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Journal of Applied Research in Finance

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ASSET PRICING WITH INCOMPLETE INFORMATION IN A DISCRETE-TIME PURE EXCHANGE ECONOMY

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Abstract

We study the consumption based asset pricing model in a discrete-time pure exchange setting with incomplete information. Incomplete information leads to a filtering problem which agents solve using the Kalman filter. We characterize the solution to the asset pricing problem in such a setting. Empirical estimation with US consumption data indicates strong statistical support for the incomplete information model versus the benchmark complete information model. We investigate the ability of the model to replicate some key stylized facts about US equity and risk-free returns.

Keywords: asset pricing, incomplete information, Kalman filter, equity returns, risk free returns

JEL Classification: G12, G13, E43

1. Introduction

We study a pure exchange Lucas (1978) asset pricing model in a setting with incomplete information on the stochastic dividends process. In incomplete information asset pricing models, the drift rate of the dividends process is assumed to be unobservable. Agents need to estimate this drift rate based on observed dividends in order to compute the expected future dividend payouts and hence set equilibrium asset prices. This introduces a filtering problem into asset pricing models.

Early work on incomplete information in asset pricing models used linear stochastic differential equations with Brownian motion increments to characterize the exogenous path of the dividends process. The unobservable drift rate of the dividends process is also characterized as a linear stochastic differential equation with Brownian motion increments. Dothan and Feldman (1986), Detemple (1986), Genotte (1986), and more recently, Brennan and Xia (2001) study asset pricing / portfolio allocation problems in this setting. Linear Gaussian setting permits use of the Kalman filter to solve the filtering problem in an optimal sense. The Kalman filter is a Bayesian updating rule that permits learning about the unobservable dividend drift rate with the arrival of new information on dividends each period. Recently, David (1997) and Veronesi (2004) study asset pricing with incomplete information in a non-Gaussian setting where the unobservable dividend growth rate undergoes jumps, driven either by a Markov switching or Poisson arrival process.

All the papers discussed above on asset pricing with incomplete information formulate the problem in continuous time. In a discrete time setting, Cecchetti *et al.* (2000) and Brandt *et al.* (2000) model dividends as a random walk driven by Gaussian innovations and a drift term that follows a discrete state Markov switching process. Such a specification fails to account for autocorrelation in the dividend growth rates.

In this paper we study the asset pricing problem with incomplete information in a discrete-time continuous-state stochastic setting. We assume that the observed dividend growth rate is the sum of an unobservable persistent component and noise. The unobservable persistent component is assumed to be an autoregressive process driven by Gaussian shocks. A complete information asset pricing model is a special case. Our model allows for a simple way to numerically solve for equilibrium asset prices, and hence implied returns. The solution is a simple extension of the solution to the asset pricing problem in complete information setting studied in Burnside (1998). We characterize the solution to the asset pricing model in such a setting. We then calibrate the model to data on quarterly US per capita consumption, and study the ability of the model to replicate the unconditional moments of observed returns.

The paper is organized as follows. We describe the economic environment and the asset pricing model in Section 2. We study the solution to the model in Section 3. We tackle empirical issues including estimation of the model in Section 4. We analyze the model implied rates of return in Section 5. The last section provides some conclusions derived from the paper.

2. The Model

In this section we lay out the economic environment, including specification of exogenous stochastic processes and information structure in the asset pricing model.

2.1 Pure Exchange Economy

In a single good Lucas (1978) economy, with a representative utility-maximizing agent and a single asset that pays exogenous dividends of non-storable consumption goods, the first-order Euler condition is:

$$P_t U'(C_t) = \theta E_t U'(C_{t+1}) [P_{t+1} + D_{t+1}] \quad (1)$$

Here, P_t is the real price of the single asset in terms of the consumption good, $U'(C)$ is the marginal utility of consumption C for the representative agent, θ is a constant subjective discount factor, D is the dividend from the single productive unit, and E_t is the mathematical expectation, conditioned on information available at time t .

Assume a constant relative risk aversion (CRRA) utility function with risk-aversion coefficient γ :

$$U(C) = (1 - \gamma)^{-1} C^{(1-\gamma)}, \quad \gamma \geq 0 \quad (2)$$

Since consumption equals dividends in this simple model, i.e. $C = D$ every period, Equation (1) reduces to:

$$P_t D_t^{-\gamma} = E_t \theta D_{t+1}^{-\gamma} [P_{t+1} + D_{t+1}] \quad (3)$$

On rearranging, this yields:

$$P_t = E_t \theta \left(\frac{D_{t+1}}{D_t} \right)^{-\gamma} [P_{t+1} + D_{t+1}] \quad (4)$$

Let v_t denote the price-dividend ratio, i.e. $v_t = P_t / D_t$. Then, we can rewrite Equation (4) in terms of v_t as:

$$v_t = E_t \theta \left(\frac{D_{t+1}}{D_t} \right)^{1-\gamma} [v_{t+1} + 1] \quad (5)$$

Thus, this equation implicitly defines the solution to the asset pricing problem in this model. One specifies an exogenous stochastic process for dividends and solves for the price dividend ratio v_t .

Let $x_t = \ln(D_t / D_{t-1})$ denote the dividend growth rate. Then, we can express Equation (5) as:

$$v_t = E_t \theta \exp[(1-\gamma)x_{t+1}] (v_{t+1} + 1) \quad (6)$$

Defining $m_{t+1} \equiv \theta \exp[(1-\gamma)x_{t+1}]$, we can rewrite Equation (6) as:

$$v_t = E_t m_{t+1} [v_{t+1} + 1] \quad (7)$$

On forward iteration, this equation yields:

$$v_t = \sum_{i=1}^{\infty} \left(E_t \prod_{j=1}^i m_{t+j} \right) + \lim_{i \rightarrow \infty} E_t \prod_{j=1}^i m_{t+j} v_{t+i} \quad (8)$$

One solution to the above difference equation in v_t is obtained by imposing the transversality condition:

$$\lim_{i \rightarrow \infty} \left(E_t \prod_{j=1}^i m_{t+j} v_{t+i} \right) = 0 \quad (9)$$

This condition rules out solutions to the asset pricing model that imply intrinsic bubbles (Froot and Obstfeld 1991). Imposing the transversality condition on Equation (8) gives:

$$v_t = \sum_{i=1}^{\infty} \left(E_t \prod_{j=1}^i m_{t+j} \right) \quad (10)$$

Thus, the solution to the price-dividend ratio can be found by evaluating the conditional expectations on the right hand side of Equation (10), under a specified exogenous stochastic process for the dividend growth rates.

2.2 Information Structure

We assume that dividend growth rates stochastically evolve according to the following process:

$$x_t = \mu_t + \varepsilon_t, \quad \varepsilon_t \sim iid N(0, \sigma^2) \quad (11a)$$

$$\mu_t - \bar{\mu} = \rho(\mu_{t-1} - \bar{\mu}) + \eta_t, \quad |\rho| < 1, \quad \eta_t \sim iid N(0, \sigma_{\eta}^2) \quad (11b)$$

We assume that ε_t and η_t are independent of each other contemporaneously as well as at all leads and lags.

We assume that agents in the economy have full knowledge about the structure of the economy. They know the stochastic process governing the evolution of the dividend growth rates, including the parameters of the process. They observe the dividend stream (and hence the realized dividend growth rates x_t as well). However, we assume that agents do not ever observe the persistent component μ_t (or equivalently the noise component ε_t) of the dividend growth rates.

Agents need to form conditional expectations of μ_t in order to compute the expected future dividend payouts, and hence determine equilibrium prices. Thus, agents face a filtering problem. We assume that agents form conditional expectations on μ_t based on Bayesian updating rules. Specifically, agents face a linear Gaussian filtering problem. In this case, the conditional density of μ_t is Gaussian (see, for instance, Harvey 1992, Ch.3) and, therefore, completely specified by its conditional mean and variance. These are given recursively by the classic Kalman filter.

In a benchmark full information economy, we assume that the innovation ε_t in Equation (11a) has zero variance (i.e. ε_t is trivially zero). In this case, $\mu_t = x_t$ and therefore agents actually observe μ_t . There is no filtering problem facing the agents in such an economy. This model is studied in Burnside (1998).

3. Model Solution

We now proceed to evaluate Equation (10) for the price-dividend ratio under the assumed process for the dividend growth rates. We also study some properties of this model implied price-dividend ratio.

3.1 Solution for the P/D Ratios

Appendix A shows that V_t in Equation (10) can be reduced to:

$$v_t = \sum_{i=1}^{\infty} \theta^i \cdot \left[E_t \exp\{b_i(\mu_t - \bar{\mu})\} \right] \cdot \exp \left[\begin{array}{c} i\bar{\mu}(1-\gamma) + i(1-\gamma)^2 \frac{\sigma^2}{2} + \\ \left(\frac{1-\gamma}{1-\rho} \right)^2 \frac{\sigma_{\eta}^2}{2} \cdot \sum_{j=1}^i (1-\rho^j)^2 \end{array} \right] \quad (12)$$

where
$$b_i = (1-\gamma) \left(\frac{\rho}{1-\rho} \right) (1-\rho^i)$$

As discussed in subsection 2.2, the conditional density of μ_t is Gaussian and its conditional mean and variance are given by the Kalman recursions. Using these conditional moments, the conditional expectations term $E_t \exp\{b_i(\mu_t - \bar{\mu})\}$ appearing in Equation (12) can then be evaluated using the formula for the moment generating function of Gaussian random variables.¹

The following theorem provides conditions for the infinite series in Equation (12) to converge, and hence for the price–dividend ratio to be finite.

Theorem 1. The series in Equation (12) converges if

$$r \equiv \theta \exp \left[(1-\gamma)\bar{\mu} + (1-\gamma)^2 \frac{\sigma^2}{2} + \left(\frac{1-\gamma}{1-\rho} \right)^2 \frac{\sigma_{\eta}^2}{2} \right] < 1 \quad (13)$$

APPENDIX A

Derivation of the Price-Dividend Ratio

In this appendix we derive the expression for the price dividend ratio V_t given in Equation (12). From subsection 2.1, we have $m_{t+j} \equiv \theta \exp[(1-\gamma)x_{t+j}]$. Let $\omega = 1-\gamma$. Therefore, $m_{t+j} = \theta \exp[\omega x_{t+j}]$.

$$\prod_{j=1}^i m_{t+j} = \prod_{j=1}^i \theta \exp[\omega x_{t+j}] = \theta^i \exp \left(\omega \sum_{j=1}^i x_{t+j} \right) \quad (A1)$$

From dividend growth rate process in Equation (11a),

$$\sum_{j=1}^i x_{t+j} = \sum_{j=1}^i \mu_{t+j} + \sum_{j=1}^i \varepsilon_{t+j} \quad (A2)$$

From dividend growth rate process in Equation (11b), $\mu_{t+j} - \bar{\mu} = \rho(\mu_{t+j-1} - \bar{\mu}) + \eta_{t+j}$, we have

$$\mu_{t+j} - \bar{\mu} = \rho^j(\mu_t - \bar{\mu}) + \rho^{j-1}\eta_{t+1} + \rho^{j-2}\eta_{t+2} + \dots + \rho^2\eta_{t+j-2} + \rho\eta_{t+j-1} + \eta_{t+j} \quad (A3)$$

¹ If $x \sim N(\mu, \sigma^2)$, then $E\{\exp(x)\} = \exp\left(\mu + \frac{1}{2}\sigma^2\right)$.

Therefore,

$$\sum_{j=1}^i \mu_{t+j} = [\bar{\mu} + \rho(\mu_t - \bar{\mu}) + \eta_{t+1}] + [\bar{\mu} + \rho^2(\mu_t - \bar{\mu}) + \rho\eta_{t+1} + \eta_{t+2}] + \dots$$

$$\dots + [\bar{\mu} + \rho^i(\mu_t - \bar{\mu}) + \rho^{i-1}\eta_{t+1} + \rho^{i-2}\eta_{t+2} + \dots + \eta_{t+i}]$$

This can be written as:

$$\sum_{j=1}^i \mu_{t+j} = i\bar{\mu} + (\mu_t - \bar{\mu}) \left[\frac{\rho(1-\rho^i)}{1-\rho} \right] + \frac{1}{1-\rho} \left[(1-\rho^i)\eta_{t+1} + (1-\rho^{i-1})\eta_{t+2} + \dots + (1-\rho)\eta_{t+i} \right] \quad (A4)$$

$$\prod_{j=1}^i m_{t+j} = \theta^i \exp \left(\omega \sum_{j=1}^i x_{t+j} \right)$$

Therefore,

$$= \theta^i \exp \left(\begin{array}{l} i\bar{\mu}\omega + \left\{ \frac{\omega\rho}{1-\rho} (1-\rho^i) \right\} (\mu_t - \bar{\mu}) + \\ \left(\frac{\omega}{1-\rho} \right) \left\{ (1-\rho^i)\eta_{t+1} + (1-\rho^{i-1})\eta_{t+2} + \dots + (1-\rho)\eta_{t+i} \right\} + \\ \omega \sum_{j=1}^i \varepsilon_{t+j} \end{array} \right)$$

