \Delta m_{t+1} &= \pi^{cb}_{t+1} - \beta \Delta i^{cb}_{t+1} + \mathrm{E}_t \, \Delta \varepsilon_{t+1}
\end{aligned}
$$

- where I suppose that $\mathrm{E}_t \, \Delta i^{cb}_{t+1} = \Delta i^{cb}_{t+1}$
- In this setup, the effect of the change in the interest rate on the demand for money is accomplished by a change in the nominal quanity of money
- This is a natural consequence of an exogenous inflation rate and an endogenous nominal quantity of money

Expected change in interest rates III

- All is consistent with the prior analysis for other periods because

$$\Delta m_t = \pi_t^{cb} + \eta_t - \beta \Delta i_t^{cb} + \Delta \varepsilon_t$$
$$\Delta m_{t+1} = \pi_{t+1}^{cb} + \eta_{t+1} - \beta \Delta i_{t+1}^{cb} + \Delta \varepsilon_{t+1}$$
$$\Delta m_{t+2} = \pi_{t+2}^{cb} + \eta_{t+2} - \beta \Delta i_{t+2}^{cb} + \Delta \varepsilon_{t+2}$$

Unexpected change in interest rates I

- Now suppose there is an unexpected change in the interest rate
- How will we introduce this?
- We are considering rational expectations equilibria so we have to have

$$\mathrm{E}_t\left[i^{cb}_{t+1} - \mathrm{E}_t\, i^{cb}_{t+1}\right] = 0$$

- In other words, people cannot predict their own forecast errors
- We will want to distinguish between predictable and unpredictable changes
- The sort of algebra we are using will work better if the changes are a well defined stochastic process
- The process need not be the usual kind of constant variance process though
- The process might have occasional large changes and none much of the time

Unexpected change in interest rates II

- I won't specify that in detail
- Suppose that

$$i^{cb}_{t+1} = \mathrm{E}_t \, i^{cb}_{t+1} + \zeta_{t+1}$$
$$\mathrm{E}_t \, \zeta_{t+1} = 0$$

- This specification for expectations of the interest rate, combined with a constant expected real interest rate, implies that

$$\pi^{cb}_{t+1} = \mathrm{E}_t \, i^{cb}_{t+1} - r$$

- and is consistent with

$$\mathrm{E}_t \, \pi_{t+1} = \pi^{cb}_{t+1}$$

- Expected changes in the interest rate are no different than before so there is no reason to repeat that analysis
- Now though we can have a difference between actual and expected inflation

Unexpected change in interest rates III

- The interest rate nails down expected inflation but the actual interest rate may deviate from the expected interest rate
- What happens to actual inflation?
- Let's see how far we can get without additional assumptions
- Consider unexpected changes in the interest rate
- From the demand for money,

$$\Delta m_{t+1} - \pi_{t+1} = -\beta \Delta i_{t+1}^{cb} + \Delta \varepsilon_{t+1}$$

- From the analysis above, it follows that

$$\mathrm{E}_t \, \Delta m_{t+1} - \mathrm{E}_t \, \pi_{t+1} = -\beta \, \mathrm{E}_t \, \Delta i_{t+1}^{cb} - \varepsilon_t$$

- and actual minus unexpected is

$$\Delta m_{t+1} - \mathrm{E}_t \, \Delta m_{t+1} - [\pi_{t+1} - \mathrm{E}_t \, \pi_{t+1}]$$
$$= -\beta \left[\Delta i_{t+1}^{cb} - \mathrm{E}_t \, \Delta i_{t+1}^{cb} \right] + \varepsilon_{t+1}$$

Unexpected change in interest rates IV

- Thus far, there has been no specification of how to get from expected inflation to actual inflation
- The growth rate of the nominal quantity of money can be written as

$$\begin{aligned}\Delta m_{t+1} - \mathrm{E}_t\, \Delta m_{t+1} \\ = [\pi_{t+1} - \mathrm{E}_t\, \pi_{t+1}] \\ - \beta \left[\Delta i^{cb}_{t+1} - \mathrm{E}_t\, \Delta i^{cb}_{t+1}\right] + \varepsilon_{t+1}\end{aligned}$$

