Recent Developments in Business Cycle Theory: News, Expectations and Demand Shocks

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Questo articolo offre una rassegna di alcuni lavori recenti sulla teoria dei cicli economici. Tali lavori evidenziano il ruolo delle fonti di informazione pubblica e dei cambiamenti nelle aspettative dei consumatori nel generare fluttuazioni aggregate di breve periodo. Usando un semplice modello a due periodi vengono introdotti e discussi tre temi riguardanti questa classe di modelli: (1) quale è il ruolo delle rigidità nominali, (2) quali sono le implicazioni testabili di questi modelli, (3) quali sono le implicazioni di queste teorie per la condotta della politica monetaria.

This paper surveys some recent work in the theory of business cycles, which emphasizes the role of public news and consumer expectations as driving forces behind short-run aggregate fluctuations. The paper uses a simple two period model to introduce and discuss three issues regarding this class of models: (1) what is the role of nominal rigidities, (2) what are the testable implications of these models, (3) what are their implications for monetary policy.
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1. - Introduction

A traditional objective of macroeconomic models is to provide a unified account of business cycles and of the effects of monetary policy, in order to provide a basis for policy analysis and evaluation. This requires both to identify what shocks de-

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termine economic fluctuations and to understand the transmission mechanism by which shocks are propagated. The keynesian models of the 50s and 60s represented the economy using a number of structural equations. The shocks hitting the economy were labeled according to the structural equation where they appeared, and they were usually categorized into "demand" and "supply" shocks. The essential feature distinguishing these shocks is that demand shocks lead to positive comovement of output and inflation, while supply shocks lead to negative comovement. This provides for a simple identification restriction based on the sign of the response of nominal prices and output. Additional identification restrictions can allow the researcher to tell apart specific shocks, like monetary policy or government spending shocks. Empirical work in this tradition shows that a sizeable fraction of short-run volatility, around 30%, seems to be associated to demand shocks that are not associated to shocks to monetary policy or to government spending. These shocks, sometimes dubbed "IS shocks", were interpreted as shifts in consumers' or investors' expectations. However, the treatment of these expectations was typically left outside the model and this interpretation was not subject to testable restrictions.

After the rational expectations revolution of the 70s the effort of researchers concentrated on explaining the effects of monetary shocks, that is, on understanding the non-neutrality of monetary interventions. This is not surprising, given that money non-neutrality was at the core of the macroeconomic controversies of the time. Progress in models with various forms of nominal rigidities has shown that sticky price models seem able to account for the observed effect of monetary shocks on the economy[1].

At the same time, this has left on the side the issue of what are the major shocks causing business cycle fluctuations. In part, this has been due to the success of Real Business Cycle

[1] The relation between individual price-adjustment and aggregate stickiness still constitute a very active area of research.

models in providing an account of cyclical movements. One can write a model with nominal rigidities and productivity shocks, where output volatility is mostly due to productivity shocks, and where, at the same time, monetary shocks have non-neutral effects. Such a model can be used to perform well-defined policy experiments and to derive welfare-based evaluation of different monetary policy rules. Alternatively, one can add to such a model a number of preference shocks and obtain a rather flexible model of the economy, which typically fits the data better than a model with only monetary and technology shocks[2]. However, the fundamental interpretation of the preference shocks in these models is not entirely satisfactory, unless one is willing to believe that most short-run fluctuations are due to changes in the intertemporal preferences of consumers or to changes in their rate of substitution between consumption and leisure.

Recently, however, a number of papers have renewed attention towards other sources of short-run fluctuations, and in particular on fluctuations caused by shifts in expectations. These shocks have some resemblance to old-fashioned "IS shocks." However, micro-founded models with rational expectations have the advantage of imposing testable restrictions on the behavior of the economy following these shocks. Here I call them broadly "news shocks", although the precise meaning of the term varies somewhat in the existing literature.

In this paper I survey some of these recent contributions (with some bias towards previous work by myself). The discussion is organized around a simple two-period model that I will use to capture the main points of the argument. In particular, I will focus on the following three issues: (1) what is the role of nominal rigidities in modelling news-driven business cycles, (2) what empirical restrictions does the theory impose on the economy's response to these shocks (3) what are the implications of this approach for monetary policy. The next section introduces the

[2] A number of medium size models of this type have been developed recently, e.g. SMETS F. - WOUTERS R. (2003).

model. The following three sections discuss, in order, the three issues raised above.