Define $b_i = \omega \left(\frac{\rho}{1-\rho} \right) (1-\rho^i)$. From the iid nature of ε_t and η_t , we can write:

$$E_t \prod_{j=1}^i m_{t+j} = \theta^i \cdot \exp[i\bar{\mu}\omega] \cdot E_t \exp[b_i(\mu_t - \bar{\mu})] \cdot$$

$$E_t \exp \left[\frac{\omega}{1-\rho} \left\{ (1-\rho^i)\eta_{t+1} + (1-\rho^{i-1})\eta_{t+2} + \dots + (1-\rho)\eta_{t+i} \right\} \right] \cdot$$

$$E_t \exp \left[\omega \sum_{j=1}^i \varepsilon_{t+j} \right]$$

$$E_t \prod_{j=1}^i m_{t+j} = \theta^i \cdot \exp[i\bar{\mu}\omega] \cdot E_t \exp[b_i(\mu_t - \bar{\mu})] \cdot$$

$$E_t \left[\exp \left[\left(\frac{\omega}{1-\rho} \right) (1-\rho^i)\eta_{t+1} \right] \cdot \exp \left[\left(\frac{\omega}{1-\rho} \right) (1-\rho^{i-1})\eta_{t+2} \right] \dots \exp \left[\left(\frac{\omega}{1-\rho} \right) (1-\rho)\eta_{t+i} \right] \right] \cdot$$

$$E_t \left[\exp(\omega\varepsilon_{t+1}) \cdot \exp(\omega\varepsilon_{t+2}) \dots \exp(\omega\varepsilon_{t+i}) \right] \quad (A5)$$

Since $\varepsilon_t \sim \text{iid } N(0, \sigma^2)$ in Equation (11a),

$$E_t \left[\exp(\omega\varepsilon_{t+1}) \cdot \exp(\omega\varepsilon_{t+2}) \dots \exp(\omega\varepsilon_{t+i}) \right] =$$

$$E_t \left\{ \exp(\omega\varepsilon_{t+1}) \right\} \cdot E_t \left\{ \exp(\omega\varepsilon_{t+2}) \right\} \dots E_t \left\{ \exp(\omega\varepsilon_{t+i}) \right\} \quad (A6)$$

From the moment generating function of normal random variables, we have

$$E_t \left\{ \exp(\omega\varepsilon_{t+1}) \right\} = E_t \left\{ \exp(\omega\varepsilon_{t+2}) \right\} = \dots = E_t \left\{ \exp(\omega\varepsilon_{t+i}) \right\} = \exp \left\{ \frac{1}{2} \omega^2 \sigma^2 \right\} \quad (A7)$$

Since $\eta_t \sim \text{iid } N(0, \sigma_\eta^2)$ in Equation (11b),

$$\begin{aligned}
 & E_t \left\{ \exp \left[\left(\frac{\omega}{1-\rho} \right) (1-\rho^i) \eta_{t+1} \right] \cdot \exp \left[\left(\frac{\omega}{1-\rho} \right) (1-\rho^{i-1}) \eta_{t+2} \right] \dots \exp \left[\left(\frac{\omega}{1-\rho} \right) (1-\rho) \eta_{t+i} \right] \right\} \\
 & = E_t \left\{ \exp \left[\left(\frac{\omega}{1-\rho} \right) (1-\rho^i) \eta_{t+1} \right] \right\} E_t \left\{ \exp \left[\left(\frac{\omega}{1-\rho} \right) (1-\rho^{i-1}) \eta_{t+2} \right] \right\} \dots E_t \left\{ \exp \left[\left(\frac{\omega}{1-\rho} \right) (1-\rho) \eta_{t+i} \right] \right\}
 \end{aligned} \tag{A8}$$

From the properties of normally distributed random variables, we have:

$$\frac{\omega}{1-\rho} (1-\rho^i) \eta_{t+1} \sim N \left(0, \left(\omega \frac{1-\rho^i}{1-\rho} \right)^2 \sigma_\eta^2 \right) \tag{A9}$$

Similarly, we have:

$$\frac{\omega}{1-\rho} (1-\rho^{i-1}) \eta_{t+2} \sim N \left(0, \left(\omega \frac{1-\rho^{i-1}}{1-\rho} \right)^2 \sigma_\eta^2 \right) \tag{A10}$$

And so forth for all the other η 's in Equation (A8).

From the moment generating function of normal random variables, we have from Equations (A9) and (A10):

$$E_t \left\{ \exp \left[\left(\frac{\omega}{1-\rho} \right) (1-\rho^i) \eta_{t+1} \right] \right\} = \exp \left[\left(\omega \frac{1-\rho^i}{1-\rho} \right)^2 \frac{\sigma_\eta^2}{2} \right] \tag{A11}$$

$$E_t \left\{ \exp \left[\left(\frac{\omega}{1-\rho} \right) (1-\rho^{i-1}) \eta_{t+2} \right] \right\} = \exp \left[\left(\omega \frac{1-\rho^{i-1}}{1-\rho} \right)^2 \frac{\sigma_\eta^2}{2} \right] \tag{A12}$$

And so forth for all the other η 's in Equation (A8):

$$E_t \left\{ \exp \left[\left(\frac{\omega}{1-\rho} \right) (1-\rho) \eta_{t+i} \right] \right\} = \exp \left[\left(\omega \frac{1-\rho}{1-\rho} \right)^2 \frac{\sigma_\eta^2}{2} \right] \tag{A13}$$

Substituting (A11), (A12), and (A13) into (A8), we get:

$$\begin{aligned}
 & E_t \left\{ \exp \left[\left(\frac{\omega}{1-\rho} \right) (1-\rho^i) \eta_{t+1} \right] \cdot \exp \left[\left(\frac{\omega}{1-\rho} \right) (1-\rho^{i-1}) \eta_{t+2} \right] \dots \exp \left[\left(\frac{\omega}{1-\rho} \right) (1-\rho) \eta_{t+i} \right] \right\} \\
 & = \exp \left\{ \left[\left(\frac{\omega}{1-\rho} \right)^2 \frac{\sigma_\eta^2}{2} \right] \cdot \sum_{j=1}^i (1-\rho^j)^2 \right\}
 \end{aligned} \tag{A14}$$

Substituting (A7) and (A14) into (A5) and collecting terms results in:

$$E_t \prod_{j=1}^i m_{t+j} = \theta^i \cdot \left[E_t \exp \{ b_i (\mu_t - \bar{\mu}) \} \right] \cdot \exp \left[\left[i \bar{\mu} (1-\gamma) + i (1-\gamma)^2 \frac{\sigma^2}{2} + \left\{ \left[\left(\frac{1-\gamma}{1-\rho} \right)^2 \frac{\sigma_\eta^2}{2} \right] \cdot \sum_{j=1}^i (1-\rho^j)^2 \right\} \right] \right] \tag{A15}$$

recognizing that $\omega = 1-\gamma$.

Equation (10) gives:

$$v_t = \sum_{i=1}^{\infty} \left(E_t \prod_{j=1}^i m_{t+j} \right) \quad (A16)$$

Substituting (A15) into (A16) gives:

$$v_t = \sum_{i=1}^{\infty} \theta^i \cdot \left[E_t \exp \{ b_i (\mu_t - \bar{\mu}) \} \right] \cdot \exp \left[\begin{array}{c} i\bar{\mu}(1-\gamma) + i(1-\gamma)^2 \frac{\sigma^2}{2} + \\ \left\{ \left[\left(\frac{1-\gamma}{1-\rho} \right)^2 \frac{\sigma_{\eta}^2}{2} \right] \cdot \sum_{j=1}^i (1-\rho^j)^2 \right\} \end{array} \right] \quad (A17)$$

where, we have
$$b_i = (1-\gamma) \left(\frac{\rho}{1-\rho} \right) (1-\rho^i)$$

Proof. See Appendix B.

Finiteness of the price-dividend ratio ensures that the expected discounted utility is finite in this model (see Burnside 1998). The next theorem derives an expression for the mean of the price-dividend ratio, i.e. the unconditional expectation of v_t in Equation (12). It also provides conditions under which this mean is finite.

Theorem 2. The mean of the price dividend ratio is given by:

$$E(v_t) = \sum_{i=1}^{\infty} \theta^i \exp \left[i\bar{\mu}(1-\gamma) + i(1-\gamma)^2 \frac{\sigma^2}{2} + \frac{b_i^2}{1-\rho^2} \frac{\sigma_{\eta}^2}{2} + \left(\frac{1-\gamma}{1-\rho} \right)^2 \frac{\sigma_{\eta}^2}{2} \cdot \sum_{j=1}^i (1-\rho^j)^2 \right] \quad (14)$$

It is finite if $r < 1$, where r is the constant defined in Theorem 1.

Proof. See Appendix C.

3.2 Solution under Complete Information

In the complete information benchmark case, recall from subsection 2.2 that $\mu_t = x_t$, which is observed at time t . All the analyses of subsection 3.1 go through exactly as in the incomplete information case, with some simplifications detailed below. The expression for the price-dividend ratio given in Equation (12) remains the same but with $E_t \exp \{ b_i (\mu_t - \bar{\mu}) \} = \exp \{ b_i (x_t - \bar{\mu}) \}$ and $\sigma^2 = 0$. Theorem 1 goes through as before with $\sigma^2 = 0$ imposed on r defined by Inequality (13). The mean of the price-dividend ratio given in Equation (14) remains the same but with $E_t \exp \{ b_i (\mu_t - \bar{\mu}) \} = \exp \{ b_i (x_t - \bar{\mu}) \}$ and $\sigma^2 = 0$. The condition for its finiteness given by Theorem 2 remains unchanged but with $\sigma^2 = 0$ imposed on r defined by Inequality (13).

The price-dividend ratio and its related properties in the benchmark complete information model are derived in Burnside (1998). Such a complete information model with habit formation utility as in Abel (1990) is studied in Collard *et al.* (2006).

4. Empirical Estimation Of The Model

We calibrate the asset pricing model to quarterly real per capita US consumption growth rates on non-durables and services from 1952:1 through 2004:2. Nominal seasonally adjusted per capita consumption data obtained from NIPA Tables are deflated using the CPI index. Summary statistics indicate an annualized mean growth rate of 2.02 percent and a standard deviation of 1.34 percent. The first order autocorrelation coefficient is 0.18 and statistically different from 0 at the 1 percent level.

The dividend growth rates process in Equations (11) constitutes a linear Gaussian state space model. Equation (11a) is the observation equation and Equation (11b) is the state transition equation. The linear Gaussian nature of the model results in the conditional density of the state variable μ_t being Gaussian as well. The Kalman filter gives recursive formulae for obtaining the conditional mean and variance of the state variable μ_t , as well as the likelihood function.

Maximum likelihood parameter estimates of the consumption growth rate process (conditional on the first observation) in Equations (11) are reported in Table 1 (Panel A). Parameter estimates indicate a mean consumption growth rate of 0.50 percent per quarter, or 2.00 percent per annum. The autoregressive (AR) parameter ρ is estimated to be 0.74. It is statistically significantly different from 0 by the usual t-test at better than the 1 percent significance level. The signal-to-noise ratio σ_η / σ is estimated to be 0.38. Figure 1 plots the mean of the filter densities $E(\mu_t | x_1, x_2, \dots, x_t)$, along with the observed consumption growth rates x_t .

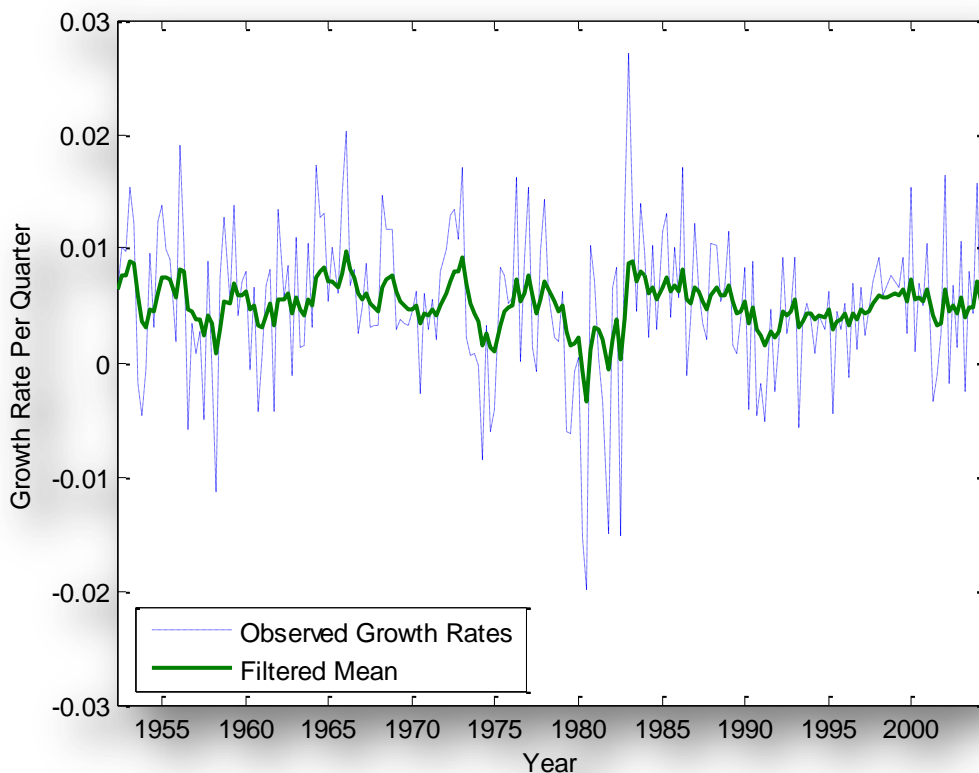


Figure 1. Filter Mean $E(\mu_t | x_1, x_2, \dots, x_t)$

Figure 1 plots the mean of the filter densities $E(\mu_t | x_1, x_2, \dots, x_t)$, along with the observed consumption growth rates x_t . The mean of the filter densities are estimated with the Kalman filter using the Maximum Likelihood parameter estimates of Panel A in Table 1.

