The Forward Exchange Rate and the Interest Rate within a Production Economy

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ABSTRACT

This paper considers some equilibrium characteristics of the forward foreign exchange rate and the interest rate within a production economy. In order to derive the optimal solutions, a two-stage decision process is assumed; the first is the production decision, and the second the portfolio decision. With some additional assumptions, both the forward exchange rate and the interest rate were shown to depend on the underlying stochastic parameter in the production function. Unlike in an exchange economy, the unbiasedness hypothesis of the forward exchange rate was shown to fail because of random technological shocks in production.

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1. Introduction

Two distinct features characterize recent economic models utilized in modern economic analysis including monetary theory. One is that the model assumes dynamic elements explicitly, and the other is that it also considers inherently stochastic elements.

Although the importance of both of these elements in economic analyses has long been recognized, it is relatively recently that their economic implications are examined simultaneously within a single unified model. A notable example is the so-called "equity premium puzzle" (Mehra and Prescott (1985)), and its related and descendent analyses (for a recent survey of the literature, see Kudoh (1991)). Those problems have been examined by the so-called "recursive method", which is expounded in, e.g., Stokey, Lucas, and Prescott (1989) (for a recent survey of the literature, see Judd (1991)). The method makes it possible to solve a wide range of stochastic dynamic optimization problems and to generate the agent's optimal decision rules that characterize the description of the equilibrium.

This article tries, with a help of those recent methods within a single model of production economy, an equilibrium analysis that has been examined by constructing different models under the traditional economics of uncertainty. To be more specific, this article examines, within a simple and single but unified model, two separate but closely related issues that have been analyzed traditionally in two different models, i.e., the first is the optimal consumption-saving decision as a solution of the constrained utility maximization, and the second is the optimal portfolio choice as a solution of a simple decision problem.[1]

To solve the problems, I focus my attention on the unbiasedness hypothesis of the forward foreign exchange rate and on the equilibrium rate of interest within a simple real business cycle model that is nothing but a growth model with random technological shocks (for recent surveys of the literature, see Plosser (1989), Mankiw (1989), and Stadler (1994)).[2]

These topics have been examined traditionally within a simple two-period model of pure exchange (i.e., no production) by, e.g., Frenkel and Razin (1980). However, my model here considers production explicitly, and thus a similar but slightly different model as those of Donaldson and Mehra (1983) and Mehra (1984) is constructed. In fact, Frenkel and Razin (1980) completely neglected production uncertainty but only concentrated on price uncertainty in an open economy. One of the motivations of the present study lies in this "incompleteness" of the previous studies of price uncertainty. Kemp (1976) clearly pointed out that taking price uncertainty as given (like in Frenkel and Razin (1980)) is analytically incomplete, "without relating it to the underlying randomness of preferences, technology or factor endowments, …" (p.264).

The unbiasedness of the forward exchange rate has been one of the necessary conditions to preclude speculative behavior in the recent literature of the full hedge theorem for the exchange rate risk within a portfolio decision model (e.g., Lehrbass (1994)).   As the problems here are slightly complicated, I simplify the model, without loss of generality, by parametrization, and derive a condition for the arbitrage-free forward exchange rate, and also show the well-know fact that in a world inhabited by risk averse individuals unbiasedness and absence of arbitrage are mutually exclusive. Furthermore, I examine several notable characteristics of the equilibrium forward exchange rate and the equilibrium rate of interest within my assumed model.

The remainder of the article is organized as follows. Section 2 presents a simple real business cycle model to examine first the implications of the optimal consumption decision of an economy consisting of infinitely lived

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representative agents. Section 3 considers the portfolio decision as the decision of optimal saving that lies behind the optimal consumption decision. My specific focal points rest on the relationship between the forward exchange rate and the expected future spot exchange rate in a production economy, and also on making detailed examination of its characteristics and its relationship with the rate of interest. Section 4 concludes the paper.

2. The Model

In order to examine some characteristics of an important hypothesis of unbiasedness with respect to the forward foreign exchange rate, and its relationship with the rate of interest, I construct and utilize a simple but standard stochastic growth model or a real business cycle model (e.g., Donaldson and Mehra (1983), Mehra (1984)). The model is described as follows.

<u>Assumption 1</u>   Preference

(a)   The representative agent's preference is given by the discounted sum of the time-separable (but state-inseparable) and instantaneous utility (or "felicity") function:

$$U(\cdot) \equiv E \left[\sum_{t=0}^{\infty} \beta^t u(C_t) \right] \tag{1}$$

(b)   u($\cdot$) is a non-negative and a concave increasing function of real consumption, C_t.