2. - A Model

2.1 *Setup*

Consider a 2 periods economy populated by a continuum of households of consumers-producers. Preferences are given by

$$\sum_{t=1}^{2}\beta^{t}\left(\log C_{it}-\frac{k}{1+\eta}N_{it}^{1+\eta}\right)$$

consumption C_{it} is the usual CES aggregate

$$C_{it}=\left(\int_{0}^{1}C_{ijt}^{\frac{\sigma-1}{\sigma}}\,di\right)^{\frac{\sigma}{\sigma-1}}$$

with $\sigma > 1$, and N_{it} is labor supply. A convenient normalization is to set $k = (\sigma - 1)/\sigma$. Household i produces good i according to the linear production function

$$Y_{it} = A_t N_{it}$$

The only source of uncertainty are the productivity shocks A_t. Let a_t denote the log of A_t. Productivities in periods 1 and 2 are given by

$$a_t = x + \varepsilon_t$$

where x and ε_t are mean-zero, independent, normally distributed random variables, with variances σ_x^2 and σ_ε^2. The variable x is a permanent shock to productivity, which is realized at date 1, while the ε_t are temporary shocks.

Households hold nominal balances directly with the central bank, and settle all payments among themselves using these nominal balances. At the end of period 1 their net balance is computed, and they receive the (gross) nominal interest rate R on these balances. At the end of period 2 they must end up with a non-negative balance. They all begin with a zero balance. Therefore, their budget constraint is

$$(P_2 C_{i2} - P_{i2} Y_{i2}) + R \cdot (P_1 C_{i1} - P_{i1} Y_{i1}) \leq 0$$

where P_t is the price index

$$P_t = \left(\int P_{it}^{1-\sigma} di \right)^{\frac{1}{1-\sigma}}$$

Prices are set at the beginning of each period: each household sets the price P_{it} and stands ready to deliver good i at that price. However, there is an asymmetry between the two periods. In period 1 prices are set before current shocks are realized, while in period 2 prices are set after all current shocks are realized. Consumption decisions, on the other hand, are made after the current shocks are realized in both periods.

2.2 *Equilibrium*

Let me proceed backward and characterize first the equilibrium in period 2. From the optimization problem of household i one can derive the optimality condition for price-setting,

$$(1-\sigma)\frac{1}{P_2 C_{i2}}\frac{P_{i2} Y_{i2}}{P_{i2}} + \kappa\sigma \frac{1}{A_2} N_{i2}^{\eta} \frac{Y_{i2}}{P_{i2}} = 0$$

In a symmetric equilibrium all prices and quantities are equal across households. Using the technological restriction $Y_2 = A_2 N_2$, the price-setting condition gives

$$N_2 = \left(\frac{\sigma - 1}{\kappa\sigma} \right)^{\frac{1}{1+\eta}} = 1$$

Therefore, in period 2 equilibrium labor supply is constant and output and consumption are given by

(1) $$C_2 = Y_2 = A_2$$

Now go back to period 1. Agents set prices before any of the shocks are realized. Therefore, the price-setting equation takes the form

$$E\left[(1-\sigma)\frac{1}{P_1 C_{i1}} \frac{P_{i1} Y_{i1}}{P_{i1}} + \kappa\sigma \frac{1}{A_2} N_{i1}^{\eta} \frac{Y_{i1}}{P_{i1}} \right] = 0$$

Rearranging terms this gives

(2) $$E\left[N_1^{1+\eta} \right] = 1$$

This condition will be used later to pin down the price level P_1.

Now let me turn to the determination of quantities in period 1, after the realization of the shocks x and ε_1. I assume consumers observe the current productivity a_1 but do not observe its permanent and its temporary component. On top of observing a_1, consumers observe a signal

$$s = x + e$$

The signal s captures public news about technological advances, current statistics about the economy, stock market prices, and all other public sources of information that are relevant for estimating long-run productivity trends. The shock e is a measurement shock, independent of all other shocks, it has mean zero and variance σ_e^2. Conditional on a_1 and s future productivity a_2 is normally distributed with mean $\beta a_1 + \delta s$ and variance $\hat{\sigma}^2$.[3]

The consumer Euler equation takes the form

$$\frac{1}{P_1 C_1} = RE\left[\frac{1}{P_2 C_2}\middle| a_1, s\right]$$

Assume that the central bank sets a constant price level in period 2, $P_2 = 1$.[4] Then since $C_2 = A_2$ and A_2 is normally distributed, the Euler equation can be written as

$$c_1 = E\left[a_2 \middle| a_1, s\right] - \frac{1}{2}\hat{\sigma}^2 - r - p_1$$

From now on, a lowercase variable denotes the logarithm of the corresponding uppercase variable.