The complete information model parameter estimates are reported in Panel B of Table 1. The AR coefficient ρ is now only 0.18. This is understandable, however, because the AR process for μ_t in Equation (11b) is now combined with the iid process for ε_t in Equation (11a), and effectively an AR model is being estimated for the resulting contaminated (with iid noise) series. Nonetheless, the AR coefficient is statistically significantly different from 0 by the usual t-test at better than the 1 percent significance level. However, the maximized log-likelihood shows a large drop. The likelihood ratio (LR) test statistic for

complete information versus incomplete information model turns out to be 3.76, with a χ^2_1 p-value of 0.05. Thus, there is significant statistical support for the incomplete information model.

Table 1. Maximum Likelihood Parameter Estimates

Panel A:	$\bar{\mu}$	ρ	σ_η	σ	log L
Incomplete Information	0.0050 (0.0007)	0.7396 (0.1260)	0.0022 (0.0008)	0.0058 (0.0004)	755.4003
Panel B:	$\bar{\mu}$	ρ	σ_η		log L
Complete Information	0.0050 (0.0006)	0.1758 (0.0674)	0.0066 (0.0003)		753.5202

This Table reports the Maximum Likelihood estimates of the model for dividend growth rates, $x_t = \mu_t + \varepsilon_t$ where $\varepsilon_t \sim \text{iid } N(0, \sigma^2)$ and where the unobserved persistent component μ_t follows:

$$\mu_t - \bar{\mu} = \rho(\mu_{t-1} - \bar{\mu}) + \eta_t, \quad \text{with } |\rho| < 1 \quad \text{and} \quad \eta_t \sim \text{iid } N(0, \sigma_\eta^2)$$

The model is calibrated to quarterly real per capita US consumption growth rates on non-durables and services from the first quarter of 1952 through the second quarter of 2004. Nominal seasonally adjusted per capita consumption data obtained from NIPA Tables are deflated using the CPI index.

Panel A reports estimates for the incomplete information model given by the two equations above. Panel B reports estimates for the complete information model obtained by setting ε_t to zero (i.e. by setting $\sigma^2 = 0$).

Conditional densities of the state variable μ_t are obtained by applying the Kalman filter in panel A. Standard errors are reported below each parameter estimate.

5. Analysis Of Model Implications

In this section we discuss the implications of the theoretical model of section 2 for rates of return on risky and risk free assets, set up a simulation framework for analyses of the unconditional properties of model implied rates of returns, and report on the results obtained.

5.1. Model-Implied Rates of Return

Equilibrium gross equity returns R_t^e on assets held from period t through period t+1 are given by:

$$R_t^e = \left(\frac{P_{t+1} + D_{t+1}}{P_t} \right) \tag{15}$$

Using $v_t = P_t / D_t$ and $x_t = \ln(D_t / D_{t-1})$, this reduces to:

$$R_t^e = \left(\frac{1 + v_{t+1}}{v_t} \right) \exp[x_{t+1}] \tag{16}$$

It is not possible to analytically evaluate the population mean of the implied equity returns, i.e. $E(R_t^e)$, in our model given the expression for v_t in Equation (12).

The price of a risk free asset P_t^f in our endowment economy guarantees one unit of the consumption good on maturity. It is given by:

$$P_t^f = \theta E_t \left(\frac{U'(C_{t+1})}{U'(C_t)} \right) \quad (17)$$

With CRRA utility and $C = D$ in the model from Section 2, this reduces to:

$$P_t^f = \theta E_t \left(\frac{D_{t+1}}{D_t} \right)^{-\gamma} \quad (18)$$

Using $x_t = \ln(D_t / D_{t-1})$, we get $P_t^f = \theta E_t [\exp(-\gamma x_{t+1})]$. Substituting for x_{t+1} using Equation (11) yields:

$$P_t^f = \theta E_t \left[\exp \left\{ -\gamma \bar{\mu} - \gamma \rho (\mu_t - \bar{\mu}) - \gamma \eta_{t+1} - \gamma \varepsilon_{t+1} \right\} \right] \quad (19)$$

Using independence of μ_t , ε_{t+1} and η_{t+1} , we can rewrite this as:

$$P_t^f = \theta \exp \left\{ -\gamma \bar{\mu} \right\} E_t \left[\exp \left\{ -\gamma \varepsilon_{t+1} \right\} \right] E_t \left[\exp \left\{ -\gamma \rho (\mu_t - \bar{\mu}) \right\} \right] E_t \left[\exp \left\{ -\gamma \eta_{t+1} \right\} \right] \quad (20)$$

We have assumed that $\varepsilon_t \sim \text{iid } N(0, \sigma^2)$ in Equation (11a). Therefore, using the moment generating function for the normal random variable:

$$E_t \left[\exp \left\{ -\gamma \varepsilon_{t+1} \right\} \right] = \exp \left\{ \frac{\gamma^2 \sigma^2}{2} \right\} \quad (21)$$

We have assumed that $\eta_t \sim \text{iid } N(0, \sigma_\eta^2)$ in Equation (11b). This yields:

$$E_t \left[\exp \left\{ -\gamma \eta_{t+1} \right\} \right] = \exp \left\{ \frac{\gamma^2 \sigma_\eta^2}{2} \right\} \quad (22)$$

Substituting Equations (21) and (22) into Equation (20) gives the price of the risk free asset:

$$P_t^f = \theta \left[\exp \left\{ -\gamma \bar{\mu} + \gamma^2 \sigma^2 / 2 + \gamma^2 \sigma_\eta^2 / 2 \right\} \right] E_t \left[\exp \left\{ -\gamma \rho (\mu_t - \bar{\mu}) \right\} \right] \quad (23)$$

Gross equilibrium returns on the risk free asset R_t^f are given by:

$$R_t^f = \frac{1}{P_t^f} \quad (24)$$

Excess returns on the risky asset over the risk free asset are given by:

$$R_t = R_t^e - R_t^f \quad (25)$$

5.2 Simulation Setup

We undertake a simulation study in order to analyze the model implications for various endogenous quantities of interest including rates of return. The simulations are performed in the following manner. We draw random numbers for ε_t and η_t in Equations (11) using parameter estimates reported in Table 1. The value of μ_0 is set to the unconditional mean of μ_t , equal to $\bar{\mu}$. We then use the simulated η_t series to generate a sequence $\{\mu_t, t = 1, 2, \dots, T\}$ using Equation (11b) with $T = 4000$. We use this sequence and the simulated ε_t series to generate a sequence of artificial dividend growth rates $\{x_t, t = 1, 2, \dots, T\}$ according to Equation (11a).

We use the simulated sequence $\{x_t\}$ and the parameter estimates from Table 1 to obtain the mean of the posterior density $E(\mu_t | x_1, x_2, \dots, x_t)$ using the Kalman filtering equations. We use this posterior mean to evaluate the price-dividend ratios V_t in Equation (12). Calculations are done for various values for the preference parameters θ (discount factor) and γ (risk aversion coefficient) that satisfy the convergence condition $r < 1$ in Equation (13). Model-implied returns on risky and risk free assets are then generated using Equations (16), (23) and (24), and excess returns from Equation (25). In order to eliminate any effects from startup of the Kalman filter, we drop the first ten implied returns.

5.3 Analysis of Unconditional Moments

Table 2. Unconditional Moments of Returns

Panel A:			$E(R_t)$	$\sigma(R_t)$	$E(R_t^f)$	$\sigma(R_t^f)$	
Data (1952:1 to 2004:2)			6.82	16.55	1.23	1.34	
Panel B:		θ	γ	$E(R_t)$	$\sigma(R_t)$	$E(R_t^f)$	$\sigma(R_t^f)$
Incomplete Information	0.98	0.60	0.07	1.99	9.39	0.24	
	0.98	0.90	0.07	1.73	10.01	0.36	
	0.98	1.50	0.06	1.22	11.23	0.61	
	0.99	0.60	0.07	1.99	5.26	0.24	
	0.99	0.90	0.07	1.72	5.86	0.36	
	0.99	1.50	0.06	1.19	7.08	0.60	
Panel C:		θ	γ	$E(R_t)$	$\sigma(R_t)$	$E(R_t^f)$	$\sigma(R_t^f)$
Complete Information	0.98	0.60	0.05	1.46	9.40	0.15	
	0.98	0.90	0.05	1.37	10.02	0.22	
	0.98	1.50	0.05	1.21	11.25	0.36	
	0.99	0.60	0.05	1.44	5.27	0.14	
	0.99	0.90	0.05	1.37	5.88	0.22	
	0.99	1.50	0.05	1.20	7.10	0.36	

Panel A reports unconditional moments of quarterly value-weighted excess returns on all NYSE, AMEX, and NASDAQ stocks obtained from CRSP dataset for the period going from the first quarter of 1952 through the second quarter of 2004. Excess returns are calculated over the riskfree rates proxied by the one-month Treasury bill rates. All rates are expressed in percent per annum.

Panels B and C report the unconditional moments of simulated returns obtained from the asset pricing model by feeding simulated consumption growth rates data using the estimated parameters from each of the

two panels in Table 1. The statistics reported in percentage per annum are the mean $E(R)$ and standard deviation $\sigma(R)$ of excess returns R and of risk free returns R^f .

Model-implied moments are reported for a range of values for the subjective discount factor θ , and the risk-aversion coefficient γ .

Table 2, Panel A reports unconditional moments of quarterly value-weighted excess returns on all NYSE, AMEX, and NASDAQ stocks obtained from CRSP dataset for the period 1952:1 through 2004:2. We subtract returns on the one-month Treasury bills from nominal returns to obtain excess returns, expressed in percent per annum. Real risk free returns are obtained by subtracting CPI inflation from the nominal T-bill returns.

Panel A indicates that quarterly excess returns have a mean of 6.83 percent per annum and a standard deviation of 16.55. Riskfree returns have a mean of 1.23 percent and a standard deviation of 1.34 percent. Explaining these set of stylized facts has proved to be a challenge in the macro-finance literature (see Mehra and Prescott 1985).

Panels B and C report the unconditional moments for returns implied by our theoretical model of section 2 using the simulation setup from subsection 5.2. Moments are reported for various values of the discount factor θ and the risk aversion coefficient γ . The maximum implied mean excess returns from our incomplete information model are only 0.07 percent and the maximum standard deviation is only 1.99 percent. On the other hand, the minimum implied mean risk free returns from our incomplete information model is 5.26 percent but the maximum standard deviation is only 0.61 percent. Overall, it is clear from looking at both the panels that neither model does a good job of replicating the unconditional moments of excess equity or risk free returns. This is simply a manifestation of the equity premium puzzle of Mehra and Prescott (1985).

It is clear from an examination of panels B and C that adding incomplete information to the asset pricing model raises the implied excess returns and reduces the implied risk free returns by a small amount, about 0.01-0.02 percent per annum. It however raises the volatility of both risk free and excess returns, but the increase is less than 0.60 percent per annum. Overall, although adding incomplete information to the standard asset pricing model moves the mean and volatility of implied returns in the right direction, the quantitative effects are too small to be of any significance in helping to resolve either the equity premium or the risk free rate puzzles.

6. Conclusion

We study the consumption based asset pricing model of Lucas (1978) in an incomplete information setting. Although agents observe realized dividends (and hence their growth rates), they do not observe the persistent and noise components that make up the observed dividends. Estimation of the persistent component is important for evaluating conditional expectations of future dividends, used to set equilibrium asset prices. Its unobservability introduces a filtering problem that agents solve using Bayesian updating schemes. Asset pricing with complete information is a special case of our framework.

We fit the model to quarterly per capita real US consumption data. Maximum likelihood parameter estimates indicate strong support for our incomplete information model. The likelihood ratio test rejects complete information in favor of the incomplete information model. We find that although adding incomplete information to the standard asset pricing model moves the mean and volatility of implied excess and risk-free returns in the right direction, the quantitative effects are too small to be of any significance in helping to resolve either the equity premium or the risk-free rate puzzles.