(c) β is a parameter representing the subjective discount rate, or the rate of time preference, which is assumed to be strictly positive.

E is an operator representing expectations. For the sake of simplicity and ease of calculation, the planning horizon is made infinite. Also for simplicity's sake, the felicity function is parametrized as follows:

<u>Assumption 1'</u>   Felicity

(b') $u(C_t) = \ln C_t$ (2)

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Assumption 1' implies that $u(\cdot)$ is a function with constant elasticity of substitution, or an iso-elastic function. (2) is also known to belong to a class of CRRA (the constant relative risk aversion) utility function. The assumption of a logarithmic utility function has frequently been adopted for reasons of analytical tractability; see, for example, Blanchard and Fischer (1989), Mehra (1984), and Salyer (1994).

The utility function given by equation (1) is maximized under the following budget constraint:

$$Y_t + R_{t-1}B_{t-1} + S_t R^*_{t-1}B^*_{t-1} + (S_t - F_{t-1})A_{t-1} = C_t + K_{t+1} + (B_t + S_t B^*_t) \qquad (3)$$

where:

Y_t = the real output of the home country in period t.

$B_t(B^*_t)$ = the one-period bond issued by the home (foreign) government in period t.

$R_t(R^*_t)$ = the rate of return of the home (foreign) bond in terms of the home (foreign) currency (i.e., one plus home (foreign) rate of interest $(r_t(r^*_t))$).

S_t = the spot exchange rate in period t (expressed as units of home currency per unit of the foreign currency)

F_t = the one-period forward foreign exchange rate in period t (defined similar to S_t).

A_t = the one-period forward foreign exchange contract in period t, to be delivered in period t+1.

C_t = the real consumption in period t, and

K_t = the real capital stock in period t.

The left-hand side of (3) represents the real resources disposable in period t, while the right-hand side the sum of real expenditures in period t. The representative agent makes a forward contract A_t in period t, which is to be delivered in period t+1, at the forward price F_t. However, since it is nothing but a contract, it does not appear in the right-hand side in period t,

because it will not be delivered until period t+1.

Assumption 2   No margin requirement

It is assumed in (3) that forward contracts do not entail a margin requirement, so that the interest cost is zero.

Assumption 3   Production

(a) The production function $\qquad Y_t = Z_t K_t{}^{\alpha} \qquad 1 > \alpha > 0$ (4)

i.e., Y is produced by a concave production function with respect to K.

(b) Z_t is an i.i.d. random shock, which obeys:

$$\ln Z_t \sim N(0, \sigma^2)$$

(c) K_t depreciates at a rate of 100 per cent in each period.

Assumption 4   The timing of optimization

Considering the simple and clear fact that production takes time, the timing of optimization by the representative agent in each period is as follows:

(a) At the first stage the optimal C_t and investment, and therefore the optimal K_t (hence output Y_t) are chosen under the constraints (3) and (4).

(b) At the second stage the optimal portfolio decision (B, B*,A) is made.

In other words, in the first stage after actual real output is observed, the representative agent allocates it between optimal current consumption and the next period's capital. In the second stage, before uncertainty about future exchange rates is resolved, she allocates her remaining realized real resource optimally between real assets to transfer it to the next period.[3]

Assumption 5   Ruling out speculative behavior

At the first stage of each period the representative agent makes the optimal choice, expecting that the unbiasedness hypothesis holds strictly. In other words, she expects $S_{t+i+1} = F_{t+i}$ for all positive integer i.

Under the assumption the constraint (3) can be rewritten as follows:

$$Y_t = C_t + K_{t+1} + [(B_t + S_t B^*_t) - (R_{t-1} B_{t-1} + S_t R^*_{t-1} B^*_{t-1})]$$

$$= C_t + K_{t+1} + Q_t \tag{5-1}$$

$$Q_t \equiv [(B_t + S_t B^*_t) - (R_{t-1} B_{t-1} + S_t R^*_{t-1} B^*_{t-1})] \tag{5-2}$$

Q_t is the net demand for the real bonds in period t, and take the value of either positive, negative, or zero.

