1. Does monetary policy matter for output?*

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Abstract

Notes for the course "Monetary Economics: Macro Aspects," Spring 2006. The relevant literature behind these notes is:

Walsh (2003, Chapter 1).
Recommended reading (not required): Romer and Romer (2004).

1 What are the "stylized facts" about money and economic aggregates?

1.1 Long run correlations

- Consensus estimates show correlation coefficients between growth rates in nominal monetary aggregates and inflation close to one

  – Therefore, a reasonable characterization is that long-run changes in nominal money growth are reflected in equivalent changes in inflation rates

  – Note, however, that mere correlations do not say anything about causality. The correlations could reflect that higher growth in nominal demand associated with higher nominal money growth translates into higher inflation rates (as is indeed the common belief). It could, in principle be the other way around: Inflation emerging from some non-monetary source, is met by the authorities by increasing nominal money growth so at to leave real money balances unchanged. One needs a theoretical model (in which one has confidence for other reasons), or more sophisticated econometrics, in order to make meaningful statements about the causal structure underlying observed co-movements.

- Long-run correlations of nominal money growth (and inflation) with output (growth and/or level) and/or, e.g., unemployment, are less robust. It remains a subject of controversy in the economics profession.

  – Some studies find positive correlations between inflation and output growth

  – Some studies find no correlation between inflation and output growth

  – Some finds a negative correlation between inflation and output growth

  – I.e., results are "all over the place." Similar ambiguous findings prevail when one looks at, e.g., unemployment instead of output. Results hinge in general also on which types of countries are used. For example, some find negative output effects of higher inflation effects in high inflation countries and zero or slightly positive effects in low-inflation countries. This non linearity could be explained by adhering to a range of theories. For example, when inflation is very high, the allocative properties of the price system begin to weaken, and higher inflation will further exacerbate this, leading to lower economic activity (also, very high inflation is often associated with high variability in inflation, causing economic agents to hold back on, for example, investment decisions). At low inflation rates, nominal wage growth is typically also relatively low. A higher inflation rate can then put "sand in the wheels" of the labour market by eroding real wages, which causes firms to hire more labor.

- Despite relatively less clear-cut results on the long-run relationship between monetary aggregates/inflation and real economic activity the quote by John Taylor represents the consensus view in the economics profession:[1]

  > "*about which there is now little disagreement, . . . that there is no long-run trade-off between the rate of inflation and the rate of unemployment*"

- In other words, the long-run Phillips curve is *vertical.* There exists some unemployment level or output level (or output trend in a growing economy), which will prevail in the long run. I.e., on average. This "natural" level of unemployment, to which actual unemployment will converge in the absence of frictions and stochastic disturbances, cannot be manipulated by monetary means. Only policies aimed at the supply side of the economy will succeed in this. Permanently expansive monetary policies (e.g., raising the growth rate of nominal money) will, at most, have real effects in the short run (that is, at business cycle frequencies). In the long run, the result will "just" be higher inflation. So, no long-run trade off between the two; only a short-run trade off.

- What about the correlations between money growth inflation and nominal interest rates in the long run?
  - We have the Fisher equation: $i_t = r_t + \mathrm{E}_t \pi_{t+1}$
  - In the long run, or, steady state, this becomes $i^{ss} = r^{ss} + \pi^{ss}$
  - Higher long-run inflation should therefore by this simple expression raise long-run nominal interest rates by the same amount. The reason being that the real interest rate is determined by real factors (e.g., in the neoclassical growth model by the marginal product of physical capital). If these are largely uncorrelated by money growth and inflation, it is only the nominal interest rate that moves.
  - This is also roughly confirmed by various empirical analyses (consistent with a "stylized fact" from the growth literature due to Kaldor, namely that the real interest is roughly constant in the long run).

1.2 Short run correlations

- Examinations of the short-run correlations between monetary policy, inflation and real activity lead to much more controversial results.