APPENDIX A
Derivation of the Price-Dividend Ratio

In this appendix we derive the expression for the price dividend ratio V_t given in Equation (12). From subsection 2.1, we have $m_{t+j} \equiv \theta \exp[(1-\gamma)x_{t+j}]$. Let $\omega = 1-\gamma$. Therefore, $m_{t+j} = \theta \exp[\omega x_{t+j}]$.

$$\prod_{j=1}^i m_{t+j} = \prod_{j=1}^i \theta \exp[\omega x_{t+j}] = \theta^i \exp\left(\omega \sum_{j=1}^i x_{t+j}\right) \tag{A1}$$

From dividend growth rate process in Equation (11a),

$$\sum_{j=1}^i x_{t+j} = \sum_{j=1}^i \mu_{t+j} + \sum_{j=1}^i \varepsilon_{t+j} \tag{A2}$$

From dividend growth rate process in Equation (11b), $\mu_{t+j} - \bar{\mu} = \rho(\mu_{t+j-1} - \bar{\mu}) + \eta_{t+j}$, we have

$$\mu_{t+j} - \bar{\mu} = \rho^j(\mu_t - \bar{\mu}) + \rho^{j-1}\eta_{t+1} + \rho^{j-2}\eta_{t+2} + \dots + \rho^2\eta_{t+j-2} + \rho\eta_{t+j-1} + \eta_{t+j} \tag{A3}$$

Therefore,

$$\begin{aligned} \sum_{j=1}^i \mu_{t+j} &= [\bar{\mu} + \rho(\mu_t - \bar{\mu}) + \eta_{t+1}] + [\bar{\mu} + \rho^2(\mu_t - \bar{\mu}) + \rho\eta_{t+1} + \eta_{t+2}] + \dots \\ &\quad \dots + [\bar{\mu} + \rho^i(\mu_t - \bar{\mu}) + \rho^{i-1}\eta_{t+1} + \rho^{i-2}\eta_{t+2} + \dots + \eta_{t+i}] \end{aligned}$$

This can be written as:

$$\sum_{j=1}^i \mu_{t+j} = i\bar{\mu} + (\mu_t - \bar{\mu}) \left[\frac{\rho(1-\rho^i)}{1-\rho} \right] + \frac{1}{1-\rho} \left[(1-\rho^i)\eta_{t+1} + (1-\rho^{i-1})\eta_{t+2} + \dots + (1-\rho)\eta_{t+i} \right] \tag{A4}$$

Therefore,
$$\prod_{j=1}^i m_{t+j} = \theta^i \exp\left(\omega \sum_{j=1}^i x_{t+j}\right)$$

$$= \theta^i \exp \left(\begin{aligned} & i\bar{\mu}\omega + \left\{ \frac{\omega\rho}{1-\rho} (1-\rho^i) \right\} (\mu_t - \bar{\mu}) + \\ & \left(\frac{\omega}{1-\rho} \right) \left\{ (1-\rho^i)\eta_{t+1} + (1-\rho^{i-1})\eta_{t+2} + \dots + (1-\rho)\eta_{t+i} \right\} + \\ & \omega \sum_{j=1}^i \varepsilon_{t+j} \end{aligned} \right)$$

Define $b_i = \omega \left(\frac{\rho}{1-\rho} \right) (1-\rho^i)$. From the iid nature of ε_t and η_t , we can write:

$$E_t \prod_{j=1}^i m_{t+j} = \theta^i \cdot \exp[i\bar{\mu}\omega] \cdot E_t \exp[b_i(\mu_t - \bar{\mu})]$$

$$E_t \exp \left[\frac{\omega}{1-\rho} \left\{ (1-\rho^i)\eta_{t+1} + (1-\rho^{i-1})\eta_{t+2} + \dots + (1-\rho)\eta_{t+i} \right\} \right]$$

$$E_t \exp \left[\omega \sum_{j=1}^i \varepsilon_{t+j} \right]$$

$$E_t \prod_{j=1}^i m_{t+j} = \theta^i \cdot \exp[i\bar{\mu}\omega] \cdot E_t \exp[b_i(\mu_t - \bar{\mu})] \cdot E_t \left[\exp \left[\left(\frac{\omega}{1-\rho} \right) (1-\rho^i) \eta_{t+1} \right] \cdot \exp \left[\left(\frac{\omega}{1-\rho} \right) (1-\rho^{i-1}) \eta_{t+2} \right] \dots \exp \left[\left(\frac{\omega}{1-\rho} \right) (1-\rho) \eta_{t+i} \right] \right] \cdot E_t \left[\exp(\omega \varepsilon_{t+1}) \cdot \exp(\omega \varepsilon_{t+2}) \dots \exp(\omega \varepsilon_{t+i}) \right] \quad (A5)$$

Since $\varepsilon_t \sim \text{iid } N(0, \sigma^2)$ in Equation (11a),

$$E_t \left[\exp(\omega \varepsilon_{t+1}) \cdot \exp(\omega \varepsilon_{t+2}) \dots \exp(\omega \varepsilon_{t+i}) \right] = E_t \left\{ \exp(\omega \varepsilon_{t+1}) \right\} \cdot E_t \left\{ \exp(\omega \varepsilon_{t+2}) \right\} \dots E_t \left\{ \exp(\omega \varepsilon_{t+i}) \right\} \quad (A6)$$

From the moment generating function of normal random variables, we have

$$E_t \left\{ \exp(\omega \varepsilon_{t+1}) \right\} = E_t \left\{ \exp(\omega \varepsilon_{t+2}) \right\} = \dots = E_t \left\{ \exp(\omega \varepsilon_{t+i}) \right\} = \exp \left\{ \frac{1}{2} \omega^2 \sigma^2 \right\} \quad (A7)$$

Since $\eta_t \sim \text{iid } N(0, \sigma_\eta^2)$ in Equation (11b),

$$E_t \left\{ \exp \left[\left(\frac{\omega}{1-\rho} \right) (1-\rho^i) \eta_{t+1} \right] \cdot \exp \left[\left(\frac{\omega}{1-\rho} \right) (1-\rho^{i-1}) \eta_{t+2} \right] \dots \exp \left[\left(\frac{\omega}{1-\rho} \right) (1-\rho) \eta_{t+i} \right] \right\} = E_t \left\{ \exp \left[\left(\frac{\omega}{1-\rho} \right) (1-\rho^i) \eta_{t+1} \right] \right\} \cdot E_t \left\{ \exp \left[\left(\frac{\omega}{1-\rho} \right) (1-\rho^{i-1}) \eta_{t+2} \right] \right\} \dots E_t \left\{ \exp \left[\left(\frac{\omega}{1-\rho} \right) (1-\rho) \eta_{t+i} \right] \right\} \quad (A8)$$

From the properties of normally distributed random variables, we have:

$$\frac{\omega}{1-\rho} (1-\rho^i) \eta_{t+1} \sim N \left(0, \left(\omega \frac{1-\rho^i}{1-\rho} \right)^2 \sigma_\eta^2 \right) \quad (A9)$$

Similarly, we have:

$$\frac{\omega}{1-\rho} (1-\rho^{i-1}) \eta_{t+2} \sim N \left(0, \left(\omega \frac{1-\rho^{i-1}}{1-\rho} \right)^2 \sigma_\eta^2 \right) \quad (A10)$$

And so forth for all the other η 's in Equation (A8).

From the moment generating function of normal random variables, we have from Equations (A9) and (A10):

$$E_t \left\{ \exp \left[\left(\frac{\omega}{1-\rho} \right) (1-\rho^i) \eta_{t+1} \right] \right\} = \exp \left[\left(\omega \frac{1-\rho^i}{1-\rho} \right)^2 \frac{\sigma_\eta^2}{2} \right] \quad (A11)$$

$$E_t \left\{ \exp \left[\left(\frac{\omega}{1-\rho} \right) (1-\rho^{i-1}) \eta_{t+2} \right] \right\} = \exp \left[\left(\omega \frac{1-\rho^{i-1}}{1-\rho} \right)^2 \frac{\sigma_\eta^2}{2} \right] \quad (A12)$$

And so forth for all the other η 's in Equation (A8):

$$E_t \left\{ \exp \left[\left(\frac{\omega}{1-\rho} \right) (1-\rho) \eta_{t+i} \right] \right\} = \exp \left[\left(\omega \frac{1-\rho}{1-\rho} \right)^2 \frac{\sigma_\eta^2}{2} \right] \quad (A13)$$

Substituting (A11), (A12), and (A13) into (A8), we get:

$$\begin{aligned}
 E_t \left\{ \exp \left[\left(\frac{\omega}{1-\rho} \right) (1-\rho^i) \eta_{t+1} \right] \cdot \exp \left[\left(\frac{\omega}{1-\rho} \right) (1-\rho^{i-1}) \eta_{t+2} \right] \dots \exp \left[\left(\frac{\omega}{1-\rho} \right) (1-\rho) \eta_{t+i} \right] \right\} \\
 = \exp \left\{ \left[\left(\frac{\omega}{1-\rho} \right)^2 \frac{\sigma_\eta^2}{2} \right] \cdot \sum_{j=1}^i (1-\rho^j)^2 \right\}
 \end{aligned} \tag{A14}$$

Substituting (A7) and (A14) into (A5) and collecting terms results in:

$$E_t \prod_{j=1}^i m_{t+j} = \theta^i \cdot [E_t \exp \{b_i(\mu_t - \bar{\mu})\}] \cdot \exp \left[\begin{aligned} & i\bar{\mu}(1-\gamma) + i(1-\gamma)^2 \frac{\sigma^2}{2} + \\ & \left\{ \left[\left(\frac{1-\gamma}{1-\rho} \right)^2 \frac{\sigma_\eta^2}{2} \right] \cdot \sum_{j=1}^i (1-\rho^j)^2 \right\} \end{aligned} \right] \tag{A15}$$

recognizing that $\omega = 1 - \gamma$.

Equation (10) gives:

$$v_t = \sum_{i=1}^{\infty} \left(E_t \prod_{j=1}^i m_{t+j} \right) \tag{A16}$$

Substituting (A15) into (A16) gives:

$$v_t = \sum_{i=1}^{\infty} \theta^i \cdot [E_t \exp \{b_i(\mu_t - \bar{\mu})\}] \cdot \exp \left[\begin{aligned} & i\bar{\mu}(1-\gamma) + i(1-\gamma)^2 \frac{\sigma^2}{2} + \\ & \left\{ \left[\left(\frac{1-\gamma}{1-\rho} \right)^2 \frac{\sigma_\eta^2}{2} \right] \cdot \sum_{j=1}^i (1-\rho^j)^2 \right\} \end{aligned} \right] \tag{A17}$$

$$\text{where, we have } b_i = (1-\gamma) \left(\frac{\rho}{1-\rho} \right) (1-\rho^i)$$

APPENDIX B

Proof of Theorem 1

From Equation (12),

$$v_t = \sum_{i=1}^{\infty} \theta^i \cdot [E_t \exp \{b_i(\mu_t - \bar{\mu})\}] \cdot \exp \left[\begin{aligned} & i\bar{\mu}(1-\gamma) + i(1-\gamma)^2 \frac{\sigma^2}{2} + \\ & \left\{ \left[\left(\frac{1-\gamma}{1-\rho} \right)^2 \frac{\sigma_\eta^2}{2} \right] \cdot \sum_{j=1}^i (1-\rho^j)^2 \right\} \end{aligned} \right] \tag{B1}$$

or, substituting $\omega = 1 - \gamma$

$$v_t = \sum_{i=1}^{\infty} \theta^i \cdot [E_t \exp \{b_i(\mu_t - \bar{\mu})\}] \cdot \exp \left[\begin{aligned} & i\bar{\mu}\omega + i\omega^2 \frac{\sigma^2}{2} + \\ & \left\{ \left[\left(\frac{\omega}{1-\rho} \right)^2 \frac{\sigma_\eta^2}{2} \right] \cdot \sum_{j=1}^i (1-\rho^j)^2 \right\} \end{aligned} \right] \tag{B2}$$

$$\text{Let } v_t \equiv \sum_{i=1}^{\infty} z_i \tag{B3}$$

$$\frac{z_{i+1}}{z_i} = \frac{\theta^{i+1} E_t \exp\{b_{i+1}(\mu_t - \bar{\mu})\} \cdot \exp\left[(i+1)\bar{\mu}\omega + (i+1)\frac{\omega^2\sigma^2}{2} + \left\{\left[\left(\frac{\omega}{1-\rho}\right)^2 \frac{\sigma_\eta^2}{2}\right] \cdot \sum_{j=1}^{i+1} (1-\rho^j)^2\right\}\right]}{\theta^i E_t \exp\{b_i(\mu_t - \bar{\mu})\} \cdot \exp\left[i\bar{\mu}\omega + i\frac{\omega^2\sigma^2}{2} + \left\{\left[\left(\frac{\omega}{1-\rho}\right)^2 \frac{\sigma_\eta^2}{2}\right] \cdot \sum_{j=1}^i (1-\rho^j)^2\right\}\right]}$$

which on simplifying becomes:

$$\frac{z_{i+1}}{z_i} = \theta \frac{E_t \exp\{b_{i+1}(\mu_t - \bar{\mu})\}}{E_t \exp\{b_i(\mu_t - \bar{\mu})\}} \exp\left[\bar{\mu}\omega + \frac{\omega^2\sigma^2}{2} + \left\{\left[\left(\frac{\omega}{1-\rho}\right)^2 \frac{\sigma_\eta^2}{2}\right] \cdot (1-\rho^{i+1})^2\right\}\right]$$

With $|\rho| < 1$ specified in Equation (11b),

$$\lim_{i \rightarrow \infty} \left| \frac{z_{i+1}}{z_i} \right| = \theta \exp\left[\bar{\mu}\omega + \frac{\omega^2\sigma^2}{2} + \left\{\left[\left(\frac{\omega}{1-\rho}\right)^2 \frac{\sigma_\eta^2}{2}\right]\right\}\right] \cdot \lim_{i \rightarrow \infty} \frac{E_t \exp\{b_{i+1}(\mu_t - \bar{\mu})\}}{E_t \exp\{b_i(\mu_t - \bar{\mu})\}} \quad (B4)$$

One can easily show that $\lim_{i \rightarrow \infty} b_{i+1} = \lim_{i \rightarrow \infty} b_i = \left(\frac{\omega}{1-\rho}\right)\rho$.

Therefore, we have $\lim_{i \rightarrow \infty} \frac{E_t \exp\{b_{i+1}(\mu_t - \bar{\mu})\}}{E_t \exp\{b_i(\mu_t - \bar{\mu})\}} = 1$. Using this in (B4), we have:

$$\lim_{i \rightarrow \infty} \left| \frac{z_{i+1}}{z_i} \right| = \theta \exp\left[\bar{\mu}\omega + \frac{\omega^2\sigma^2}{2} + \left\{\left[\left(\frac{\omega}{1-\rho}\right)^2 \frac{\sigma_\eta^2}{2}\right]\right\}\right] \equiv r \quad (B5)$$

Substituting $\omega = 1 - \gamma$, we get:

$$r = \theta \exp\left[\bar{\mu}(1-\gamma) + \frac{(1-\gamma)^2\sigma^2}{2} + \left\{\left[\left(\frac{1-\gamma}{1-\rho}\right)^2 \frac{\sigma_\eta^2}{2}\right]\right\}\right] \quad (B6)$$

Proof for convergence of v^t in (D1) for $r < 1$ now follows from the ratio test (see, for instance, Marsden 1974, Theorem 13, p.47).

