The “neutral” rate of interest and the role of uncertainty in a New Economics theoretical framework

by

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January 28/29, 2010

The “neutral” interest rate in the New Neoclassical Synthesis (I)

- The “neutral” interest rate is usually defined as the long-term real interest rate which is *neutral* with respect to the inflation rate and tends neither to increase it nor to decrease it in the absence of supply shocks.

- In the context of the New Neoclassical Synthesis (NNS), Woodford (2003, p. 248) refers to it as the “natural” interest rate and defines it as ‘the equilibrium real rate of return in the case of fully flexible prices’.

The “neutral” interest rate in the New Neoclassical Synthesis (II)

- He notes that the “natural” interest rate ‘must increase in response to temporary increases in government purchases or in the impatience of households to consume and decrease in response to temporary increases in labor productivity or in the willingness of households to supply labor’ (Woodford 2003, p. 250).

- Although a range of shocks may well render it negative, Woodford (2003, p. 251) notes that the model implies a positive *average* level of the “natural” rate determined by the rate of time preference of the representative household.

The “neutral” interest rate in the New Neoclassical Synthesis (III)

- Thus, the determination of the “neutral” or “natural” interest rate in the *NNS* is reminiscent of the Ramsey (1928) and Sidrauski (1967) models which make up the backbone of “optimal” growth theory.

- However, the standard *NNS* model assumes that agents exhibit perfect foresight and, as a result of it, it *precludes* the possibility that changes in the level of uncertainty affect the level of economic activity and thus the “neutral” interest rate.

The “neutral” interest rate and uncertainty (I)

- Some developments in the context of consumption and investment theory over the last two decades show that, even if we assume that agents optimize and uncertainty is of the “insurable” type, changes in the level of (mean-preserving) uncertainty will affect aggregate demand.
- Likewise, models that explore the impact of asymmetric information in credit markets like the ones developed by Greenwald, Stiglitz and Weiss also imply that changes in the (subjective) perception of riskiness by lenders will affect the degree of credit-rationing.

The “neutral” interest rate and uncertainty (II)

- If so, the former means that the “neutral” interest rate is no longer determined solely by preferences and techno-logy; it will also depend on the level of uncertainty as subjectively perceived by economic agents.
- More precisely, in the contributions I will refer to below, changes in the level of (mean-preserving) uncertainty are typically associated to changes in the degree of volatility of output, consumption or market prices as subjectively perceived by economic agents.

The “neutral” interest rate and consumption (I)

- According to Carroll (2001), the main development in consumption theory in the last three decades is that improvements in computer speed allowed economists to relax the perfect foresight/certainty equivalence assumption and to analyze optimal behaviour under sensible assumptions about uncertainty.

- In particular, the notion of “precautionary saving” has served as a benchmark for the development of the so-called “buffer-stock” saving model by Zeldes (1989), Deaton (1991) and Carroll (1992, 1994, 1997).

The “neutral” interest rate and consumption (II)

- Contrary to standard LC/PIH models, in the “buffer-stock” saving model unemployment expectations are important determinants of consumption.

- This is because, when consumers become more pessimistic about unemployment, their uncertainty about future income increases, so their target buffer-stock increases, and they increase their saving to build up wealth toward the new target (Carroll, 1992).

The “neutral” interest rate and consumption (III)

- Importantly, the “buffer-stock” saving model predicts that a sufficiently strong increase in mean-preserving uncertainty will make the “neutral” interest rate negative even in steady-growth.

- To illustrate this, let´s consider a typical Euler equation for consumption growth when the utility function of the representative household exhibits “constant relative risk aversion” or CRRA (Carroll, 1992, p. 130):

$$\Delta \ln C_{t+1} \approx \rho^{-1}(r - \vartheta) + \frac{1}{2}\rho E_t \operatorname{var}(\Delta \ln C_{t+1}) + e_{t+1} \quad (1)$$

The “neutral” interest rate and consumption (IV)

- When gross wealth is at the target ratio the expected growth rate of consumption will be roughly equal to the expected growth rate of income *g* so that, in steady-growth we have:

$$\Delta \ln C_{t+1} \approx \rho^{-1}(r^* - \vartheta) + \frac{1}{2}\rho E_t \operatorname{var}(\Delta \ln C_{t+1}) = g \quad (2)$$

or $r^* = \rho\left(g - \frac{\rho Z}{2}\right) + \vartheta$ so that $\frac{\partial r^*}{\partial Z} = \frac{-\rho^2}{2} \prec 0$ (3)

where $Z = E_t \operatorname{var}(\Delta \ln C_{t+1})$ and the asterisk denotes the steady-growth value of a variable.

The “neutral” interest rate and investment (I)

- According to the neoclassical investment model, a firm should increase its capital stock when the market value of the capital assets exceeds their replacement cost or, equivalently, when the net present value (*NPV)* of the project is positive.

- As noted in Hubbard (1994), the neoclassical theory of investment theory relies on two subtle assumptions:
  - Invested capital is “reversible”, that is, it can be sold easily in second-hand markets.
  - Each investment opportunity facing the firm is a once-and-for-all opportunity; if the firm declines the project, it will not be able to reconsider it out in the future.