[1] In general, always *beware* when somebody refers to a "consensus view." This is rarely meant as reporting results from some poll. Rather, it usually reflects the author's view on the issue. This is also the case here, but seriously, John Taylor and I are definitely not the only economists having the view!

- The aim is mainly to assess whether monetary aggregates are correlated with real activity at business cycle frequencies
  - One usually examines detrended data; that is, data exhibiting deviations from underlying, hypothetical trend values (i.e., the natural rates).
  - The central issue is then whether above average monetary aggregates are associated with above or below average economic activity
- Figure 1.1 in Walsh (2003) shows dynamic correlations for three monetary aggregates (M0, M1, M2) and GDP (USA data for 1967-2000).
  - In particular, M2 exhibits a pattern: It is positively correlated with GDP at *lags* and negatively correlated at *leads*
  - This means that if M2 is above average, it is associated with above-average GDP in future time => money *leads* output
- Even though we are going beyond contemporaneous correlations between variables, the correlations tell nothing about causality
- E.g., Milton Friedman and Anna J. Schwartz' classic study, which concluded that money movements *cause* output movements after long (and variable) time, has been questioned since it appeared in the 1960s.
- The positive correlations observed in data may as well reflect that money adjust endogenously to real output movements ("reverse causality") — even with the observed timing of the correlations.
  - To see this, note that endogeneity of money is predominant for broader measures of money (such as M2, over which the central bank has little control compared with M0), and in cases where the central bank uses the nominal interest rate as a monetary policy instrument
  - Indeed, some find that the positive correlation is only prevalent for broad monetary aggregates ("inside money" — money created "within" the economy as opposed to outside money, which is controlled by the central bank "outside" the economy), as it reflects the banking system's endogenous response to changes in economic activity.
    * E.g., increased demand for deposits by firms and consumers *in correct anticipation* of an upcoming boom, will increase broad monetary aggregates, even though the boom that follows is *not* caused by money (it could be caused by a huge expected drop in oil prices, or by implementation of new productivity-enhancing technologies).

- **Lots** of econometric work has therefore been conducted to assess the effects of money on output

- Early famous econometric studies regressed (often nominal) output on money and other variables, and Milton Friedman and David Meiselman (1963) found statistically significant coefficients on money in such regressions. One could then be (mis?)lead to believe that money causes output.

- Such "St. Louis" regressions were influential, but again the issue of endogeneity pops up

  - If money is endogenous, the regressions are misspecified
  - E.g., to put things upside down, if the coefficient on money is insignificant, one may incorrectly conclude that money does not matter for output. But if data is emerging out of a regime, where money does matter for output, and monetary policy has been conducted by superhumans managing to completely eliminate any variation in output by their policymaking, then money and output would be uncorrelated. Money would move a lot, but output would be stable. A St. Louis regression will (falsely) show that money had no effect on output — even though it had (and the effect was skillfully used by policymakers)!

- Chris Sims (1972) introduced so-called *Granger causality* analysis, which is one formal econometric test for causality, and found that money "Granger caused" output.

  - In brief, this means that lagged values of money have some predictive power regarding output while the opposite is not true

- Findings less robust when other monetary variables, e.g., interest rates, are included in empirical analysis, which indicates that how one *measures* monetary policy matters. I.e., in monetary policymaking, what is the monetary policy instrument (the more or less exogenous variable) and what are the other monetary aggregates (the endogenous monetary variables)?

- This and other evidence that followed are somewhat mixed.

- We now look at another problem using St. Louis type regressions, and subsequently look at more recent methods of assessing the real effects of monetary policy on output in the short run.