Regarding $(K_{t+1} + Q_t)$ as a slack variable for the Kuhn-Tucker conditions, maximization of (1) with respect to C_t under the constraints of (4) and (5) yields the following optimal conditions for the first stage:

$$C_t = \beta C_{t-1} = (1-\alpha\beta)Y_t - Q_t = (1-\alpha\beta)Z_tK_t{}^\alpha - Q_t \qquad (6\text{-}1)$$

$$K_{t+1} = \alpha Y_{t+1} = \alpha\beta Y_t = \alpha\beta Z_tK_t{}^\alpha \qquad (6\text{-}2)$$

This last solution represents the "law of motion" for the capital stock (Mehra (1984), p.277). Substituting these optimal solutions into (5) and rearranging yield the following expressions:

$$Y_t = \beta^tY_0 + (1-\alpha\beta)\beta^tQ_0 \qquad (6\text{-}3)$$

$$Q_t = \beta^tQ_0 \qquad (6\text{-}4)$$

Y_0 and Q_0 are the initial values of Y_t and Q_t, respectively, and are assumed to be positive. The first term of the right-hand side of (6-3) is the solution of the homogeneous part, while the second term is the particular solution of the non-homogeneous part, and together they constitute the general solution.

From (6-3) and (6-4) defining $\gamma \equiv Q_0/[Y_0+(1+\alpha\beta)Q_0]$ (hence $1>\gamma>0$) yields a simple expression $Q_t=\gamma Y_t$, and upon substitution of this into (6-1) yields the following optimal consumption function:

$$C_t = (1-\alpha\beta-\gamma)Y_t \qquad (6\text{-}1')$$

$1-\alpha\beta-\gamma$ is the APC and the MPC, and is assumed to be a positive fraction.

Substituting the optimal solution (6-2) into the production function (4) successively, and taking logarithms yield the following condition under the optimality:

$$\log Y_T = \sum_{i=1}^{T} \alpha^{i-1}\log Z_{T+1-i}+\log \alpha\beta \sum_{i=1}^{T} \alpha^i +\alpha^T\log Y_0 \qquad (7\text{-}1)$$

Defining the unconditional mean of Y_t by the limit of the expectation of (7-1), assumption 3 yields:

$$E[\log Y_T] = \lim_{T\to\infty} E[\log Y_T] = (\log \alpha\beta)[\alpha/(1-\alpha)] \qquad (7\text{-}2)$$

Thus, under the conditions of optimality the optimal real output will disperse around the constant mean value (7-2).

3. The Optimal Portfolio in a Production Economy

Once the optimal decisions of consumption C_t and investment K_t (and hence output Y_t) at the first stage in each planning period are made as summarized in (6-1) and (6-2) as assumed in assumption 4, the remaining problem to be solved at the second stage is the optimal portfolio decision. This decision is made formally by maximizing (1) with respect to $\{B_t, B^*_t, A_t\}$ under the constraint (3). The first-order conditions of the optimization are:

$$\beta \ E[C_t/C_{t+1}] = 1/R_t \qquad (8\text{-}1)$$

$$\beta \ E[C_t S_{t+1}/C_t] = S_t/R^*_t \qquad (8\text{-}2)$$

$$E[(S_{t+1} - F_t)/C_{t+1}] = 0 \qquad (8\text{-}3)$$

Note that, because $1/C_{t+1}$ is a *convex* function of C_{t+1}, it follows that C_t/C_{t+1} < $C_t E[1/C_{t+1}]=1/\beta \ R_t$. It then follows immediately that:

$$E[C_{t+1}] \ > \ C_{t+1}$$

Thus, it was shown that the optimal consumption level is on average higher under uncertainty than under certainty. This is consistent with similar results obtained in the economic analysis under uncertainty (e.g., McKenna (1986), chapter 5).

Next from (8) the following relationship, stating that the ratio of the forward to the spot exchange rate is equal to the ratio of the real rate of return of the bonds between the two countries, is derived:

$$F_t/S_t = R_t/R^*_t \qquad (9)$$

Subtracting unity from both sides of (9) yields the well-known approximating relationship of the covered interest rate parity (CIP), i.e.:(Frenkel and Razin (1980)).

$$(F_t - S_t)/S_t \doteqdot r_t - r^*_t \qquad (9')$$

This implies, as is well-known, absence of arbitrage.