- Note that

$$\Delta i^{cb}_{t+1} - \Delta\, \mathrm{E}_t\, i^{cb}_{t+1} = \zeta_{t+1}$$

- Therefore

$$\Delta m_{t+1} - \mathrm{E}_t\, \Delta m_{t+1} = \pi_{t+1} - \mathrm{E}_t\, \pi_{t+1} - \beta\zeta_{t+1} + \varepsilon_{t+1}$$

- This is one equation to determine the two unknowns, $\Delta m_{t+1} - \mathrm{E}_t\, \Delta m_{t+1}$ and $\pi_{t+1} - \mathrm{E}_t\, \pi_{t+1}$

Unexpected change in interest rates V

- Suppose that the growth rate of the nominal quantity of money adapts to the ex post demand for money to maintain $\pi_{t+1} = \mathrm{E}_t\, \pi_{t+1}$
- Then
$$\Delta m_{t+1} = \mathrm{E}_t\, \Delta m_{t+1} - \beta \zeta_{t+1} + \varepsilon_{t+1}$$
- Suppose on the contrary that the actual and expected growth rate of money are equal, i.e. $\Delta m_{t+1} = \mathrm{E}_t\, \Delta m_{t+1}$
- Then
$$\pi_{t+1} = \mathrm{E}_t\, \pi_{t+1} + \beta \zeta_{t+1} - \varepsilon_{t+1}$$
- Possible resolution is description of adjustment process
- Friedman's spending adjustment
  - People want to reduce their money holdings
  - So they increase their spending
  - The whole point of the liquidity effect is that spending first increases on financial assets
  - Households try to use money to buy additional financial assets
    - The riskfree government security here

Unexpected change in interest rates VI

- Households try to buy more securities, which tends to raise the price and lower the interest rate
- The central bank supplies the additional securities by selling them
- This reduces the central bank's balance sheet and reserves, thereby reducing the nominal quantity of money m
- As a result, Δm_{t+1} adjusts and p_{t+1} need not
- All of which implies

$$\Delta m_{t+1} - \mathrm{E}_t \, \Delta m_{t+1} \neq 0$$
$$\pi_{t+1} - \mathrm{E}_t \, \pi_{t+1} = 0$$

- Alternatively, suppose that households increase their spending on final goods and services
  - Then nominal income increases because total spending on final goods and services equals nominal income
  - The increase in nominal income $p + y$ (in logarithms) implies that p increases here because y is constant

Unexpected change in interest rates VII

- Hence p increases and

$$\Delta m_{t+1} - \mathrm{E}_t \, \Delta m_{t+1} = 0$$
$$\pi_{t+1} - \mathrm{E}_t \, \pi_{t+1} \neq 0$$

- One could of course imagine a case in which spending on both the riskfree government security and on final goods and services increase
  - This would suggest, with unspecified proportions for unexpected money growth and inflation,

$$\Delta m_{t+1} - \mathrm{E}_t \, \Delta m_{t+1} \neq 0$$
$$\pi_{t+1} - \mathrm{E}_t \, \pi_{t+1} \neq 0$$
$$[\Delta m_{t+1} - \mathrm{E}_t \, \Delta m_{t+1}] - [\pi_{t+1} - \mathrm{E}_t \, \pi_{t+1}] = -\beta \zeta_{t+1} + \varepsilon_{t+1}$$

General Equilibrium Analyses

- Cochrane found that standard New Keynesian models and DSGEs with monetary policy can be consistent with this neo-Fisherian view that raising interest rates will raise inflation
- Neo-Fisherian analysis not generally accepted
  - In fact, can generate harsh reactions
  - The importance of the liqudity effect is a strongly held belief

Empirical evidence on Neo-Fisherian View

- Crowder
- Must discuss orthogonal complement

Conclusion I

- I have yet to find a contradiction or problem
- I have not looked at the stability of the equilibrium, which is an issue
- I have not looked at learning, either Bayesian learning or regression learning
- The analysis I presented is not a model with optimizing agents
- It is consistent with a large class of optimizing models, as Cochrane shows

Stuff I

- Leftover stuff

$$\Delta m_{t+1} = \pi_{t+1} - \beta \Delta i^{cb}_{t+1} + \Delta \varepsilon_{t+1}$$
$$\mathsf{E}_t\, \Delta m_{t+1} = \mathsf{E}_t\, \pi_{t+1} - \beta\, \mathsf{E}_t\, \Delta i^{cb}_{t+1} - \varepsilon_t$$