2 Empirical problems/issues

2.1 Problems with using simple regressions for policy evaluation: The Lucas critique

- Consider a "St. Louis"-type estimated relationship between log of real output, y_t, and log of the nominal money supply, m_t:[2]

$$y_t = a_0 m_t + c_1 z_t + c_2 z_{t-1} + u_t \tag{1.3 simplified}$$

- Then consider an output stabilizing money supply rule (given z_t and u_t are i.i.d. shocks that are zero in expectations, and that the rule can only be made contingent on z_{t-1}):

$$\begin{aligned} m_t &= -\frac{c_2}{a_0} z_{t-1} + v_t \\ &= \pi_2 z_{t-1} + v_t, \quad \pi_2 \equiv -\frac{c_2}{a_0} < 0; \end{aligned} \tag{1.4 simplified}$$

  v_t is a "control error, that is, an unanticipated, *unsystematic* part of monetary policy

- Resulting solution for output *if* (1.3) is a true representation of the economy is: $y_t = a_0 v_t + c_1 z_t + u_t$. Hence, the *systematic* monetary policy response towards z_{t-1} works! Indeed it works to perfection: Any output impact of a shock that the authorities can respond to is completely eliminated.

- Note that output stabilization is achieved without having access to any monetary theory — only the empirical result from the St. Louis regression

- Using just this information can be *very misleading* in design of the policy rule, i.e., in the construction of (1.4). Suppose namely that the *true* model for output determination in the economy is not (1.3) but instead:

$$y_t = d_0 v_t + d_1 z_t + d_2 z_{t-1} + u_t \tag{1.5 simplified}$$

  I.e., only *unanticipated* monetary policy has real effects. Since v_t is i.i.d. we have $v_t = m_t -$ $\mathrm{E}_{t-1} m_t$. *Many* theoretical models have this feature as will be seen later in the course.

- With the policy rule (1.3), we have $v_t = m_t - \pi_2 z_{t-1}$, so:

$$\begin{aligned} y_t &= d_0 \left[m_t - \pi_2 z_{t-1}\right] + d_1 z_t + d_2 z_{t-1} + u_t \\ &= d_0 m_t + d_1 z_t + \left[d_2 - d_0 \pi_2\right] z_{t-1} + u_t \end{aligned} \tag{1.6 simplified}$$

[2] In all the documents, an equation number is referring to the number in Walsh (2003), but potentially amended with the tag "simplified" or just " ' " to indicate a simplified version of the equation.

- This is *observationally equivalent* to (1.3)
  - **I.e., even if only unsystematic monetary policy matters, a simple estimation can give the false impression that systematic monetary policy matters!**
- What is even worse: The estimated coefficients depend on policy parameters!
  - Here: coefficient "$d_2 - d_0\pi_2$" depends on π_2
  - Hence, a systematic change in policy (here, a change in π_2) will change the estimated coefficients
  - Simple estimated relationships will therefore "break down" when the policy rule changes
    $\Longrightarrow$ One *cannot* evaluate the implications of a policy change using the estimated relationships. These relationships are based on data of the past. These data contains in the true model information about the expected money supply and the policy rule of the past. These two are intimately related:
  - The expected money supply is given by $\mathrm{E}_{t-1}m_t = \pi_2 z_{t-1}$. Hence, it is a function of the policy regime. A shift in the systematic part of money, π_2, will thus systematically change expectations about the money supply. In fact, in this example it will change so as to neutralize any impact of actual money (apart from the part which is unanticipated). The parameters from estimations based on past data are therefore useless when evaluating the impact of new policies, e.g., a change in policy regime.
  - This is an example of Lucas' (1976) famous and influential *critique of policy evaluation*
- To make the point formal within this simple example, assume one believes in (1.3) based on some empirical investigation
- One then want to assess the output effects of a policy rule that reacts less towards z_{t-1} (never mind why one wants to do this; but it could be simply due to a desire of having a more stable money supply *per se*):

$$m_t = (\pi_2 + \varepsilon)\, z_{t-1} + v_t, \quad \varepsilon > 0$$

- As $\pi_2 < 0$ we see that the response to observed z_{t-1} is muted (given, of course, that $\pi_2 + \varepsilon < 0$ still holds). The solution for output when one believes in the estimation, (1.3) becomes:

$$\begin{aligned} y_t &= a_0\left[(\pi_2+\varepsilon)\, z_{t-1} + v_t\right] + c_1 z_t + c_2 z_{t-1} + u_t \\ &= a_0\left[\left(-\frac{c_2}{a_0} + \varepsilon\right) z_{t-1} + v_t\right] + c_1 z_t + c_2 z_{t-1} + u_t \\ &= a_0 v_t + c_1 z_t + a_0 \varepsilon z_{t-1} + u_t \end{aligned}$$

One will then conclude that z_{t-1} now affects y_t by $a_0\varepsilon$. And one can chose a value of ε that provide a desire balance between output and money stability.

