Foreign Exchange Market Inefficiency and the Noise Trader Model

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요 약

본 논문은 외환시장의 효율성과 노이즈 트레이더 모델에 관해 고찰하며, 별도의 실증분석을 수행하지는 않지만 비효율적인 외환시장에서 통화의 가격결정 메커니즘에 대해 노이즈 트레이더 모형의 적용가능성을 분석함으로써 향후 연구방향을 제시하고자 한다. 본 논문과 관련해 의미 있는 또 하나의 연구방향으로는 외환시장에서 정부의 역할이 있다. 정부가 특정한 수준으로 통화를 유지하거나, 정책 목적을 위해 통화를 특정한 수준으로 변경시키기 위한 노력의 일환으로 외환시장에 자주 개입하는 것은 분명하다. 이러한 정부의 역할은 그 자체로는 분명히 노이즈 트레이딩이 아니지만, 외환시장에 대한 영향으로 보면 노이즈 트레이딩과 크게 다르지 않을 것이다. 합리적인 차익거래자, 노이즈 트레이더 및 중앙은행을 통합하는 모델을 개발하고 검증하는 것은 외환시장의 메커니즘을 이해하는데 많은 도움이 될 것이다.

Ⅰ. Introduction

In the finance literature, the notion that asset prices (including foreign exchange rates) are determined in efficient markets has been a time-honored tradition, and, in effect, the efficient market hypothesis has been regarded as the essential paradigm over the last fifty years. However, there has been doubt on

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the validity of the efficient market models, and the many empirical studies on the stock market and on the foreign exchange market seem to verify this doubt. Therefore, several alternative models are developed and the noise trader model holds a promising position as an alternative paradigm to the efficient market hypothesis.

When the most common definition of market efficiency is applied to the foreign exchange market, it implies that the forward exchange rate should be an appropriate, unbiased predictor of the corresponding future spot exchange rate (Copeland, 1991). More precisely, this indicates the efficiency in the forward foreign exchange market. There are basically two components of market efficiency-spot exchange market efficiency and forward exchange market efficiency. The tests of forward exchange market efficiency are based on how the current forward rate is related to the expected future spot rate and the actual future spot rate, while the tests of spot exchange market efficiency primarily focus on the profitability of technical trading strategies like the filter rule (Levich, 1989).

However, this relationship has been extensively rejected by the real-world data-especially for the foreign exchange market. The interpretation of this rejection will differ among researchers since the efficient market hypothesis is a joint hypothesis, which will be examined in the next section in detail. Many scholars have explained the meaning of the rejection of market efficiency as indication of the existence of a currency risk premium, and, on the other hand, other scholars interpret the rejection of the hypothesis as evidence of the inefficient information processing, which is also understood as agents' irrational expectations. In other words, because of the jointness of the hypothesis, it cannot be clearly distinguished whether the reason for rejecting the efficient market hypothesis is that the equilibrium model used in the test is misspecified or that economic agents fail to form the rational expectations.[1)]

The purpose of the study is to examine the noise trader model, which has

received the support of a number of researchers recently among the models adopting the latter interpretation-the failure of agents' expectation formation, and to explore the applicability of the noise trader model to the foreign exchange market. This approach is called the irrational pricing model, which includes speculative bubbles, noise trading, and overreaction, in contrast with the rational pricing theory like the efficient market hypothesis (Scott, 1991).

The paper is organized as follows : Section Ⅱ provides a survey of the literature on the empirical studies, mainly focused on the failure of the efficient market hypothesis for the foreign exchange market. Section Ⅲ reviews two versions of the noise trader model and examines the applicability of the model to the behavior of foreign exchange rates. Section Ⅳ summarizes and concludes the paper.

Ⅱ. Failures of the Efficient Market Hypothesis

Copeland and Weston (1988) provide several methods of testing the efficiency of the foreign exchange market. First, the tests of arbitrage relationships look at outliers, which are observations outside the arbitrage boundary of transaction costs. It suggests that a significant proportion of outliers can serve as evidence for the inefficiency of the foreign exchange market. Second, the tests of equilibrium pricing models imply that the rejection of an asset pricing model

1) One trend of the research into the foreign exchange market efficiency is to investigate whether the rejection of the joint efficient market hypothesis is resulted from the existence of a foreign exchange risk premium or from the agents' irrationality, using survey data and exchange rate expectations (Hallwood and MacDonald, 1994). One of such efforts is the work, using the survey data on exchange rate expectations, done by MacDonald and Torrance (1988).