APPENDIX C

Proof of Theorem 2

Derivation of Equation (14)

From Equation (12),

$$v_t = \sum_{i=1}^{\infty} \theta^i \cdot \left[E_t \exp\{b_i(\mu_t - \bar{\mu})\} \right] \cdot \exp\left[\begin{array}{l} i\bar{\mu}(1-\gamma) + i(1-\gamma)^2 \frac{\sigma^2}{2} + \\ \left\{ \left[\left(\frac{1-\gamma}{1-\rho} \right)^2 \frac{\sigma_\eta^2}{2} \right] \cdot \sum_{j=1}^i (1-\rho^j)^2 \right\} \end{array} \right] \quad (C1)$$

Therefore, from the law of iterated expectations,

$$v_t = \sum_{i=1}^{\infty} \theta^i \cdot \left[E \exp \{ b_i (\mu_t - \bar{\mu}) \} \right] \cdot \exp \left[\begin{array}{c} i\bar{\mu}(1-\gamma) + i(1-\gamma)^2 \frac{\sigma^2}{2} + \\ \left\{ \left[\left(\frac{1-\gamma}{1-\rho} \right)^2 \frac{\sigma_{\eta}^2}{2} \right] \cdot \sum_{j=1}^i (1-\rho^j)^2 \right\} \end{array} \right] \quad (C2)$$

$$b_i (\mu_t - \bar{\mu}) \sim N \left(0, \frac{b_i^2 \sigma_{\eta}^2}{1-\rho^2} \right)$$

From Equation (11b), we have generating function for normal random variables:

$$E[\exp \{ b_i \cdot (\mu_t - \bar{\mu}) \}] = \exp \left[\frac{b_i^2 \sigma_{\eta}^2}{2(1-\rho^2)} \right] \quad (C3)$$

Substituting into Equation (C2) gives:

$$E(v_t) = \sum_{i=1}^{\infty} \theta^i \exp \left[i\bar{\mu}(1-\gamma) + i(1-\gamma)^2 \frac{\sigma^2}{2} + \frac{b_i^2 \sigma_{\eta}^2}{2(1-\rho^2)} + \left\{ \left(\frac{1-\gamma}{1-\rho} \right)^2 \frac{\sigma_{\eta}^2}{2} \cdot \sum_{j=1}^i (1-\rho^j)^2 \right\} \right] \quad (C4)$$

Proof of convergence of $E(v_t)$

Let $E(v_t) \equiv \sum_{i=1}^{\infty} z_i$ (C5)

Using Equation (E4), one can easily show that:

$$\lim_{i \rightarrow \infty} \left| \frac{z_{i+1}}{z_i} \right| = \theta \exp \left[\bar{\mu}\omega + \frac{\omega^2 \sigma^2}{2} + \left(\frac{\omega}{1-\rho} \right)^2 \frac{\sigma_{\eta}^2}{2} \right] \cdot \lim_{i \rightarrow \infty} \exp \left[\frac{\sigma_{\eta}^2}{2(1-\rho^2)} \{ b_{i+1}^2 - b_i^2 \} \right]$$

Using the definition of r in Theorem 1,

$$\lim_{i \rightarrow \infty} \left| \frac{z_{i+1}}{z_i} \right| = r \cdot \lim_{i \rightarrow \infty} \exp \left[\frac{\sigma_{\eta}^2}{2(1-\rho^2)} \{ b_{i+1}^2 - b_i^2 \} \right] \quad (C6)$$

Following from the proof of Theorem 1 in Appendix B, it suffices to show that:

$$\lim_{i \rightarrow \infty} \exp \left\{ \frac{\sigma_{\eta}^2}{2(1-\rho^2)} [b_{i+1}^2 - b_i^2] \right\} = 1$$

or that, $\lim_{i \rightarrow \infty} \{ b_{i+1}^2 - b_i^2 \} = 0$. With $|\rho| < 1$ specified in Equation (11b), $b_i^2 = \left(\frac{\rho(1-\gamma)}{1-\rho} \right)^2 [1-\rho^i]^2$

.Therefore,

$$\lim_{i \rightarrow \infty} \{ b_{i+1}^2 - b_i^2 \} = \left(\frac{\rho(1-\gamma)}{1-\rho} \right)^2 \cdot \left[\lim_{i \rightarrow \infty} \{ [1-\rho^{i+1}]^2 - [1-\rho^i]^2 \} \right] = 0$$

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EFFECTS OF FDI IN THE EUROPEAN TRANSITION ECONOMIES

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Abstract

The Foreign Direct Investments (FDI) formed one of the most important pillars of economic transformation of the so called former Eastern Bloc countries. In general, many countries considered it to be the only solution for recovery of industry and trade in respect of 'mismanaged' domestic enterprises. Such opinion shall be confirmed or disconfirmed on long-term basis. However, certain conclusions may be drawn at present. The following analysis aims at analysing the impact of a permanent shock in FDI on selected economic variables in the ten European Union member countries (Poland, Hungary, Czech Republic, Slovakia, Slovenia, Romania, Bulgaria, Estonia, Latvia and Lithuania). The analysis shall be done through the VAR method where we shall use the approach of the recursive Cholesky decomposition of the variance-covariance matrix of reduced form VAR residuals. We expect that the results of the analysis shall enable us to determine the shock impact on the development of the selected variables. The data necessary for the analysis shall be taken from the IMF statistics collected in the time period 2001-2009.

Keywords: foreign direct investments, economic growth, inflation, unemployment, trade balance, VAR, Cholesky decomposition, impulse-response function

JEL Classification: F15, F36, F41

1. Introduction

The Foreign Direct Investments (FDI) became one of the determining elements of economic transformation in the transition economies. Opening of such economies and the entry of foreign capital is considered to be one of the important factors of the gross domestic product growth, mainly after 2000. Besides the running privatisation, the period 2001-2009 was characteristic in these countries (Poland, Hungary, Czech Republic, Slovakia, Slovenia, Romania, Bulgaria, Estonia, Latvia and Lithuania) in respect of the FDI by building foreign plants on green meadows. Such investments were supposed to increase employment, labour productivity, export, GDP, transfer of technologies and other positive effects on economy. The following analysis aims at analysing the extent of impact of changes (shocks) of the FDI on development of basic macroeconomic parameters.

2. Development of the FDI in the European transition countries

The FDI in the selected group of countries (Poland, Hungary, Czech Republic, Slovakia, Slovenia, Romania, Bulgaria, Estonia, Latvia and Lithuania) developed slightly different in comparison with developed countries. It was caused by their gradual opening and transformation taking place in the 90's and the beginning of the new millennium. The FDI inflow into such economies reacted to the conditions in the abovementioned countries - privatization of state owned enterprises, bank sector transformation, changing business environment, road infrastructure, price of labour, level and terms and conditions of subsuppliers, growing living standard, etc. In general we may state that both the FDI inflow into the abovementioned economies and the FDI outflow from the abovementioned economies is increasing from 1994 to 2007 (Figure 1).

In 1998, the major share of the FDI in domestic economy belonged to Poland, Hungary and the Czech Republic. The FDI increased in all of the 10 countries being monitored from 1998 to 2007. Poland, Hungary and the Czech Republic maintained their leader position but in a different order. In 2007, Hungary got ahead of Poland and reached the leader position in respect of the FDI position in domestic economy. It is necessary to point out the development in Romania, Bulgaria and the Slovak Republic where the main wave of the FDI inflow occurred after 2000. The major component of the FDI in all the economies being monitored is formed by equity interest and reinvested profit. The other capital has the greatest share in the FDI position - over 30% in Bulgaria in 2005-2009. It was between 9-30 % in other economies.

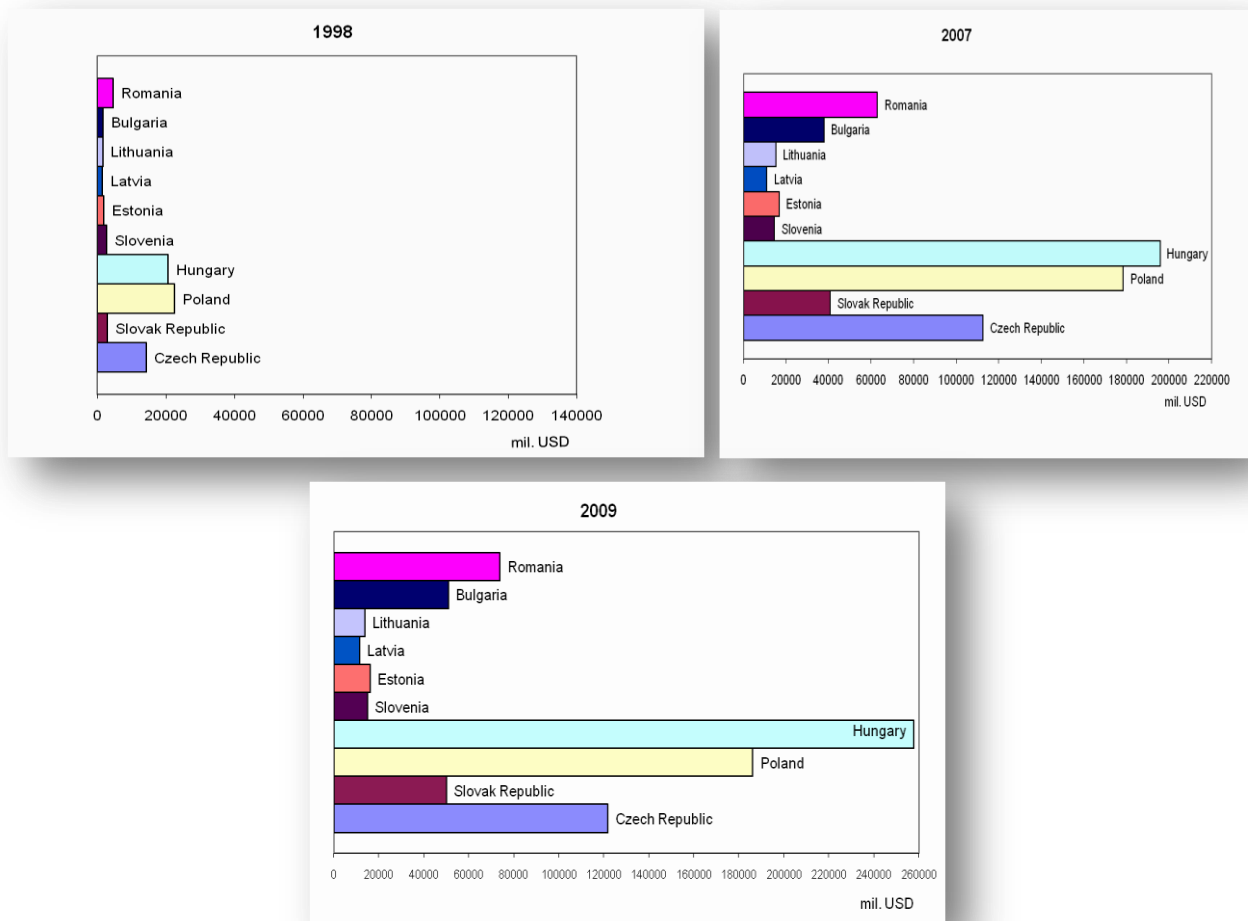


Figure 1. FDI in reporting economies in mil. USD (1998, 2007, 2009)

Source: Data from IMF (International Financial Statistics, May 2011)

Until 2008 the FDI inflow was increasing in all the monitored countries (Figure 2). The FDI inflow growth often exceeded the GDP growth. In the period 1998-2009 (Figure 3), the share of FDI in the GDP was constantly increasing in all the countries, but mainly in Hungary and Slovakia. The year 2009 showed a rapid decrease of the FDI inflow in such countries as well as worldwide. The greatest drop was recorded in Hungary where the FDI inflow values dropped below zero. The following cases of Hungary and Poland shall be stated for better illustration of the FDI inflow.

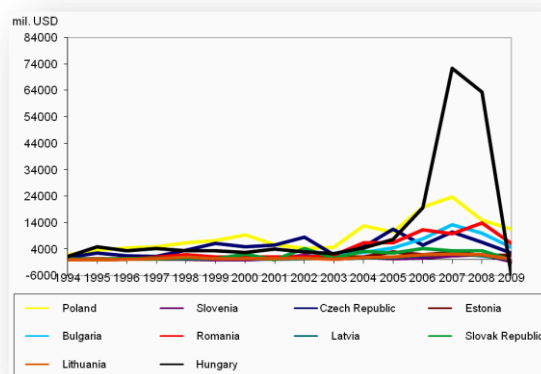


Figure 2. Inward FDI in mil. USD (1994-2009)

Source: Data from IMF (International Financial Statistics, May 2011)

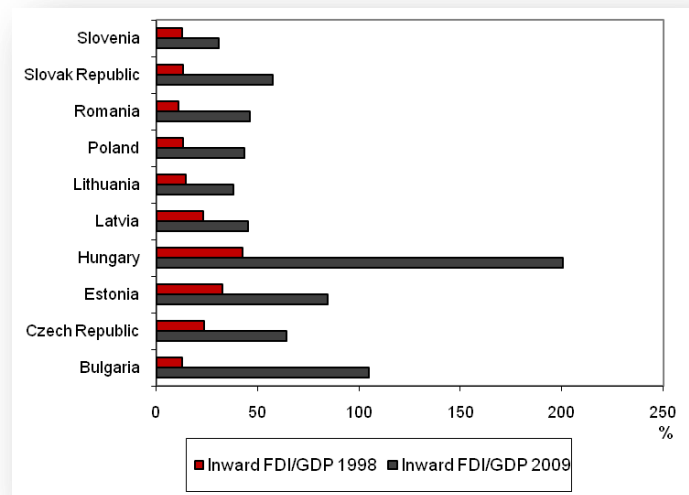


Figure 3. Inward FDI/GDP in %, (1998 and 2009)

Source: Data from IMF (International Financial Statistics, May 2011)

Since the beginning of the 90's Hungary belonged to the attractive countries for foreign investments because it based its strategy of development and transformation on luring foreign investments into the country. The year 1995 was the record year with the highest inflow of the FDI. Hungary ranked among the four greatest FDI beneficiaries in Central and Eastern Europe. The greatest foreign investors into such country come from the European Union, namely Germany (25%), the Netherlands (14%) and Austria (13%). In 2000, there were about 27,000 TNC present in Hungary which created jobs for approximately 610,000 employees. Nowadays the sector of services, where the foreign investments doubled during 2004-2008, is the sector with the greatest number of foreign investments. The dominant position within the FDI belongs to the reinvested profit forming more than half of all the FDI in Hungary. The reinvested profit has significantly increased in the sector of services over the last years. The crisis substantially affected the FDI inflow into Hungary. Since 2008 the volume of the FDI has decreased, and the decrease by 30% was higher than the average drop of the Central and Eastern European countries (9%) but lower than the average drop of the EU countries – 27 (40%).