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Furthermore, solving (8-3) for the forward foreign exchange rate F_t yields:

$$F_t = E[S_{t+1}/C_{t+1}]/E[1/C_{t+1}] \tag{10}$$

$E[1/C_{t+1}]$ is nothing but the expected marginal utility of U with respect to the future consumption level C_{t+1}. Thus, equation (10) means that the relationship between the forward and the future spot exchange rates will be affected by the expected marginal utility of the future real consumption level. Our assumption 1' with respect to a parametrized utility (felicity) function implies that from equation (6-1'), $C_{t+1}=(1-\alpha\beta-\gamma)Y_{t+1}$. Thus, under the optimal conditions, (6-2), together with (4), yields:

$$C_{t+1}=(1-\alpha\beta-\gamma)(\alpha\beta)^\alpha K_t^\alpha Z_t^{\alpha^2} Z_{t+1}$$

Finally, substituting this into (10) yields:

$$F_t = E[S_{t+1}] + cov(Z_t^{-\alpha} Z_{t+1}^{-1}, S_{t+1})/E[1/Z_t^{-\alpha} Z_{t+1}^{-1}] \tag{11}$$

Thus, it is proved that the unbiasedness hypothesis does not in general hold within a production economy. Statistically, the probability of the hypothesis to hold is actually zero. A proposition stating that the unbiasedness hypothesis is constantly disturbed has been well-known both theoretically and empirically.[4] For example, Frenkel and Razin (1980), Engel (1984), and Andersen and Sorensen (1994) pointed out that, when the future prices are kept constant, the agent's attitudes towards risk, and the initial holding of assets, are responsible for the failure of the unbiasedness hypothesis within an exchange economy. According to Taylor (1995), if the risk-neutral efficient market hypothesis holds, then the unbiasedness of the forward exchange rate necessarily follows, given covered interest rate parity, (9'). However, in our production economy, it is interesting to observe in (11) that a more basic *technological uncertainty* is shown to hinder the realization of the unbiasedness hypothesis.[5]

If the hypothesis holds, F_t must be equal to $E[S_{t+1}]$ in equation (11). Also, the CIP is shown to hold in equation (9'). On the other hand, if the

representative agent is risk averse, then:

$$(E[S_{t+1}]-S_t)/S_t = \lambda_t \qquad\qquad \lambda_t \neq r_t - r^*_t$$

must be assumed for the existence of the risk premium, λ_t. Therefore, the well-known fact is confirmed here, i.e., in a world inhabited by risk-averse individuals, unbiasedness and absence of arbitrage are mutually exclusive. In other words, in general the covariance term in equation (11) must be non-zero. The reasons for it do not lie in those offered by Frenkel and Razin (1980), Engel (1984), Andersen and Sorensen (1994) or Taylor (1995), but in *those generated from uncertainty in production.*

Finally, characteristics of F_t and R_t are examined. First of all, for F_t, equations (9) and (8-1) yield:

$$F_t = S_t R_t / R^*_t = S_t E[C_{t+1}/\beta\ C_t]/E[C^*_{t+1}/\beta\ C^*_t]$$

If we further assume that the same production condition applies to the foreign country, so that assumptions 1 to 3 are valid, and the foreign variables are identified with asterisks, then substitution into the above relationship yields:

$$F_t = S_t E[Z_{t+1} Y_t^{\alpha-1}]/E[Z_{t+1} Y_t^{*\alpha-1}] \qquad (12)$$

Equation (12) was derived under an additional assumption that the production function, together with its parameter, is the same between both countries. Part (b) of assumption 3 is here modified slightly, and Z_{t+1} is assumed as follows:

Assumption 3'

(b') Z_t is an i.i.d. random shock, which obeys:

$$\ln Z_{t+1} = (-\delta)(\ln Y_t) \sim N(0, \sigma'^2) \qquad\qquad \delta > 0 \qquad (13)$$

In other words, assumption 3' signifies that an increase in Y_t,, *ceteris paribus,* will decrease Y_{t+1} through a decrease in Z_{t+1}.[6] Then, using equation (4) and the corresponding foreign country's production function, equation (12) can be rewritten as follows:

$$F_t = S_t V_t E[Z_t^{\alpha-\delta-1}]/E[Z^*_t{}^{\alpha-\delta-1}]$$

$$= S_t V_t \exp\{[(\alpha-\delta-1)/2]^2(\sigma^2 - \sigma^{*2})\} \qquad (14)$$

where $V_t \equiv E[(K_t^\alpha)^{\alpha-\delta-1}]/E[(K^*_t{}^\alpha)^{\alpha-\delta-1}] > 0$. The equilibrium relationship

(14) contains the following important implications: (a) an increase in Y_t (Y^*_t) will decrease (increase) F_t, (b) an increase in σ^2 (σ^{*2}) will increase (decrease) F_t, (c) an increase (decrease) in S_t will increase (decrease) F_t, but (d) the effect of a change in α or δ will depend on the relative size and scale of the home to foreign country.