for exchange rates can imply the inefficiency of the foreign exchange market. Third, the tests of trading rules indicate that the profits from the mechanical trading techniques can be interpreted as evidence of the inefficiency of the foreign exchange market. The filter rule is used primarily to test weak-form market efficiency by creating the filters derived from the past exchange rates, but can be used to test strong-form market efficiency. Fourth, the tests of forward speculation focus on the returns to forward speculation. The rejection of the unbiasedness hypothesis, which says that the forward exchange rate is an unbiased predictor of the future spot exchange rate, means the inefficiency in the exchange market. Fifth, the tests of the performance of forecasting services examine the effectiveness of forecasting services. This approach is primarily the test on the semistrong-form market efficiency. The newer, more expanding approach to foreign exchange market efficiency is the cointegration test. If there exists any cointegrating relationship, the efficient markets hypothesis could be rejected (Lajaunie, McManis, and Naka, 1996).

Noting the difficulties in testing market efficiency, Campbe11, Lo, and MacKinlay (1997) suggest the concept of relative efficiency, which is defined as "the efficiency of one market measured against another", as an alternative to the notion of traditional market efficiency, namely, absolute market efficiency. And, they argue that "market efficiency is an idealization that is economically unrealizable, but that serves as a useful benchmark for measuring relative efficiency."

Hallwood and MacDonald (1994) indicate the failure of the efficient market hypothesis for international financial markets since the hypothesis has been rejected by the data.[2] However, they emphasize that the important property to

2) Hallwood and MacDonald (1994) provide a nice survey of the literature on the efficient market hypothesis for the foreign exchange market. A large number of researchers who test foreign exchange market efficiency have rejected the

be understood in the market efficiency tests is the jointness of the efficient market hypothesis. The jointness of the hypothesis can be easily recognized by noting that the efficient market model is the one about how the equilibrium asset prices are determined under the assumption of informational efficiency, which means that economic agents use all available information efficiently or form their expectations rationally. Therefore, rejecting the efficient market hypothesis when we test market efficiency empirically could either reflect the inefficient information processing or irrational expectations, or simply imply that an inappropriate equilibrium model is chosen.[3)]

MacDonald and Torrance (1988) attempt to solve the problem of the jointness of the efficient market hypothesis for the foreign exchange market through the use of the survey data on exchange rate expectations, and find that the forward exchange rate is a biased predictor of the corresponding future spot rate in the exchange market for the German mark and the U.S. dollar.

In his extensive study on the efficiency of the foreign exchange market, Levich (1989) does not come to the definite conclusion that the foreign exchange market is inefficient, but suggests the potential role of noise traders in the market. He provides two explanations for volatile changes in the prices of international financial assets including foreign exchange rates. The first one is that the economic fundamentals underlying those international financial assets tend to vary often or widely and there exists the uncertainty in the fundamentals. Other factors, for example, how quickly the financial asset market is adjusted compared to the goods market, would also cause volatile movements in foreign exchange rates. The second explanation is the inability for market participants to form rational expectations. This is due to their misperception of

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hypothesis.

3) In this context, Campbell, Lo, and MacKinlay (1997) argue that, due to the joint hypothesis problem, we can never reject market efficiency.

the available information or due to their failure in understanding the influence of the information on asset prices.

Ⅲ. Noise Trader Model and Its Applicability

1. Noise Trader Model

In the noise trader model, there exist two types of economic agents : rational speculators and noise traders. Shleifer and Summers (1990) define rational speculators, also described as arbitragers or smart money group, as "investors who form fully rational expectations about security returns", and noise traders, also called liquidity traders, as investors who have systematic biases in their opinions and trading patterns. These two groups interact in the market, thereby determining risk-adjusted equilibrium asset prices. In fact, they build the noise trader approach based on the two assumptions, the roles of irrational investors' sentiments and limited arbitrage. The first assumption suggests that some market participants are not fully rational and the beliefs or sentiments of these investors, which are not fully justifiable by the new information on economic fundamentals, would affect their demand for risky assets. And, the second assumption states that arbitrage is risky and hence restricted. They define arbitrage as the trading by investors with no irrational beliefs or sentiments.

The distinctive assumption of the noise trader model is that irrational economic agents account for a considerable portion of the market. Stout (1995) uses the term "cognitive defects" in defining the concept of irrationality :

> "Although what is meant by "irrational" is not always made clear, the noise literature seems for the most part to presume that a subset of invest-

ors suffer cognitive defects that render them unable to make unbiased estimates and to distinguish information from "noise." Trading by "rational" investors (who are not presumably free of such cognitive defects) fails to eliminate the distortive effects of noise traders' transactions, because noise traders add market risk that limits rational traders' willingness to bet against them."

He also suggests that the implication of the noise trader model is that the price of assets like stocks deviates from their fundamental value, because noise traders provide the market price risk that disturbs rational traders from fully taking advantage of an arbitrage opportunity created by biased asset prices.