The FDI inflow into Poland was growing and its record year was in 2007. Even though the FDI inflow decelerated in 2008 and 2009, it was still the highest in comparison to all the 10 countries being analysed. In 2007, there were 18,515 companies with foreign capital registered in Poland. The most important ones comprise 1,111 big companies with 63% share in the total FDI and 72% share in employment. 27.3% of all the foreign companies in Poland operate in the field of trade, 27.4% in the field of industry and 23.6% in the field of real estate and business services. In 2009, the main investors in Poland came from Germany (21.7%), France (13.9%), Luxembourg (12.7%), Sweden (9.5%) and the USA (9.1%).

Romania began to be attractive for the FDI mainly after 1999. Privatisation programs together with low wage costs, closeness of the euro-zone market and optimistic macroeconomic indicators lured strongly foreign investors. Approximately half of the FDI was directed at Romania due to privatisation of state owned enterprises up to 2006. Presence of the FDI accompanied by macroeconomic growth and other factors increased the average wage that continued growing by 20% annually. The average wage costs are still competitive for industries with high added value but they are unable to compete in low-cost industries such as textile and leather industry. Consequently we may observe the increase of the share of services in the total FDI inflows into Romania, specifically financial procurement and insurance business. The major investors in the country come from the EU, and 50% of the total FDI come from three countries - Austria, Netherlands and Germany.

One of the characteristic features of transitive economies of the EU is the fact that the share of the FDI inflow into such countries is much higher than the FDI outflow from such countries (Figure 4). The FDI outflow from such economies is getting increased until the end of the 90's. It was caused by the strong impact of external globalization factors and the pressure of small market factors (with the exception of Poland as the only big economy among the countries being analysed). Since the FDI flows are oscillating

abroad, the positions of the FDI abroad are still growing. Such investments are geographically directed mainly at the neighbouring countries. That means the major part of the FDI outflow remains within such economies. The dominance of the FDI movement into such countries is based on long-time export experience, historical and cultural familiarity.

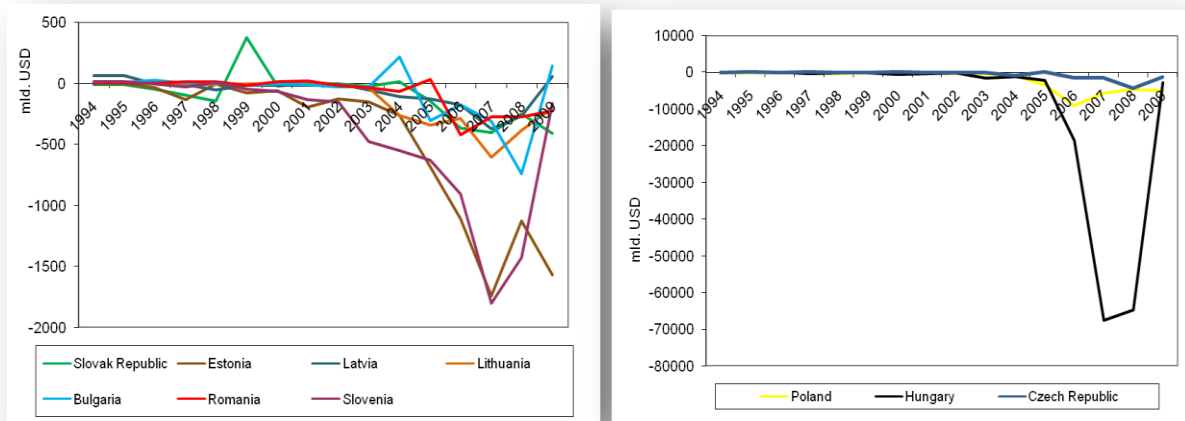


Figure 4. FDI abroad in mil. USD 1994-2009

Source: Data from IMF (International Financial Statistics, May 2011)

Hungary shall be a good example from the countries being analysed. Hungary is the second greatest foreign investor among the new EU member countries, ranking immediately after Poland. The FDI outflow abroad accelerated after 2000. In the period 2000-2005, the FDI outflow increased more than six times and subsequently it doubled from 2005 to 2007. Among the main destinations of the Hungarian FDI belong the surrounding countries such as Slovakia, Croatia and Bulgaria. Several speculative investments are directed at Cyprus, Luxembourg, the Netherlands and Switzerland due to tax reasons. The number of Hungarian TNC is estimated at 7,000, and the five greatest investors include the companies MOL, OTP Bank, Magyar Telekom, MKB Bank and Gedeon Richter, having the share in the amount of 65% in all the FDI outflows from the country in 2008.

3. Overview of the literature

Many current studies deal with the issue of the FDI impact on economics of a host country. Balasubramanyan, Salisu and Sapsford (1996) gave reasons for the FDI impact on economic growth in a host country that applies liberalization business policy. They pointed out that the FDI had a greater impact on economic growth in export oriented economies than import oriented economies. Borensztein, De Gregorio, Lee (1998) also state that the FDI effects on economic growth depend on the level of human capital available in a host country. There is a strong positive dependence between the FDI and the level of education. Chen, Chang, Zhang (1995) point at the strong influence of the FDI on economic growth in China since 1978. The FDI have supported economic growth in China through their substantial contribution to the export efficiency of the country. Hoang, Wiboonchutikula, Tubtimtong (2010) state that there is a strong influence of the FDI on economic growth in Vietnam. The additional capital from the FDI inflows is the only channel increasing economic growth in the country. Bajo-Rubio, Díaz-Mora, Díaz-Roldán (2010) draw a conclusion based on the analysis that the FDI plays a special role as the means of technology transfer and productivity growth factor. In the case of Spain they influence positively and significantly the growth of the GDP share per an employee. Hudáková (2006) monitors the FDI impact on real economy in the case of Slovakia. Based on the tests performed she states that the FDI influences development of labour productivity and the testing also indicates existence of influence of labour productivity on the GDP (delayed approximately up to one year) that indirectly indicates the FDI impact on the GDP. Hošková (2001) states that the FDI has contributed to the high growth of labour productivity, growing volume of production in the corresponding quality as well as sustainable employment in Slovakia. However, there are some studies showing small or no impact of the FDI on economics of a host country. Carkovic, Levine (2002) analysed the dependency between the economic growth and the FDI based on the data of 72 countries collected during the time period from 1960 to 1995. Their results show that the FDI does not have any strong impact on the economic growth. The Mercinger's studies (2004) deal with the FDI impact on real economy of 10 Central and Eastern European countries who states that the FDI impact on real convergence in such countries is not too significant. Dobrylovský, Löster (2009) test macroeconomic effects of the FDI flows from and into the Czech Republic. They emphasize that

the results of the mass FDI inflow into the Czech Republic should not be overestimated. Based on the quantitative analysis they showed that the FDI should not be deemed a growth factor where the possible explanation is the fact that the boom of efficient foreign companies resulted in forcing out the part of domestic investments. Another fact they point out is that the rate of unemployment in the Czech Republic does not decrease significantly despite hundreds of billions of the FDI pumped into the Czech economy. They did not show any clear correlation in the case of the FDI impact on the trade balance.

4. Data and econometric model

For the purpose of estimating the effect of the FDI exogenous shocks on economy of the country we have used the quarterly data from 2001Q1 to 2009Q4 (33 observations) for four macroeconomic indicators (gross domestic product, inflation, rate of unemployment and amount of trade balance) for each country from the group being analysed (Czech Republic, Hungary, Poland and Slovak Republic). All the data were taken from the IMF statistics (International Financial Statistics, May 2011).

For the purpose of econometric analysis of the impact of the FDI shocks on economy of a host country the VAR method - vector autoregressive methodology was implemented. This method is very flexible and convenient method to analyse time series of more variables. The final causal impacts of unexpected shocks on the variables being examined are summarized in the impulse response functions (Figures 5-14). For our purposes we shall use the approach of the recursive Cholesky decomposition of the variance-covariance matrix of reduced form VAR residuals.

Before using the results of econometric analysis it is necessary to test the time series for stationarity and cointegration. Stationarity of time series is an important precondition of an econometric analysis quality. We shall determine stationarity through the unit root test using the ADF (Augmented Dickey-Fuller Test) and the PP (Phillips-Perron) Test. Both of the tests verify the zero hypothesis that the time series are non-stationary. The unit root test performed on the values and particularly on the first differentials of the time series has rejected the zero hypothesis, thus it has proven the existence of stationarity in the time series being monitored. Most of the time series were I(1) though we've also found some variables I(0) - FDI (Poland, Romania), trade balance (Estonia, Lithuania, Slovak republic)

After verification of stationarity it is necessary to carry out the Johansen's cointegration test in order to verify existence of a long-term balance relationship among the variables. Cointegration testing is also important for distinguishing between real and false regression. The results of the Johansen's cointegration test have proven that there are no stable long-run relationships among the variables being examined, i.e. the variables are not cointegrated (both trace statistics and maximum eigenvalue statistics reported a presence of none cointegrating vector in all countries). The results of the unit root and cointegration tests are not reported here. They are available upon request from the authors.

5. Results and discussion

On the basis of the analysis performed through the VAR method we may form the course of IRF (impulse-response functions) in the conditions of the analysed countries shown in the following charts.

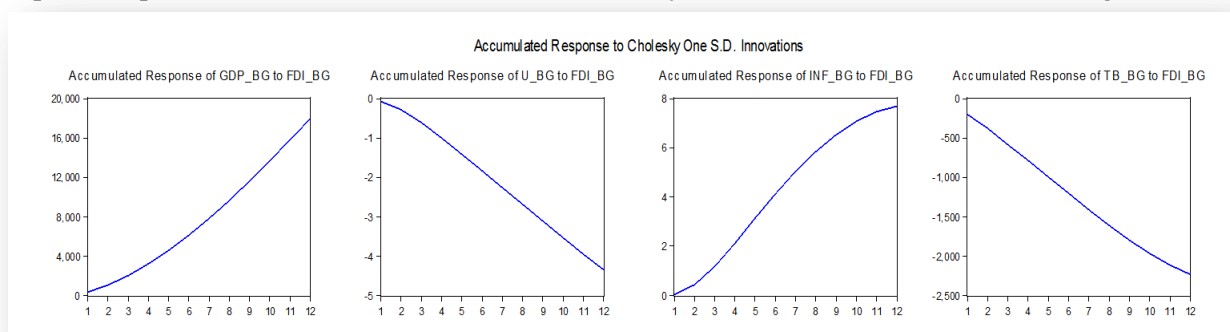


Figure 5. Accumulated responses of endogenous variables to the FDI shocks in Bulgaria

Source: Authors' calculations.

On the basis of the course of the IRF function in the environment of Bulgaria we may state that the FDI shock having a permanent effect positively influences the GDP development as well as the employment development in the country. However, the FDI shock resulted in increasing the rate of inflation and worsening the trade balance position.

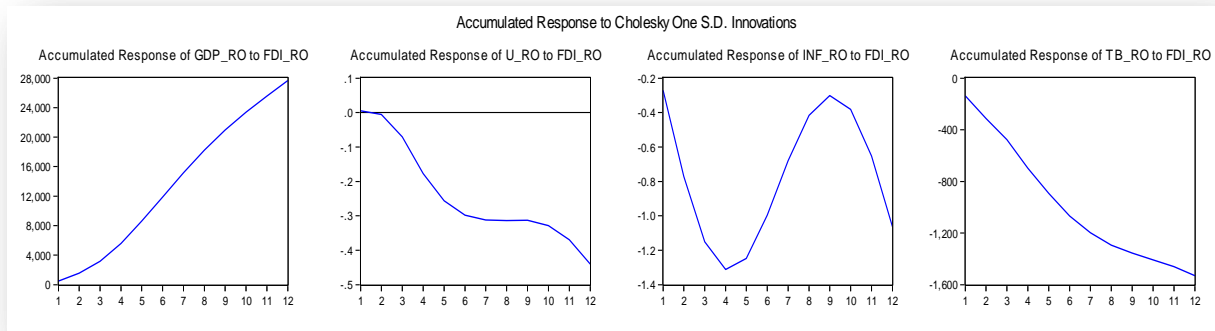


Figure 6. Accumulated response of endogenous variables to the FDI in Romania.