Suppose the central bank sets the interest rate r as a function of the current level of output y_1, and follows the interest rate rule

[3] The expressions for β, δ and $\hat{\sigma}^2$ are

$$\beta = \frac{\frac{1}{\sigma_\varepsilon^2}}{\frac{1}{\sigma_x^2} + \frac{1}{\sigma_\varepsilon^2} + \frac{1}{\sigma_e^2}}$$

$$\delta = \frac{\frac{1}{\sigma_e^2}}{\frac{1}{\sigma_x^2} + \frac{1}{\sigma_\varepsilon^2} + \frac{1}{\sigma_e^2}}$$

$$\hat{\sigma}^2 = \left(\frac{1}{\sigma_x^2} + \frac{1}{\sigma_\varepsilon^2} + \frac{1}{\sigma_e^2}\right)^{-1} + \sigma_\varepsilon^2$$

[4] Given that period 2 is the last period, this price level can be implemented with a fiscal commitment, i.e., the government commits to accept (pay) 1 unit of consumption good in exchange for each unit of nominal debt (credit) that agents have, and uses taxation to fulfill this commitment. Notice that no taxation is needed on the equilibrium path.

(3) $$r = \alpha_0 + \alpha_1 y_1$$

Putting together the last two equations, using $y_1 = c_1$, gives

(4) $$y_1 = \frac{1}{1+\alpha_1}\left\{-\alpha_0 + E\left[a_2 \left| a_1, s\right.\right] - \frac{1}{2}\hat{\sigma}^2 - p_1\right\}$$

where $E\,[a_2|a_1, s] = \beta a_1 + \delta s$.

It only remains to pin down p_1. Rewrite equation *(2)* as

(5) $$E\,[e^{(1+\eta)(y_1 - a_1)}] = 1$$

thanks to log-normality this equation can be solved explicitly and gives

(6) $$-\frac{1}{1+\alpha_1}\left(\alpha_0 + \frac{1}{2}\hat{\sigma}^2 + p_1\right) + \frac{1}{2}(1+\eta)\left(\frac{\beta+\delta}{1+\alpha_1} - 1\right)^2 \sigma_x^2 + \\ + \frac{1}{2}(1+\eta)\left(\frac{\beta}{1+\alpha_1} - 1\right)^2 \sigma_\varepsilon^2 + \frac{1}{2}(1+\eta)\left(\frac{\delta}{1+\alpha_1}\right)^2 \sigma_e^2 = 0$$

This equation gives an expression for p_1 in terms of exogenous parameters and the monetary policy parameters. The choice of α_0 is irrelevant for equilibrium quantities and relative prices, since it only affects the expected component of the nominal interest rate. An increase in α_0 simply leads to a proportional increase in p_1, leaving the expected real interest rate $E\,[r - p_1]$ unchanged. On the other hand, the coefficient α_1 matters for the determination of equilibrium output, both for its level (through *(6)*) and for its response to shocks (through *(4)*).

This economy gives a baseline case of an economy where productivity expectations drive current activity. News about future productivity affect consumers' decisions through their effect on their long-run income expectations, measured by $\beta a_1 + \delta s$. Consumers' spending affects real activity due to the presence of a nominal rigidity. The strength of this effect depends on the monetary policy response, captured here by the coefficient α_1.

Notice that here current productivity a_1 affects current spending only because it affects expected income. If σ_ε^2 is large and σ_e^2 is small, then β is relatively small and δ is relatively large. In this case output fluctuations will be dominated by movements in the signal s.

3. - The Role of Nominal Rigidities

Consider an alternative environment where prices are set after agents observe the current shocks in period 1. In this case, the price setting equation *(2)* holds without the expectation operator and gives

$$N_1 = 1$$

The equivalent of *(1)* is

$$y_1 = a_1 \tag{7}$$

Therefore, in the baseline flexible price model output is only driven by current productivity and news about the future have no effect. In this case the response of consumption spending to expected income is exactly compensated by an increase in the real interest rate. Substituting equilibrium output in the consumer's Euler equation one gets:

$$r + p_1 = E\left[a_2 \middle| a_1\right] - a_1 - \frac{1}{2}\hat{\sigma}^2 \tag{8}$$

The real interest rate corresponds to the slope of the expected consumption path. In this case the demand side has no effect on the determination of equilibrium output, and only affects the determination of intertemporal prices.