De Long, et al.(1990) propose an asset pricing model, which is labeled as the noise trader model, based on the existence of two types of risk in the market, namely, fundamental risk and noise trader risk. Noise trader risk represents the uncertainty in the opinions of noise traders for the future, and is assumed to be a common factor to all market participants. They set up the expected- utility maximization problem for both rational speculators and noise traders by imposing several constraints on the model-the existence of two assets, riskless and risky assets in the economy, the same fixed real dividend for the two assets, and perfectly elastic supply of the riskless asset and inelastic supply of the risky asset, among others. And, the equilibrium pricing model for the risky asset is derived :

$$P_t = 1 + \frac{\mu(\rho_t - \rho^*)}{1+r} + \frac{\mu\rho^*}{r} - \frac{(2\gamma)\mu^2\sigma_\rho^2}{r(1+r)^2} \qquad (1)$$

where P_t = the price of the risky asset,

μ = the proportion of noise traders in the economy,

ρ_t = the expected price of the risky asset misperceived by noise traders,[4)]

ρ^* = the mean misperception,

σ_ρ^2 = the variance of noise traders' misperceptions,

r = the fixed real dividend, regarded as the riskless rate,

γ = the coefficient of absolute risk aversion.

Several points should be mentioned regarding equation (1). First, the second term in the right-hand side of the equation, $\frac{\mu(\rho_t - \rho^*)}{1+r}$, is interpreted as the variation of noise traders misperceptions, which influences the price of the risky asset. This term will be larger as μ increases, implying that the price of the risky asset becomes more volatile as the proportion of noise traders rises. Second, the third term, $\frac{\mu\rho^*}{r}$, captures the difference between the asset price, P_t, and its intrinsic value. This deviation is because the average misperception by noise traders is not equal to zero. Third, the last term, $\frac{(2\gamma)\mu^2\sigma_\rho^2}{r(1+r)^2}$, plays a key role in the model and represents the influences of agents' attitude toward risk and the risk created by noise traders on the risky asset price. Finally, one, the first term of equation (1), is the fundamental value of the risky asset in this model. They assume that the riskless asset price is fixed at one with consumption each period taken as numeraire. Thus, the price of the risky asset would be the same as that of the riskless asset, which is one, if each asset's price correctly reflected its fundamentals. The fair price of the asset should be the net present value (NPV) of its future dividends. The equation implies that

4) It is assumed that noise traders' misperceptions of the expected price of the risky asset are independently and identically distributed with $\rho_t \sim N(\rho^*, \sigma_\rho^2)$.

the price of the risky asset will be equal to the fundamental value of one when there is no noise trader in the market, i.e., when ρ^* and σ_ρ^2 are both zero.

The main result of the noise trader model is that if noise traders earn higher expected returns than rational speculators, the average price of the risky asset must be below its fundamental value. To see this, taking the expectation of the price of the risky asset :

$$E(P) = E\left[1 + \frac{\mu(\rho_t - \rho^*)}{1+r} + \frac{\mu\rho^*}{r} - \frac{(2\gamma)\mu^2\mu_\rho^2}{r(1+r)^2}\right]$$

$$= 1 + E\left[\frac{\mu(\rho_t - \rho^*)}{1+r}\right] + E\left[\frac{\mu\rho^*}{r}\right] - E\left[\frac{(2\gamma)\mu^2\sigma_\rho^2}{r(1+r)^2}\right]$$

$$= 1 + \frac{\mu\rho^*}{r} - \frac{(2\gamma)\mu^2\sigma_\rho^2}{r(1+r)^2}$$

since all terms are not random except for ρ_t and $E(\rho_t) = \rho^*$.

The implication of this result is that noise traders can earn higher expected returns than rational speculators only when the dividend on the risky asset leads to a higher rate of return, on average, than the same dividend on the riskless asset, because noise traders hold more of the risky asset and earn, on average, negative capital gains. For this to hold, the risky asset has to be sold at an average price below its fundamental value, which is one. This is the most striking implication of the model : noise traders can earn higher expected returns solely by bearing more of the risk, which is created by noise traders themselves, and so they will persist in the market and can affect the asset prices.

Campbell and Kyle (1993) propose another version of the noise trader model to account for the excessive volatility of the stock price behavior :

$$P = -\frac{\lambda}{r-\xi} + \left[\frac{1}{r-\xi}\right]D_0 + \left[\frac{1}{r-\xi} - \frac{1}{r-\xi+\alpha_I}\right]I + \left[\frac{1}{r-\xi+\alpha_1}\right]D_1 + Y \qquad (2)$$

where P = the detrended stock price,

λ = the unconditional expected excess return per detrended share of stock,

r = the time-invariant riskless rate of interest,

ξ = the exponential growth trend,

D_0 = the component of the actual dividend following a Brownian motion,

a_I = the univariate autoregressive parameter for I,

I = the error measuring non-dividend information,

a_1 = the univariate autoregressive parameter for D_1,

D_1 = the component of the actual dividend following a AR(1) process,

Y = the noise.