Source: Authors' calculations.

Similar tendencies as in Bulgaria can be observed in Romania in respect of the first two monitored variables - GDP responses and the development of unemployment. Both of the examined variables react to the FDI changes positively. A rather unstable response may be observed at the development of inflation. It had decreased on short-term basis and later on started to increase during three years and again dropped at the end of the monitored time period. The FDI shock impact on the trade balance development is negative.

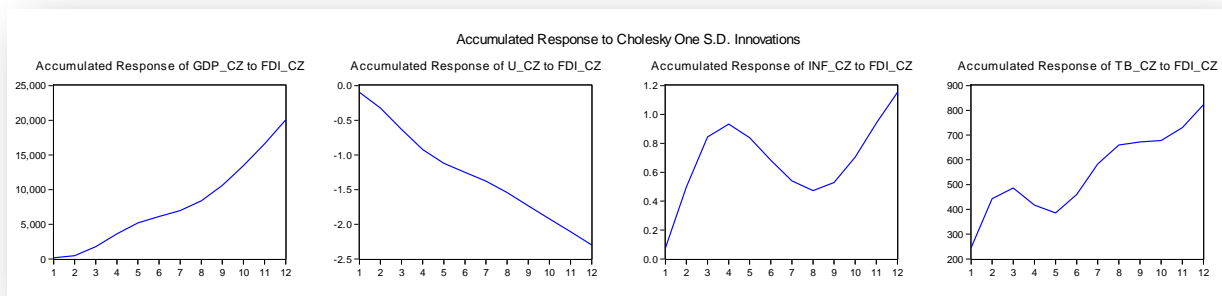


Figure 7. Accumulated response of endogenous variables to the FDI shocks in the Czech republic.

Source: Authors' calculations.

The FDI shock impact on the development of the GDP and unemployment proves to be positive in the case of the Czech Republic. We may observe a rather unstable development at the course of the IRF function for the development of inflation. It was increasing during the first third of the monitored time period, decreasing during the second third and then began to increase again. We may observe the positive FDI shock impact on the trade balance development.

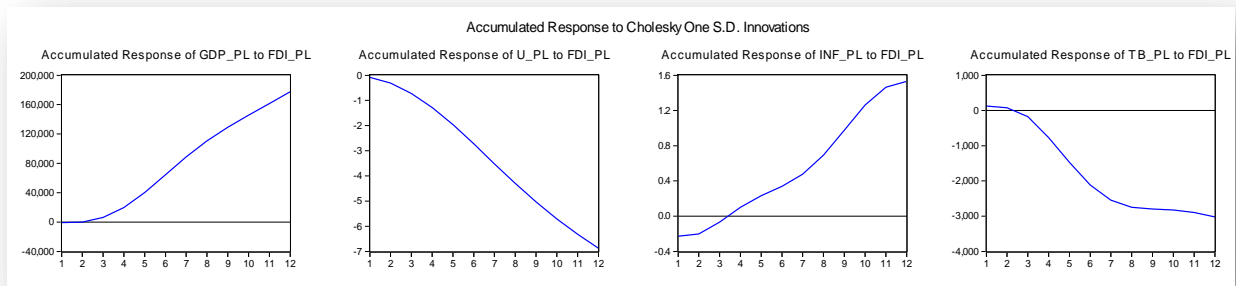


Figure 8. Accumulated response of endogenous variables to the FDI shocks in Poland

Source: Authors' calculations.

The positive response may be seen in the GDP indicators and development of unemployment in the case of Poland. However, the FDI shock had a negative impact on the development of inflation and trade balance.

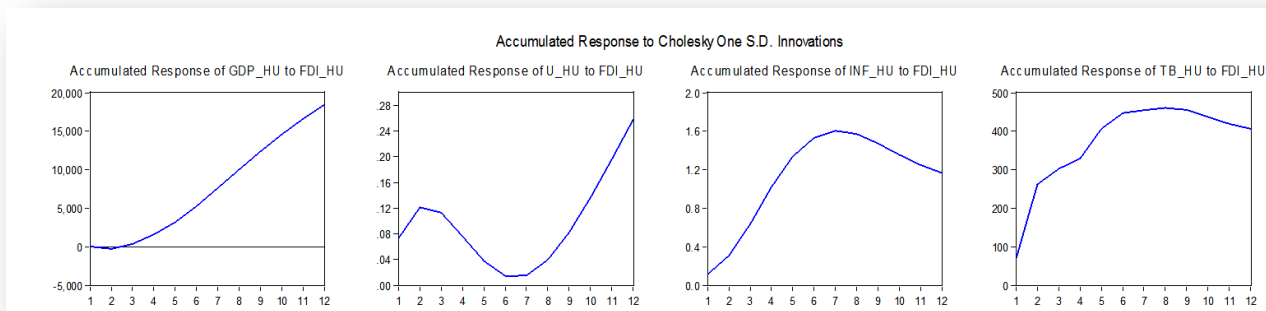


Figure 9. Accumulated response of endogenous variables to the FDI in Hungary.

Source: Authors' calculations.

The response to the FDI shock in Hungary in respect of the GDP had the same course as in the aforementioned countries. The response of unemployment developed differently. The unemployment reacted to the FDI by decrease in the first years. However the positive impact disappeared later and the unemployment started to increase again. We may also observe the negative impact in the case of inflation tending to increase up to the beginning of the second half of the monitored time period when the development gets slightly stabilized. On the contrary, the FDI influences positively the trade balance development almost throughout the entire monitored time period.

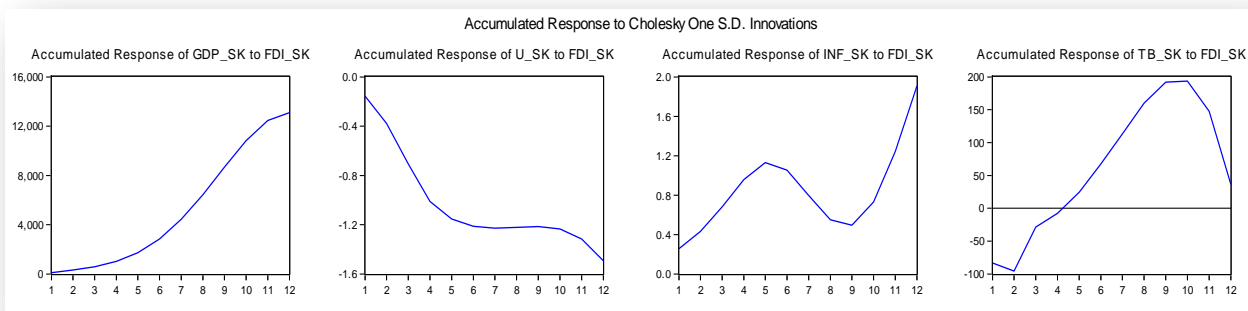


Figure 10. Accumulated response of endogenous variables to the FDI shocks in the Slovak republic.

Source: Authors' calculations.

In the case of Slovakia, we may observe the positive effect of the FDI permanent shock on the development of the GDP, unemployment, and trade balance where the positive influence gradually disappears at the end of the monitored time period (2009). The development of inflation has a negative response from the long-term point of view even though the rate of inflation dropped on short-term basis in the middle of the monitored time period.

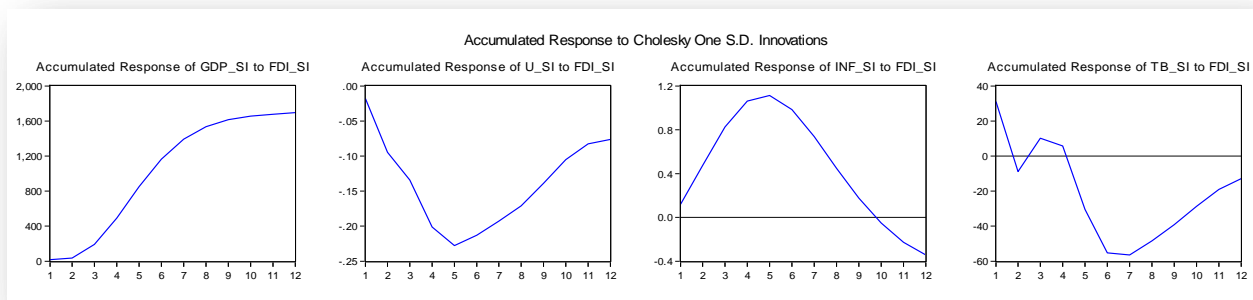


Figure 11. Accumulated response of endogenous variables to the FDI shocks in Slovenia.

Source: Authors' calculations.

The case of Slovenia proves the positive impact of the FDI on the GDP development. We cannot draw similarly clear conclusions in the case of unemployment whose development reacts positively to the FDI up to the middle of the monitored time period but the unemployment starts to increase in the second half. The opposite effect may be seen in respect of inflation with prevailing negative impact at the beginning - inflation increases, but it starts to decrease in the second half of the monitored time period. The negative FDI impact on the trade balance of the country disappears from the second half of the monitored time period.

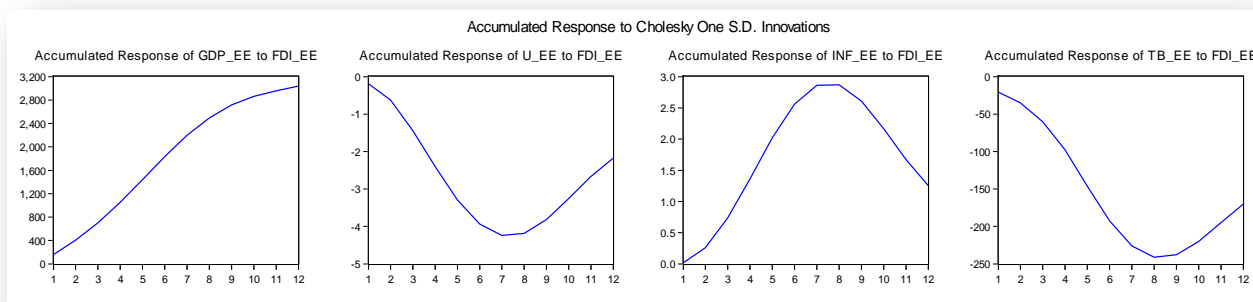


Figure 12. Accumulated response of endogenous variables to the FDI shocks in Estonia.

Source: Authors' calculations.

The course of the IRF function in the environment of Estonia indicates similar results to the case of Slovenia. The GDP reacts positively to the FDI shock impact. The unemployment drops in the first half of the time period but subsequently starts increasing. On the contrary, the inflation responds by increase from the beginning but decreases in the second half of the time period. The trade balance development indicates negative impact that changes at the end of the time period.

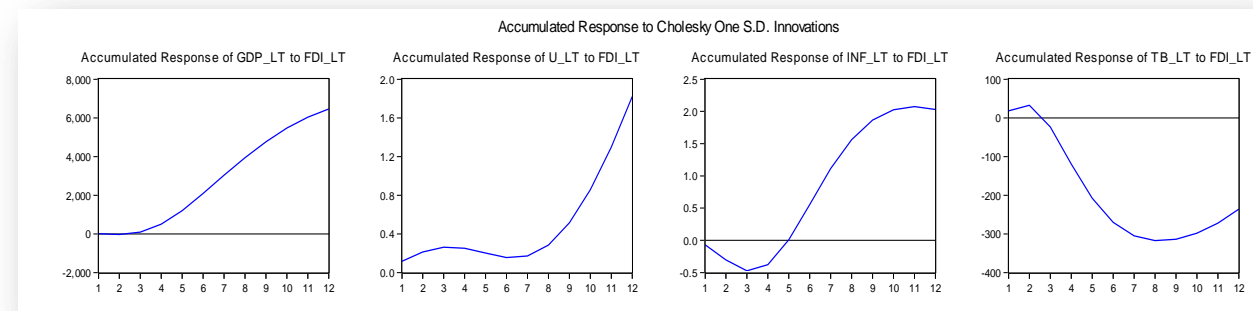


Figure 13. Accumulated response of endogenous variables to the FDI in Lithuania.

Source: Authors' calculations.

The positive response of the GDP development to the FDI shock may be observed in the case of Lithuania. All other examined variables do not show very positive response. The unemployment during the first four years of the monitored time period did not react significantly but starts increasing from the second half of the time period on. Likewise the negative response to the shock in the case of inflation, i.e. increase of inflation, occurs from the second half of the monitored time period on. The FDI shock has a negative impact on the trade balance as well.

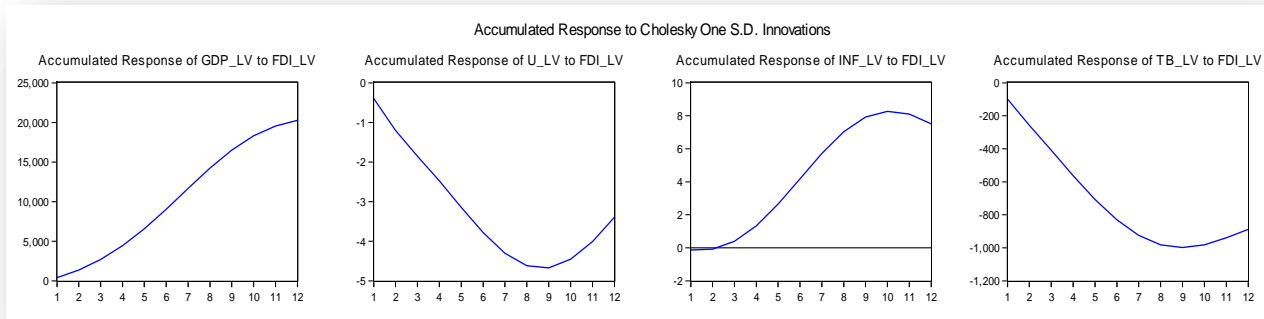


Figure 14. Accumulated response of endogenous variables to the FDI shocks in Latvia.