- But if (1.5) is in fact the true model, the change the in policy rule has *no effect* on output, and the conclusion is false!
  - Even though m_t systematically responds less negative towards z_{t-1} — allowing a greater impact on output of size $d_0\varepsilon = a_0\varepsilon$ — this will be perfectly neutralized by the *decrease in the coefficient* on z_{t-1} in the estimated relationship: $d_2 - d_0(\pi_2 + \varepsilon)$
  - It falls by $d_0\varepsilon$ as a result of the shift in the policy rule; i.e., the estimated parameters based on past data are not valid anymore. The reason is that expected money $\mathrm{E}_{t-1}m_t = (\pi_2 + \varepsilon) z_{t-1}$ now also responds less negatively to z_{t-1}. Hence, only unanticipated, non-systematic, money changes (realizations of v_t) matters. Before and after the regime shift and by the same amount.
  - In sum, there will in this example be no output effects of a systematic change in the policy rule
  - Even though this is an extreme result stemming from the simple nature of this model, the main insight is general and important. If a change in policy patterns lead to changes in the behavior of the private sector (in this example a change in their money supply expectations), then estimations not capturing this, will be useless to some extent (depending on the importance of the change in behavior).[3]
- All this therefore calls for use of models where estimated coefficients are *invariant* to changes in policy rules. Only then does it make sense to make an examination of the impact of a regime change.
- This, in turn, calls for *theories* on how money may or may not affect the economy (as this will help assessing whether (1.3) or (1.5) have policy invariant coefficients)

2.2 Using VAR analysis for assessing monetary policy effects

- Recently, Vector Autoregressive (VAR) methods have been widely adopted to empirically assess the impact of monetary policy

[3] Another extreme, yet illuminating, example is in neo-classical consumption theory with taxation. In a model with infinitely lived consumers and non-distortionary taxes, a known temporary tax cut may have no effects on consumption even though data shows a negative relationship between taxes and consumption. The reason is that forward-looking consumers know that the tax cut leads to accumulation of public debt which will necessitate tax increases in the future. The consumers like smooth consumption, and respond to the tax cut by *changing behavior*! In particular they will save more to be ready to pay the higher taxes in the future. Under mild assumptions the result can be that consumption doesn't change at all. The higher dispopable income is completely offset by a higher savings rate (i.e., lower consumption rate). Such an example of "Ricardian Equivalence" is indeed extreme, but again points to the importance of accounting for potential changes in private sector behavior when contemplating a change in policy.

- One typically estimates a system like

$$\begin{bmatrix} y_t \\ x_t \end{bmatrix} = A(L) \begin{bmatrix} y_{t-1} \\ x_{t-1} \end{bmatrix} + \begin{bmatrix} u_{yt} \\ u_{xt} \end{bmatrix} \tag{1.8}$$

  - y_t is, e.g., output and x_t is the policy variable (for example the money supply or the nominal interest rate)
  - $A(L)$ is a matrix polynomial in L (the lag operator) — so independent variables can go far back in time
  - u_{yt} and u_{xt} are innovations to output and policy, defined as linear combinations of underlying output and policy shocks:

$$\begin{bmatrix} u_{yt} \\ u_{xt} \end{bmatrix} = \begin{bmatrix} e_{yt} + \theta e_{xt} \\ \phi e_{yt} + e_{xt} \end{bmatrix} = \begin{bmatrix} 1 & \theta \\ \phi & 1 \end{bmatrix} \begin{bmatrix} e_{yt} \\ e_{xt} \end{bmatrix} \tag{1.9}$$

    hence, a priori, output and policy shocks can each affect both output and policy

- The main purpose of these types of analyses, is to estimate the impact of a policy shock on, e.g., output.