The “neutral” interest rate and investment (II)

- By contrast, the starting point for the new literature on investment under uncertainty is that (Dixit, 1992):
  - Investment entails some “sunk” costs (capital goods are industry and/or firm-specific) thus implying that an investment expenditure *cannot* be fully recouped if the action is reversed at a later date,
  - The economic environment has ongoing uncertainty and information arrives gradually, and
  - Investment opportunities do not disappear if not taken immediately so there is some leeway about the *timing* of the investment plan).

The "neutral" interest rate and investment (III)

- When such conditions are present, waiting has positive value because, as time brings new information about the prospects of the investment project, a later decision may be a better one.
- However, the value of waiting must be set against the sacrifice of foregone current profit. Thus, if current profitability increases sufficiently, the firm should eventually take the investment plan and not wait any longer.
- Consequently, the "trigger" level of currently expected profit that makes it optimal to execute an investment plan in the presence of uncertainty may substantially *exceed* the neoclassical threshold.

The "neutral" interest rate and investment (IV)

- Dixit and Pindyck (1994) argue that firms invest in projects that are expected to yield a rate of return in excess of a "hurdle" rate that is typically as large as *three or four times* the cost of capital.
- They emphasize that compared to the predictions of neoclassical models, investment models that take account of irreversibility and uncertainty help predict:
  - The low sensitivity of investment expenditure to changes in interest rates and
  - Its high sensitivity to changes in the degree of uncertainty about future profits.

The "neutral" interest rate and investment (V)

- In an example presented in Dixit (1992), it is assumed that the flow of net operating revenues per unit time *R* can either increase or decrease by a fixed percentage in each period so that the resulting geometric series is governed by a geometric Brownian motion with drift.

- Let us suppose that:

  – The project can be launched by incurring a "sunk" cost *K*
  – The investor is risk-neutral
  – The trend rate of growth of *R* is zero
  – The aim of the firm is to maximize the expected *NPV* and
  – Future revenues are discounted at a rate $r > 0$

The "neutral" interest rate and investment (VI)

- Then, given a current level *R* of revenues, the expected present value of the discounted future stream of revenues is R/r.

- The textbook criterion would be to invest when the project has positive *NPV*, i.e., when $R/r > K$.

- The borderline level *M* of *R* that would make one indifferent between investing and not investing is $M = rK$. Hence, *M* is the "Marshallian" investment trigger.

- As Dixit (1992) remarks, this criterion comes from thinking that the choice is between acting now to get $R/r – K$, and not investing at all, which gets *0*.

The “neutral” interest rate and investment (VII)

- However, he shows that, if it is possible to postpone the decision to a later date, then the resulting investment trigger, say *H*, will exceed *M*, possibly, by a large amount.
- The reason is that ‘waiting for a certain amount of time enables an investor to avoid the downside risk in revenues over the interval, while realizing the upside potential’ (Dixit, 1992, p. 111).
- Hence, the insight is that the selective reduction in risk over time generates a *positive* value of waiting.

The “neutral” interest rate and investment (VIII)

- As shown in Dixit (1992), the optimal *H* is given by:

$$H = \left(\frac{\beta}{\beta - 1}\right) rK \qquad (4)$$

where $\beta = \frac{1}{2}\left[1 + \sqrt{1 + \frac{8r}{\sigma^2}}\right] \succ 1$ and

σ^2 is the variance of the logarithm of *R* per unit time.

- Thus, the optimal trigger *H* is $\beta/\beta - 1$ times the Marshallian trigger *M*.

The “neutral” interest rate and investment (IX)

- The project will thus be worth undertaking when *NPV > 0* using the “corrected” discount rate *r´* where:

$$r' = \left(\frac{\beta}{\beta - 1}\right) r \qquad (5)$$

and $\partial r' / \partial \sigma \succ 0$ so that, ceteris paribus, an increase in the variance of the logarithm of *R* raises *r´* and vice-versa.

- The former means that the higher the degree of volatility and, thus, of uncertainty, the larger the gap between *r* and *r´* and the *lower* the amount of investment that the firm will undertake.

The “neutral” interest rate and investment (X)

- In terms of the *q*-theory of investment, we can define a hurdle *q´* that is *larger* than one. In particular, (5) implies that an investment project should only be undertaken if:

$$q' = \left(\frac{H}{r} - K\right) \succ \left(\frac{\beta}{\beta - 1}\right) \succ 1 \qquad (6)$$

- An important implication of (6) is that, the larger is the variance of the logarithm of *R*, σ^2 the larger will be the *wedge* between the cost of funds in capital markets *r* and the “corrected” discount rate *r´* and, hence, the *lower* will be the desired stock of capital.

Summary

- An increase in uncertainty will:
  - Enlarge the wedge between the steady-growth "neutral" interest rate and the rate of time preference of the representative household so that the former may become negative
  - Enlarge the wedge between the steady-growth "neutral" interest rate and the "corrected" discount rate and, hence,
  - Reduce the "desired" stock of capital

Conclusions

- Introducing changes in mean-preserving uncertainty into models where economic agents are nevertheless optimizing has, at least, the three following implications:
  - Unlike in the standard NNS model, the "neutral" interest rate is a negative function of the level of uncertainty.
  - As uncertainty increases, the former may become *negative* even in steady-growth thus rendering monetary policy ineffective.
  - There emerges a rationale for *fiscal* policy that is absent in the *NNS*, i.e., to reduce the level of macroeconomic volatility in order to raise the "neutral" interest rate and, hence, to reduce the likelihood that the economy exhibits a "liquidity trap".