This result is more general than the simple two-period model presented here. In richer models with investment and a full treatment of dynamics, it is still true that flexible price models have a difficult time generating output fluctuations driven by news about the future. Recent advances in this direction are in Rebelo and Jaimovich (2006) and Beaudry and Portier (2006*b*).[5] In particular, Rebelo and Jaimovich (2006) show that two required ingredients to generate realistic responses to news in flexible price models are adjustment costs in investment and consumer preferences that imply a low short-run wealth effect on labor effort. However, Christiano, Motto and Rostagno (2006) show that a model with these features still faces difficulties accounting for the response of financial market prices, in particular asset prices and interest rates unless one introduces both wage and price stickyness. In general, nominal rigidities seem an essential ingredient to account for the weak response of the real interest rate during cycles divren by news.

4. - Some Empirical Implications

Equation *(4)* captures in a nutshell the idea that cycles are driven both by actual productivity shocks and by shocks to long-run income expectations of agents. Recent empirical work by Beaudry and Portier (2006*a*) suggests that shocks to long-run expectations about TFP are relevant in determining short-run output fluctuations. Namely, they use stock prices as signals about long-run trends in TFP, and use the forecast of future TFP contained in stock prices in a VAR model. They show that innovations in future expected TFP have a positive persistent effect on consumption, and a temporary positive effect on labor supply. An interesting feature of their empirical results is that they identify shocks to news about future TFP which are virtually uncorrelated with changes in current TFP, so, empirically, the economy's response does not seem to be driven by current changes in productivity.

[5] Earlier work in this direction includes COCHRANE J.H. (1994) and DANTHINE J.-P. - DONALDSON J. - JOHNSEN T. (1998).

In Lorenzoni (2006*a*) I develop a model with nominal rigidities similar to the model described above, but with idiosyncratic productivity shocks and imperfect information. The model is used to derive joint implications regarding inflation and output responses to actual productivity shocks, like x, and to pure "news shocks", that only affect productivity expectations, like e. Both type of shocks tend to increase current output, but actual productivity shocks lead to a negative inflation surprise, while news shock leads to a positive inflation surprise. This difference is due to the fact that after a fundamental shock producers believe that aggregate spending will rise less than their own productivity, and, thus, tend to lower relative prices in order to attract consumers' demand. After a pure news shock, instead, producers believe that aggregate spending will rise more than their own productivity, and tend to raise relative prices. This approach connects the recent models of news-driven cycles with the old fashioned keynesian distinction between "demand" and "supply" shocks. Productivity shocks in the model have the features of a supply shock, while news shocks have the feature of a demand shock. This leads to a number of testable restrictions. In particular, one can test wether a model based on news shocks can account for the amount of short-run output volatility obtained in empirical VAR studies. I have followed this route in a simple calibration exercise in Lorenzoni (2006*a*).

To understand the spirit of the exercise it is worth noticing that the amount of volatility due to news shocks is, in general, bounded. In particular, the model imposes restrictions on the fraction of short-run volatility explained by news. Going back to equation *(4)* the total volatility of y_1 depends on the volatility of $E\,[a_2|a_1, s]$ and is equal to

$$Var\left[y_1\right] = \left(\frac{1}{1+\alpha_1}\right)^2 \left[(\beta+\delta)^2\sigma_x^2 + \beta^2\sigma_\varepsilon^2 + \delta^2\sigma_e^2\right]$$