- I.e., how will a certain realization of e_{xt} affect output in the short, medium and long run?

  - What is the *impulse response pattern*?

- Problem: Estimation of (1.8) gives the parameters of $A(L)$, and the residuals u_{yt} and u_{xt}

- One cannot, however, as long as $\theta \neq 0$ and $\phi \neq 0$, say anything about the individual effects of e_{yt} and e_{xt}

  - As θ and ϕ are unknown, knowledge about $u_{yt} = e_{yt} + \theta e_{xt}$ and $u_{xt} = \phi e_{yt} + e_{xt}$ makes inference about e_{yt} and e_{xt} impossible
  - The VAR model is not *identified*

- Hence, one needs to place an *a priori* **restriction** on either θ or ϕ. Take the case of θ. This means that one "simply" *assigns* a particular value to θ. Then one can estimate ϕ by the available residuals obtained in estimation (1.8), and infer the shocks e_{yt} and e_{xt}. To see this, use that

$$\begin{aligned} u_{xt} &= \phi e_{yt} + e_{xt} \\ &= \phi [u_{yt} - \theta e_{xt}] + e_{xt} \\ &= \phi u_{yt} + (1 - \phi\theta) e_{xt} \end{aligned}$$

  Then estimate u_{xt} on u_{yt}, and obtain an estimate of ϕ. The residual from the estimation is $(1 - \phi\theta) e_{xt}$. But since both ϕ and θ are now known, e_{xt} can readily be found. The shock e_{yt} can then readily be found as $e_{yt} = u_{yt} - \theta e_{xt}$.

- One can then assess the impact of a shock e_{xt} as the system

$$\begin{bmatrix} y_t \\ x_t \end{bmatrix} = A(L) \begin{bmatrix} y_{t-1} \\ x_{t-1} \end{bmatrix} + \begin{bmatrix} 1 & \theta \\ \phi & 1 \end{bmatrix} \begin{bmatrix} e_{yt} \\ e_{xt} \end{bmatrix}$$

  is now identified

- Big question: How can one just *assign* a value to either θ or ϕ?

- One does this by using appropriate *identifying restrictions.* Note, of course, that the word "appropriate" signals that this involves judgement by the researcher. Economic theory and other empirical observations can, however, help in making at least educated restrictions.

To see this, consider an example with a simple version of the VAR:

$$\begin{bmatrix} y_t \\ x_t \end{bmatrix} = \begin{bmatrix} a_1 & a_2 \\ 0 & 0 \end{bmatrix} \begin{bmatrix} y_{t-1} \\ x_{t-1} \end{bmatrix} + \begin{bmatrix} 1 & \theta \\ \phi & 1 \end{bmatrix} \begin{bmatrix} e_{yt} \\ e_{xt} \end{bmatrix}, \quad 0 < a_1 < 1$$

Hence,

$$\begin{aligned} y_t &= a_1 y_{t-1} + a_2 x_{t-1} + e_{yt} + \theta e_{xt} \\ x_t &= \phi e_{yt} + e_{xt} \end{aligned}$$

Output can be solved as (though successive iteration back in time)

$$\begin{aligned} y_t &= \sum_{i=0}^{\infty} a_1^i \left(e_{yt-i} + \theta e_{xt-i}\right) + a_2 \sum_{i=0}^{\infty} a_1^i \left(\phi e_{yt-i-1} + e_{xt-i-1}\right) \\ &= e_{yt} + (a_1 + a_2\phi) \sum_{i=0}^{\infty} a_1^i e_{yt-i-1} + \theta e_{xt} + \sum_{i=0}^{\infty} a_1^i \left(a_1\theta + a_2\right) e_{xt-i-1} \end{aligned}$$

The impulse response pattern of output following a policy shock can now be assessed:

-
  - Period t: θ
  - Period $t+1$: $a_1\theta + a_2$
  - Period $t+2$: $a_1 \left(a_1\theta + a_2\right)$
  - Period $t+3$: $a_1^2 \left(a_1\theta + a_2\right)$

    .