Next, the relationship $R_t = E[C_{t+1}/\beta\,C_t] = 1+r_t$ which is transformed from equation (8-1) is examined. This relationship is further rewritten as:

$$R_t = (1/\beta)E[(\alpha\beta)^\alpha Z_{t+1}Y_t^{\alpha-1}] = \alpha^\alpha \beta^{\alpha-1}E[Z_{t+1}Y_t^{\alpha-1}] \tag{15}$$

Applying the previous additional assumption 3' (i.e., equation (13)) to (15), it is further simplified as:

$$R_t = \alpha^\alpha \beta^{\alpha-1}E[Y_t^{\alpha\cdot\delta-1}]$$

$$= \alpha^\alpha \beta^{\alpha-1}(K_t^\alpha)^{\alpha\cdot\delta-1}\exp\{\sigma^2(\alpha\cdot\delta-1)^2/2\} \tag{16}$$

The following implications are deduced from the equilibrium relationship (16). That is, (a) the well-known countercyclical movement is observed on average between Y_t and R_t (and hence r_t)(e.g., Salyer (1994)), (b) an increase in the rate of time preference β unambiguously decreases r_t (and hence R_t), while the effect of a change in the degree of concavity α in production function is ambiguous, (c) an increase in technological uncertainty σ^2 will increase r_t (and hence R_t), and (d) an increase in K_t will decrease r_t (and hence R_t).

Intuitively, (a) means that an increase in Y_t brings about, through the optimal life-cycle consumption decision, an increase in the demand for bonds, which in turn leads to a decrease in the rate of interest. (b) implies that, because an increase in the rate of time preference can enhance the current felicity level with less current consumption, the demand for bonds is also increased. As has already been pointed out, in general, the optimal consumption level under uncertainty is larger than that under certainty. Corresponding to this fact, (c) means that the optimal saving is smaller under uncertainty than under certainty, so that a decrease in the demand for bonds gives rise to an increase in the rate of interest. The relationship (d) will not need further explanation.

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4. Conclusions

The purpose of this article rests on a consistent study of the equilibrium analysis, which has been considered using different models in the traditional monetary theory or economics of uncertainty, within a model of a simple production economy by assuming a standard real business cycle model. Our analysis was also partly motivated by the intrinsic deficiency inherent to economic models of price uncertainty which has been criticized by Kemp (1976) and Turnovsky (1976). A partial resolution of this important problem was challenged here by assuming production uncertainty in an open economy. In order to perform the exercise, the optimal consumption decision, together with the simultaneous investment (and hence output) decision, was first examined within a growth model with stochastic technological shocks. At the next stage of the optimal portfolio decision analysis, a relationship between the forward exchange rate and the expected future spot exchange rate was considered. At first glance, the relationship seems to be similar to the one obtained within a pure exchange economy model, but the analysis clearly shows that a completely different element of technological uncertainty actually plays an important role in it. Furthermore, some equilibrium characteristics with respect to the forward exchange rate and the interest rate derived from the assumed model were closely analyzed. All of them were convincing because they are intuitively appealing to common sense. It should be emphasized once more that those important characteristics were made explicit here within a simple *production economy*.

FOOTNOTES

1, For textbookish exposition of a stage analysis of saving decision under uncertainty, see, e.g., McKenna (1986).

2, See also Mankiw (1990), Blanchard and Fischer (1989) for implications of real business cycles in macroeconomics.

3, A similar, but slightly different, model of a two-stage decision process under uncertainty is employed by, e.g., Barari and Lapan (1993). The present analysis is actually motivated partly by an intrinsic criticism first clearly expressed by Kemp (1976) on price uncertainty (see the quotation in the introduction section). Turnovsky (1976) also made the point clear, stating that "··· one wishes to ··· consider the ultimate random disturbances, such as fluctuations in tastes and technological conditions, which presumably are what the random movements in price must be reflecting" (p.134).

4, See MacDonald and Taylor (1992) and Taylor (1995) for references to the existing relevant literature on both empirical and theoretical analyses of the unbiasedness hypothesis of the forward exchange rate.

5, Unfortunately, the sign of the covariance term in equation (11) cannot be determined at this stage of specification of our model. It should be stressed, however, that a valid reason for assumption 5 lies in this indeterminacy.