Equation (2) suggests that the stock price depends on the fundamental value, the sum of the three terms in the middle, and the noise, the last term. The fundamental value is the expected present value of future dividends subject to the information available to rational speculators. In other words, all the information on future dividends is incorporated into the fundamental value, and this is including both the information on past dividends and the information on non-dividend factors, which is available to rational speculators. They point out that the asset price would be different from its fundamental value by the first term of the right-hand side of the equation, which is constant, and the last term, which represents the noise having the mean of zero, if rational speculators were risk averse. They suggest that noise traders will play a significant role in explaining stock market movements in their model when the discount rate, r, is five percent or higher.

2. Applicability to the Foreign Exchange Market

Hallwood and MacDonald (1994) claim that the efficient market hypothesis

"has been seriously undermined as a way of thinking about the determination of asset prices like exchange rates, and an alternative paradigm which presents a more realistic portrayal of the behavior of investors is required", and that the noise trader model can be widely applicable to asset pricing.

In the noise trader mode1, asset prices are determined by both fundamentals and noise. The noise trader model for the foreign exchange market has the same implication, as seen in the previous section for other financial assets, that foreign exchange rates would deviate from their fundamental values due to the behavior of noise traders. In order to apply the noise trader model to the foreign exchange market, however, an understanding about the difficulty in an analysis of the exchange market is needed.

As indicated by Scott (1991), the researchers who study the foreign exchange market can be faced with the difficult problem that the appropriate form of market fundamentals is not well defined. On the other hand, the stock market literature has the general consensus on the form of the market fundamental, although there still exists a problem that the lack of consensus regarding the specification of discount rates. Therefore, more rigorous research into the market fundamental of the foreign exchange market, which can provide the thorough knowledge about the mechanism of foreign exchange market movements and the fundamental of the foreign exchange market, will be an essential prerequisite for applying the noise trader model to the foreign exchange market.

Ⅳ. Conclusion

This paper examines the empirical studies on the failure of the efficient market hypothesis for the foreign exchange market and the alternative para-

digm-the noise trader model. Although the empirical studies, using the various testing methods, on foreign exchange market efficiency cannot give the simple answer of yes or no, the overwhelming message from the literature is that the reality has not been consistent with the efficient market hypothesis.

As pointed out by Shleifer and Summers (1990), the noise trader model has some noteworthy advantages over the efficient market hypothesis :

> "First, theoretical models with limited arbitrage are both tractable and more plausible than models with perfect arbitrage. The efficient markets hypothesis obtains only as an extreme case of perfect riskless arbitrage that is unlikely to apply in practice. Second, the investor sentiment/limited arbitrage approach yields a more accurate description of financial markets than the efficient markets paradigm. The approach not only explains the available anomalies, but also readily explains broad features of financial markets such as trading volume and actual investment strategies. Third, and most importantly, this approach yields new and testable implications about asset prices, some of which have been proved to be consistent with the data."

One of the main implications of the noise trader model is that the behavior of noise traders creates the risk, which, in turn, affects asset prices, and that this noise trader risk is not captured in standard models (Hallwood and MacDonald, 1994). The prediction by Black (1986) that "the influence of noise traders will become apparent" turns out to be right in a sense that more and more researchers are trying to explain the various anomalies of the stock market through using the concept of noise. The further refinement and the rigorous empirical studies of the noise trader model will determine the viability of the model as an alternative paradigm to the efficient market hypothesis. More recent studies in this direction include Schmeling (2007) and Scruggs (2007),

among others. On the other hand, the establishment of the market fundamental widely agreed in the foreign exchange market literature will be necessary.

Although this study does not conduct an independent empirical analysis, it does suggest the possibility of further analysis, specifically to apply the noise trader model to test the behavior of the foreign exchange market. One promising future research is on the role of governments in the foreign exchange market. It is clear that governments frequently intervene in the foreign exchange market in an effort to maintain their currencies at particular levels or to move their currencies to particular levels for policy purposes, both of which may be different from their fundamental levels. Clearly this role of governments in itself can not be regarded as noise trading since their intervention would be based on informed decisions, although it may have an impact on the market not perceptibly different than noise trading. Developing and testing a model that incorporates rational arbitragers, noise traders, and policy-driven central banks is left for future research.

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