    .

    .

    . etc. By the simplification of the model, only θ plays a role for output determination

- *Possible* identifying assumptions:

- $\theta = 0$. This is the same as assuming that a policy shock has no contemporaneous effect on output (in VAR-language: policy is "ordered last")
- $\phi = 0$. This is assuming that the policy variable is exogenous to contemporaneous output shocks (in VAR-language: policy is "ordered first")
- $\theta + (a_1\theta + a_2) + a_1 (a_1\theta + a_2) + a_1^2 (a_1\theta + a_2) + ... = 0.$
  This is assuming that the cumulative effect of the policy shock on output is zero. If y_t is representing output *growth*, this corresponds to an assumption that policy is neutral on the output level in the long run

- All involves a *judgement* about what is a reasonable identifying assumption
- Other potential problems with the VAR approach:
  - What is the relevant monetary policy variable?
  - A satisfactory VAR should include more variables than just output (but this increases the needed number of identifying restrictions accordingly). Which ones?
  - The data frequency will matter for the appropriateness of identifying restrictions (at a monthly frequency, it may be appropriate to believe that policy affects output with a lag, whereas with yearly data such a restriction may be less appropriate)
  - Monetary policy is seen as a sequence of exogenous and random events; monetary policy's endogenous nature is neglected:
    - E.g., if monetary policy is a feedback rule (a rule where policy respond to actual output), one could conclude that $e_{xt} = 0$, all t
    - I.e., conclude that monetary policy did not matter even though it may have played an important role for how the economy have adjusted to other shocks
  - Different operating procedures and policy instruments in monetary policymaking across various time periods will make the results sensitive to choice of period
- Nevertheless, several VAR studies have some common findings:
  - A *contractionary* monetary policy shock (e.g., an increase in the short interest rate), has a "hump-shaped" impact on output, and a *negative* effect on output is most prominent after some time
  - See Figure 1.5 in Walsh (2003) and for a four-variable VAR (with a "$\theta = 0$" type of identifying restriction; that is, an assumption that policy shocks does not affect the remainder variables immediately).

  - A "price puzzle" is apparent: Prices *increase* after a contractionary policy shock; in contrast to common priors. Economists use the catch-phrase "a puzzle" whenever patterns in the data conflict with their theoretical perceptions. But here we have an example where the common prior is quite well founded. A contractionary policy shock, decreases aggregate demand, and most theories — even the simplest *ad hoc* ones, would posit that this will put downward pressure on prices in the short run.
    * Possible explanation: The VAR ignores some of the monetary policymakers' information; e.g., forecasts about rising inflation due to factors the policymakers cannot offset, or maybe the policymaker reacts too late to raising prices. Then a contractionary policy shock may be associated with future price increases (but in the data these price increases could have been greater had the policymaker not reacted — so policy could put downward pressure on prices, *ceteris paribus*, even though we actually observe rising prices). But the simplest VARs cannot account for such forward-looking behavior.
    * Introducing forward-looking variables like asset prices in a VAR sometimes eliminates the price puzzle; they act as a proxy for the policymaker's forecasts
    * Romer and Romer (2004) directly controls for US Fed's forecasts, and "eliminates" the "prize puzzle" in US data. Holding everything else constant a negative shock to the short term interest rate leads to significantly lower prices with substantial lag (up to two years).