$$= \left(\frac{1}{1+\alpha_1}\right)^2 (\beta+\delta)^2\sigma_x^2$$

while the volatility due to the news shock e is given by

$$\left(\frac{1}{1+\alpha_1}\right)^2 \delta^2\sigma_e^2$$

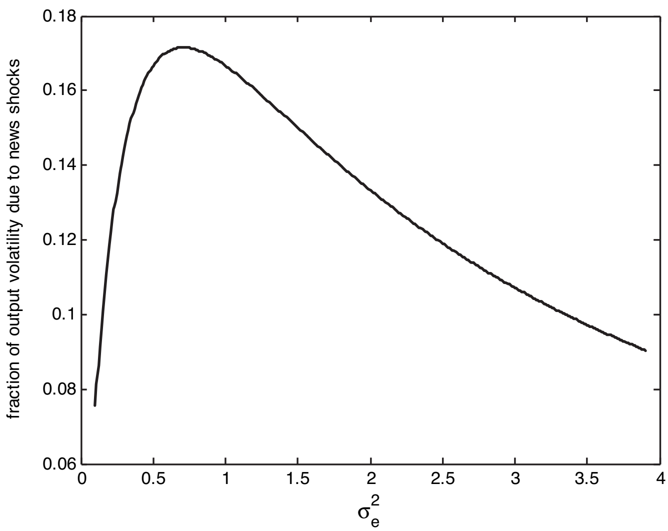
The fraction of short-run variance due to news shocks is then given by

$$\frac{\delta^2\sigma_e^2}{(\beta+\delta)\sigma_x^2}$$

This expression is non-monotone in σ_e^2: when the volatility of the news shock is too high agents tend to disregard the signal s and δ is small, when the the volatility of the news shock is too small, on the other hand, δ is large but the shocks themselves are small. Graph 1 shows the relation between σ_e^2 and the fraction of output volatility due to news shocks.[6]

GRAPH 1

NEWS SHOCKS AND OUTPUT VOLATILITY
Relation between σ_e^2 and the fraction output volatility due to news shocks



[6] The parameters for this figure are $\sigma_\varepsilon^2 = \sigma_x^2 = 1$.

This brief discussion shows that, on the one hand, observable variables like stock market prices can be used to empirically identify changes in consumers' expectations. On the other hand, one can derive theory-based restrictions on the response of various endogenous variables to news. Combining these two approaches seems a promising avenue for future research.

5. - Monetary Policy

To evaluate monetary policy consider the effects of choosing the parameters α_0, α_1, in the policy rule *(3)*. As seen above, all real variables in period 2 are independent of the policy rule chosen. Therefore, let me concentrate on the effects of the choice of α_0, α_1 on consumers' utility in period 1,

$$W \equiv E\left[\log C_1 - \frac{K}{1+\eta} N_1^{1+\eta}\right]$$

Thanks to the assumption of log-normality the expected utility of consumers in period 1 can be derived explicitly. In particular, it is possible to show that welfare is inversely related to the volatility of the "output gap" measure $y_1 - a_1$,[7]

$$w = -\frac{1+\eta}{2} Var\left[y_1 - a_1\right] \tag{9}$$

where

$$Var\left[y_1 - a_1\right] = \left(\frac{\beta+\delta}{1+\alpha_1} - 1\right)^2 \sigma_x^2 + \left(\frac{\beta}{1+\alpha_1} - 1\right)^2 \sigma_\varepsilon^2 + \left(\frac{\delta}{1+\alpha_1} - 1\right)^2 \sigma_e^2 \tag{10}$$

Suppose for a moment that $\alpha_1 = 0$, i.e., the monetary authority keeps a constant nominal interest rate. Then, output gap volatility is due to three causes. First, $\beta + \delta < 1$, as agents tend to discount

[7] The derivation is in the *APPENDIX*.

the two signals s and a_1, since they are both noisy signals. This implies that output responds less than one-for-one to permanent productivity shocks. Second, $\beta - 1 > 0$: output responds less than one-for-one to a temporary shock ε_1. Third, $\delta > 0$: since the signal s is informative, and the "news shock" e generates unwanted volatility in the output gap.

Optimal monetary policy is found by choosing the value of α_1 that maximizes consumers' welfare. The trade-off faced by the monetary authority is reflected in the three terms of equation *(10)*. On the one hand, an aggressive monetary policy rule (i.e., a large value for α_1) reduces the third term, that is, it reduces unwanted output gap volatility due to the news shock. On the other hand, if $1 + \alpha_1$ is too large, i.e. larger than β and $\beta + \delta$, this tends to increase the first two terms, reducing the response of output to actual productivity shocks, temporary or permanent.

Optimal monetary policy corresponds to

$$1 + \alpha_1 = \beta + \delta \tag{11}$$

Interestingly, in this model optimal monetary policy implies $\alpha_1 < 0$, that is, the monetary authority lowers the nominal interest rate in an expansion. This is optimal because it induces the economy to increase its response to permanent productivity shocks. At the same time, this policy amplifies the boom in cases in which the expansion is driven by pure noise. This emphasizes a more general point: if monetary policy is conducted under imperfect information then it may not be feasible or optimal to completely eliminate the role of demand shocks driven by news.