6, Defining $\ln Z_{t+1} \equiv y$ and $\ln Z_t \equiv x$, assumption 3 implies that $x \sim N(0, \sigma^2)$. Also equation (4) implies $y = -\delta x - \alpha \delta \ln K_t$, so that if the p.d.f.'s of x and y are expressed as $f(x)$ and $g(y)$, respectively, the following relationship is immediate:

$$g(y) = f(x) \mid dx/dy \mid = f(x)/\delta$$

In other words, assumption 3' simply means that the p.d.f. of y actually scales down that of x by δ. This modification, although slightly contradicts assumption 3, is made only for facilitating better understanding the meaning of equations (12) and (15).

REFERENCES

Andersen, Torben M. and Sorensen, Jan Rose "Interest Rate Spreads and Exchange Rate Variability" *The Manchester School, 62(2)*, June 1994; 151-166.

Barari, Mahua and Lapan, Harvey E. "Stochastic Trade Policy with Asset Markets: The Role of Tariff Strcture" *Journal of International Economics, 35(3-4)*, November 1993; 317-333.

Blanchard, Olivier Jean and Fischer, Stanley *Lectures on Macroeconomics.* Cambridge, MA.: The MIT Press, 1989.

Donaldson, John, and Mehra, Rajnish "Stochastic Growth with Correlated Production Shocks" *Journal of Economic Theory, 29*, 1983; 281-312.

Donaldson, John, and Mehra, Rajnish "Comparative Dynamics of an Equilibrium Intertemporal Asst Pricing Model" *Review of Economic Studies, 51*, 1984; 491-508.

Donaldson, John B., Johnsen, Thore, and Mehra, Rajnish "On the Term Structure of Interest Rates" *Journal of Economic Dynamics and Control, 14*, 1990; 571-596.

Engel, Charles M. "Testing for the Absence of Expected Real Profits from Forward Market Speculation" *Journal of International Economics, 17(3/4)*, 1984; 299-308.

Frenkel, Jacob A. and Razin, Assaf "Stochastic Prices and Tests of Efficiency of Foreign Exchange Markets" *Economics Letters, 6*, 1980; 165-170.

Judd, Kenneth L. "A Review of Recursive Methods in Economic Dynamics" *Journal of Economic Literature, 29(1)*, March 1991; 69-77.

Kemp, Murray C. *Three Topics on the Theory of International Trade: Distribution, Welfare and Uncertainty.* Amsterdam: North-Holland Publishing Company, 1976.

Kudoh, K. "CAPM no Saikin no Tenkai - Tenbou" (Recent Evolution of CAPM - A Survey), The University of Tsukuba, 1991.

Lehrbass, Frank B. "Optimal Hedging with Currency Forwards, Calls, and Calls on Forwards for the Competitive Exporting Firm Facing Exchange Rate Uncertainty" *Journal of Economics, 59(1)*, 1994: 51-70.

MacDonald, Ronald and Taylor, Mark P. "Exchange Rate Economics: A Survey" *IMF Staff Papers, 39(1)*, March 1992: 1-57.

McKenna, C.J. *The Economics of Uncertainty.* London: Wheatsheaf Books Ltd., 1986.

Mankiw, N. Gregory "A Quick Refresher Course in Macroeconomics" *Journal*

of Economic Literature, 28(4), December 1990; 1645-1660.

Mankiw, N. Gregory "Real Business Cycles: A New Keynesian Perspective" *Journal of Economic Perspective, 3(3)*, Summer 1989; 79-90.

Mehra, Rajnish "Recursive Competitive Equilibrium: A Parametric Example" *Economics Letters, 16*, 1984; 273-278.

Mehra, Rajnish and Prescott, Edward C. "The Equity Premium: A Puzzle" *Journal of Monetary Economics, 15(2)*, March 1985: 145-161.

Plosser, Charles I. "Understanding Real Business Cycles" *Journal of Economic Perspective, 3(3)*, Summer 1989; 51-77.

Salyer, Kevin D. "The Term Structure of Interest Rates within a Production Economy: A Parametric Example" *Journal of Macroeconomics, 16(4)*, Fall 1994; 729-734.

Stadler, George W. "Real Business Cycles" *Journal of Economic Literature, 32(4)*, December 1994; 1750-1783.

Stokey, Nancy, Lucas, Jr., Robert E., and Prescott, Edward C. *Recursve Methods in Economic Dynamics.* Cambridge, MA.: Harvard University Press, 1989.

Taylor, Mark P. "The Economics of Exchange Rates" *Journal of Economic Literature, 33(1)*, March 1995: 13-47.

Turnovsky, Stephen J. "the Distribution of Welfare Gains from Price Stabilization: The Case of Multiplicative Disturbances" *International Economic Review, 17(1)*, February 1976; 133-148.