- Despite many methodological problems and issues, the VAR literature at least tend to confirm that monetary policy *does have* effects on output in the short and medium run

2.3 Other approaches to address monetary policy and output

- Structural Econometric Models
  - These are typically models with various estimated behavioral equations (consumption functions, labour supply schedules, etc.)
  - Monetary policy is typically modelled as a feedback rule, making it possible to assess the implications of various policy regimes
  - Earlier models emerged in 1960s and 1970s. Like the Danish "ADAM" and "SMEC" for the Danish economy. These models are still used by e.g. the Ministry of Finance and the Danish Economic Council, respectively, to this

day (with appropriate care though!). These models are vulnerable to the Lucas critique, but recent models have progressed (both small-scale and large scale models)

  - It is also reassuring that results from these models regarding monetary policy shocks are not grossly inconsistent with the VAR results

- The "Narrative approach" (initiated by Friedman and Schwartz)
  - Exogenous shifts in monetary policy in the US are identified by reading policy directives and detailed minutes from FOMC meetings (FOMC = Federal Open Market Committee; the decision-making body concerning monetary policy in the US)
  - Christina and David Romer (in earlier work), e.g., identify six instances of clear contractionary shifts in monetary policymaking
  - All of these instances are followed by recessions
  - Again, supportive of the view that monetary policy matter for output in the short and medium run
  - Romer and Romer (2004) extends their earlier work, and extract time series for *intended* interest-rate policy, to distinguish this from the interest rate's endogenous response to output movements (example: higher economic activity usually cause endogenous increase in interest rates dampening activity)
    * This distinction suggests that intended policy changes (interpreted as the true, exogenous shock component of policy) have *stronger output effects* than those found in earlier VARs (where the identified shocks are contaminated by endogenous movements).
- Examination of disinflations
  - Has bringing down inflation (presumably through contractive monetary policy) had negative output effects?
  - Some empirical studies say yes, some say no
  - The approach suffer from identification problems: Is disinflation indeed a result of contractive monetary policy?
  - Also, if disinflation is *credible*, it may in theory have no output effects; yet monetary policy shocks may still be important for output
    * Consider simple expectations-augmented Phillips-curve:

$$\pi = \mathrm{E}[\pi] + \gamma y, \quad \gamma > 0$$

· If inflation, π, is brought down, and $E[\pi]$ goes down accordingly (the disinflation is *credible*), output, y, is unchanged

· But if $E[\pi]$ does not go down (the disinflation is not credible), the disinflation *has* output costs (y falls)

3 Summary

- In the long run:
  - Monetary policy has predominantly effects on prices, and not output
  - Changes in money growth rates are reflected in changes in inflation rates, and nominal interest rates and very small effects on output growth (and of qualitative ambiguous sign)
- In the short run:
  - The impact of monetary policy on real output is more controversial
  - Many empirical problems arise when assessing the impact
  - Some consensus have emerged: Monetary policy shocks produce a "hump-shaped" impact on output, and the maximum effect is reached after some lag
  - Monetary policy shocks affect prices with an even longer lag
  - Endogenous monetary policy responses, and their impact, are only understood within structural econometric models, which are not vulnerable to the Lucas critique

- So, we need *theories* to think about how monetary policy affects the economy. Both in terms of pure "policy shocks" but, also in terms of assessing how endogenous responses to the state of the economy affect economic fluctuations (as this will be important for design of appropriate stabilization policy).

Appendix

A Key concepts you should know

- The long-run correlation between inflation, nominal interest rates and nominal money growth
- The (potential) long-run correlation between inflation, nominal money growth and output
- The (approximately) vertical long-run Phillips curve
- Short-run effects of money on output: Causality problems
- St. Louis regressions
- The Lucas critique of simple regressions of money on output
  - Observational equivalence
  - Only unanticipated money may have effects on output; yet, St. Louis estimations may look as if systematic money matters
  - Dependence of estimated parameters on policy regime => shift in policy regime renders parameter estimates based on pre-policy shift data irrelevant
- VAR analyses and identification problems
- VAR analyses and problems with choosing the "right" monetary policy variable
- Consensus finding from VAR literature: Negative money shocks have negative and hump-shaped effects on output
- The "prize puzzle" and potential "solutions"
- Structural econometric models and their problems
- The narrative approach
- Examination of disinflations: Identification and credibility issues