If the monetary authority had full information about the source of the expansion, e.g. if the monetary authority could observe both s and a_1, then it would be optimal to mimic the flexible price equilibrium and target $y_1 = a_1$ by setting the nominal interest rate so as to satisfy *(8)*.

In a similar way, Christiano, Motto and Rostagno (2006) show that under optimal monetary policy the expansionary effect of news is greatly reduced, and the model behaves essentially as its flexible-price counterpart. In this view, if news shocks have an effect on the business cycle, this is a symptom of an inefficient monetary policy rule.

The model presented here shows that this conclusion is unwarranted if the monetary authority and the private sector have limited information. Under limited information if the monetary authority tries to stabilize the effect of news it ends up neutering the effects of actual productivity shocks, thus generating unwanted inertia. In the example presented above, indeed, the optimal response to imperfect information is for the monetary authority to amplify the effect of demand shocks!

However, the model presented is somewhat unsatisfactory because it assumes that all agents in the private sector observe a_1, while the monetary authority fails to observe this information. In Lorenzoni (2006*b*) I consider a model with dispersed information, where private agents and the monetary authority have the same information regarding aggregate variables, although private agents have superior information about their own individual shocks. In that setup, I derive optimal monetary policy and show that *(i)* an inertial monetary policy rule can, in principle, achieve a zero output gap (i.e. $y_1 = a_1$), in the aggregate, but *(ii)* to achieve a zero output gap involves undesirable cross-sectional consequences, so that the optimal monetary policy involves partial accommodation of news shocks.

The introduction of news shocks in business cycle models can potentially generate fluctuations in output, some of which will be revealed to be *ex post* inefficient (i.e. fluctuations in the output gap). Whether this *ex post* inefficiency can be corrected by optimal monetary policy, however, depends on the way in which these news shocks are introduced. Therefore, the policy implications of this new area of research are, at the moment, open and deserve further investigation.

APPENDIX

1. - Derivation of Expression (9)

Substitute equilibrium output and labor supply in the expression for *W*, using *(5)*, gives

$$W = E\left[y_1 - \frac{1}{1+\eta} e^{(1+\eta)(y_1 - a_1)} \right] =$$

$$= E\left[y_1 \right] - \frac{1}{1+\eta}$$

Taking expectations on both sides of *(4)* and using $E\,[a_2] = 0$, gives

$$E\left[y_1 \right] = -\frac{1}{1+\alpha_1}\left(\alpha_0 + p_1 + \frac{1}{2}\hat{\sigma}^2 \right) \tag{12}$$

Equation *(6)* can be rearranged to get

$$\frac{1}{1+\alpha_1}\left(\alpha_0 + p_1 + \frac{1}{2}\hat{\sigma}^2 \right) = \frac{1}{2}(1+\eta)\left(\frac{\beta+\delta}{1+\alpha_1} - 1 \right)^2 \sigma_x^2 +$$

$$+\frac{1}{2}(1+\eta)\left(\frac{\beta-1}{1+\alpha_1} \right)^2 \sigma_e^2 + \frac{1}{2}(1+\eta)\left(\frac{\delta}{1+\alpha_1} \right)^2 \sigma_e^2 =$$

$$= Var\left[y_1 - a_1 \right]$$

Substituting in *(12)* gives *(9)*.

2. - Derivation of Expression 11

Let $\zeta = 1 / (1 + \alpha_1)$. Then the first order condition for optimal monetary policy is

$$(\beta + \delta)\,(\zeta\,(\beta + \delta) - 1)\,\sigma_x^2 + \beta\,(\zeta\beta - 1)^2\,\sigma_\varepsilon^2 + \zeta\delta^2\sigma_e^2 = 0$$

which gives

$$\zeta = \frac{(\beta+\delta)\sigma_x^2 + \beta\sigma_\varepsilon^2}{(\beta+\delta)^2\sigma_x^2 + \beta^2\sigma_\varepsilon^2 + \delta^2\sigma_e^2}$$

Substituting the expressions for β and δ, and simplifying gives

$$\zeta = \frac{\dfrac{1}{\sigma_x^2} + \dfrac{1}{\sigma_\varepsilon^2} + \dfrac{1}{\sigma_e^2}}{\dfrac{1}{\sigma_\varepsilon^2} + \dfrac{1}{\sigma_e^2}} = \frac{1}{\beta+\delta}$$

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