Source: Authors' calculations.

The effect of the FDI shock in the case of Latvia was positive in respect of the development of the GDP and unemployment. On the contrary, inflation was increasing almost up to the end of the monitored time period and the impact on trade balance was negative as well.

Under the foregoing facts we may state that the FDI shocks (i.e. the changes in the FDI during the monitored time period 2001-2009) influenced the development of the examined macroeconomic parameters in the 10 European transition countries. Such influence is positive in the case of the GDP development in all countries. This conclusion could support the results of the studies in respect of the positive impact of the FDI on the economic growth and development of the GDP in host countries. However, it is necessary to point out that the FDI in greater extent came to the analysed countries within the monitored time period between 2001-2009 that commenced production and thus contributed to the GDP growth during the aforementioned time period. The monitored time period also reflected the impact of the crisis. Therefore this conclusion should be confirmed in the following time period when their negative or positive effect comes through in greater extent.

In the case of unemployment it is generally expected that the FDI bring new job opportunities, increases labour productivity and decreases unemployment in a host country from the long-term point of view. Otherwise the FDI and many other investment incentives to lure the FDI to the monitored countries would not be supported and provided. However, not all the studies carried out so far confirm this generally expected contribution. E.g. Dobrylovský, Loster (2009) state on the basis of the analysis carried out by them that the rate of unemployment in the Czech Republic has not decreased significantly despite hundreds of billions of the FDI pumped into the Czech economy. But the Czech Republic has never worried so much about the high rate of unemployment as for instance Slovakia or Poland. The positive response to the FDI shock in our case occurred in Bulgaria, Romania, the Czech Republic, Poland, the Slovak Republic and Latvia. The unemployment had a decreasing tendency due to the FDI shock in the abovementioned countries from the long-term point of view. The results in the case of Lithuania, Estonia, Slovenia and Hungary were not so clear, the response of unemployment was positive or neutral on short-term basis, from the long-term point of view the response turns to be negative. Hungary had one of the lowest rates of unemployment in comparison to the countries being analysed, around 6%, therefore we could not expect any significant decrease of unemployment. The unemployment in the case of Estonia, Slovenia and Lithuania was decreasing down to 3-6% within the first half of the time period, therefore the increase of unemployment in the second half of the time period up to the end of 2009 is not such a surprising phenomenon.

The general conclusion on the basis of the analysis performed in the field of response and development of inflation in the economies being monitored proves that the permanent shock of the FDI

causes increase of inflation. Such negative tendency occurred in all the countries being analysed even though it gradually disappears in some cases on long-term basis. We may support this conclusion by the following argument. In general, companies with foreign capital bring higher salaries to a host country than domestic companies. It creates space to push on general raise of salaries in economy subsequently resulting in the increased domestic demand and the related price level increase. The second argument relying on the economic growth supported by the FDI has a similar effect. The GDP growth is associated with the price level increase.

The incoming FDI may worsen the trade balance of a home country during the first years of their effect. It is connected with building new plants where the equipment and technologies are imported and such country reports it as the import in the balance sheet. However, such negative effect should disappear immediately after the plant starts production and places its production not only on domestic market but exports a great part thereof. Thus the export increases. The negative response to the FDI shocks, mainly at the beginning of the time period, may be observed in our case in Estonia, Lithuania, Latvia, Poland and Slovenia. The FDI shock has a long-term impact in the case of Bulgaria and Romania. In this case, especially in the case of Bulgaria, we could consider the impact of the exchange rate since the exchange rate of the Bulgarian Lev was getting significantly stronger against dollar during the monitored time period. The FDI changes positively influenced the trade balance in the Czech Republic, Hungary and Slovakia.

6. Conclusion

The performed analysis of the FDI shock impact, mainly the positive one, connected with the increased inflow of the FDI into the monitored economies, has proven its impact on all the indicators being analysed (GDP, unemployment, inflation and trade balance). The clear positive impact of the FDI permanent shock has been proven on the GDP development in all the analysed countries. We may observe the positive response to the shocks even in the case of unemployment decrease but not in all the countries being monitored. The positive effect of the FDI shock on long-term basis did not incur in the countries with the low rate of unemployment such as Hungary or in the countries where the rate of unemployment dropped to 5-6% at the beginning of the time period (Lithuania, Estonia, Slovenia). The negative impact of the shocks has been proven in the case of another monitored variable - inflation. It responded by increase on short-term basis in all the countries being monitored. The FDI shock impact on the trade balance has been proven as well but we may observe different reactions in this case. The negative short-term effect but the positive effect on long-term basis, or only the positive effect has been proven in eight countries altogether. The long-term negative impact has been monitored only in Bulgaria and Romania.

In conclusion it is necessary to point out that many enterprises of the FDI were only being established or running for a short time 2001-2009. The economic process was negatively affected by the world crisis during the monitored time period. Therefore FDI effects, positive or negative ones, shall occur or settle on long-term basis.

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FINANCIAL DECISIONS BASED ON DIAGNOSTIC ANALYSIS

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Abstract

The paper presents aspects regarding the assessment of company Saturn Alba Iulia. The objective of this paper is to establish the entity's diagnostic through three evaluation methods that have already been established on the market, namely: the Altman method, the Conan-Holder method and Cematt method. The diagnostic indicators of the entity have been computed for all three methods and a diagnostic was established afterwards through comparison. The usefulness of this paper is evident due to the acute need for certification of the results obtained by diagnosing the entities with the help of methods that exist on the entities' assessment market, in a context where there is a wide variety of this type of methods.

Keywords: diagnostic, assessment, indicators, balance sheet, financial diagnostic

JEL Classification: M00, C01, E00

1. The diagnostic of the enterprise

The word 'diagnostic' is of Greek origin and means 'apt to discern'. According to the Romanian Explanatory Dictionary, diagnostic represents 'a precise determination of the medical condition of a being, based on clinical data and laboratory analyses'. Through analogy, in the case of enterprises, the diagnostic refers to identifying the symptoms, the dysfunctionalities, and the development of a therapy that leads to recovery or readaptation of the enterprise in conditions of normal functioning. Regardless of its use, the diagnostic approach imposes the complete analysis of the mechanism of development and change of the specific phenomena as a preliminary phase.

Like human beings, it is known that an enterprise needs diagnosing not only when it is 'sick' but also when it is in a 'good' condition, monitoring potential imbalances, certain organizational structures that would be vulnerable to market fluctuation, the preparation of strategic decisions for mergers or acquisitions, and self-diagnosing to highlight strengths and weaknesses of the enterprise.

Determining the 'state of health' of companies is an important activity because diagnosing can establish the measures that managers must take so that companies will withstand the competitive environment. In the current conditions, when the global financial crisis is more acute, it's important for companies to set objectives in order to overcome the crisis in that country.

2. Global diagnostic

According to the publication 'Revista Tinerilor Economisti' (Young Economists Journal), Second Year, No. 2 April 2004, p. 15, the global diagnostic 'aims the analysis of the main functions of the enterprise and is developed on the basis of partial diagnostics, namely: legal diagnostic, commercial diagnostic, the supplies' diagnostic, technical, technological and production diagnostic, human resources diagnostic and financial diagnostic.'

The global diagnostic:

- implies high expenses and specialized training (expert appraisal);
- is elaborated when the company is sold, reorganized through acquisitions/mergers or when it faces major challenges;
- its study object is the whole enterprise.

3. Financial diagnostic

Maria Niculescu in the paper 'Strategic Global Diagnostic', volume 1, Economica Publishing House, Bucharest, 2003, p. 22, defines the economic financial diagnostic as 'a handy instrument for managers that allows phrasing qualitative and/or quantitative value judgements about the state, dynamic and perspectives of an economic agent, highlighting its strengths and weaknesses and its ability to develop in a profitable manner'. The same paper mentions that 'the analysis of the enterprise's activity represents a set of concepts, techniques and tools that ensure the approach of internal and external information in order to enunciate

pertinent assessments regarding its economic, financial and strategic situation in terms of the quality of its performances and the risk level in an extremely dynamic environment’.

The *Informatica Economica Journal*, no. 7/1998, p. 1, presents the economic financial diagnostic as ‘a managerial tool that allows phrasing qualitative and quantitative value judgements regarding the state, dynamic and business perspectives of an economic agent’.

Financial diagnostic is an important component of global diagnostic, which ‘lives’ through the indicators that reflect the performances of companies at a given moment. It is known that no matter how many indicators are used in financial diagnosing, if it isn’t correlated with the other component of global diagnosing, the results are inconclusive.

The gained knowledge about the strengths and opportunities, weaknesses and risks regarding the current and future activity of the enterprise can be synthesized and graded by using a scale. The assessor may use models developed by specialists or may create its own scale.

Putting a financial diagnostic means assessing the financial situation of the company in terms of performance and the following methods are used for this: the ALTMAN Model, the CONAN-HOLDER Model, the CEMATT Model. The Altman and Conan-Holder models use scores, which are based on aggregating a certain number of rates with the significance of profitability, financial structure and risk into a score function. The comparative analysis of the individual score’s dynamic with the constant evolution at the level of the activity sector reflects the enterprise’s predisposition to risk in a given professional environment.

The data used for illustration belong to Saturn Alba Iulia company and are part of the annual financial statements for the period 2006-2010, according to <http://www.saturn-alba.ro>.

Table 1. Balance Sheet

	2006	2007	2008	2009	2010
ASSETS					
1. Fixed assets	6,700,173	7,774,952	9,235,144	10,095,707	9,525,636
2. Current assets	27,717,266	27,336,582	30,318,669	23,606,506	25,307,244
3. Accrued expenses	961,545	961,545	961,545	961,545	961,545
TOTAL ASSETS	35,378,984	36,073,079	40,515,358	34,663,758	35,794,425
LIABILITIES					
1. Short term debts (less than one year)	17,739,652	17,974,868	17,472,969	7,612,332	8,899,805
2. Long term debts (more than one year)	193,668	569,256	1,241,852	2,439,041	2,114,338
3. Provisions for risks and charges	0	0	0	0	0
4. Deferred income	1,690,742	1,673,140	2,168,021	1,972,803	1,762,518
5. Equity	15,754,922	15,855,815	19,632,516	22,639,582	23,017,764
TOTAL LIABILITIES	35,378,984	36,073,079	40,515,358	34,663,758	35,794,425

Table 2. Profit and loss account
– lei –

Indicators	No. In.	Figures recorded during the reporting period				
		2006	2007	2008	2009	2010
A	B	1	2	3	4	5
1. Net turnover (ln.02 to 05)	01	57,671,285	61,136,536	82,633,030	63,596,715	53,706,452
Sold production (ac.701+702+703+704+705+706+708)	02	57,472,353	60,907,720	82,378,413	63396130	53696311
Sales of goods (an.707)	03	198,932	228,816	254,617	200,585	167,932
Granted discounts (ac. 709)					0	157,791

Indicators	No. ln.	Figures recorded during the reporting period				
		2006	2007	2008	2009	2010
Interest income recorded by entities whose main activity is leasing (ac. 766)	04	0	0	0	0	0
Subsidies related to the net turnover (ac.7411)	05	0	0	0	0	0
2. Changes in inventories (ac.711)	06	0	46,798	1,035,134		1,792,985
- Balance C						
And in production in progress	07	800,954	0	0	1,559,043	0
- Balance D						
3. Production achieved by the entity for its own purposes and capitalized (ac.721+722)	08	0	140,301	70,787	143,961	0
4. Other operating incomes (ac.7417+758)	09	777,561	1,068,155	1,163,910	691,002	1,068,229
OPERATING INCOME – TOTAL (ln.01+05-06+07+08+09)	10	57,647,892	62,391,790	84,902,861	62,872,635	56,567,666
5.a) Expenses with raw materials and consumables (ac.601+602-7412)	11	23,199,821	24,780,867	36,060,435	23,568,299	24,019,241
Other material expenses (ac.603+604+606+608)	12	584,159	830,298	1,089,551	556,068	740,833
b) Other external expenses (with energy and water) (ac.605-7413)	13	6,406,935	7,101,565	8,035,042	6,403,042	5,770,518
c) Goods for resale (ac.607)	14	198,739	227,348	252,058	206,642	191,297
Received discounts (ac. 609)					0	48,948
6. Personnel expenses (ln.16+17)	15	16,445,013	18,951,052	21,345,507	19,208,281	17,263,352
a) Salaries and allowances (ac.621+642-7414)	16	12,074,710	13,865,846	15,922,778	14,556,834	12,997,484
b) Social security contributions (ct.645-7415)	17	4,370,303	5,085,206	5,422,729	4,651,447	4,265,868
7.a) Reversal on tangible and intangible assets (ln. 19-20)	18	753,172	686,575	733,580	895,330	965,459
a.1) Expenses (ac.6811+6813)	19	753,172	690,410	788,638	897,249	965,459
a.2) Incomes (ac.7813)	20	0	3,835	55,058	1,919	
b) Reversal of write-down of current assets (ln.22-23)	21	413,389	825,351	2,270,880	810,450	36,692
b.1) Expenses (ac.654+6814)	22	413,389	825,351	2,270,880	1,019,189	36,692
b.2) Incomes (ac.754+7814)	23	0	0	0	208,739	0
8. Other operating expenses (ln.25 la 28)	24	7,994,104	8,324,812	10,308,669	7,186,506	6,899,494
8.1. Expenses with third parties services (ac.611+612+613+614+621+622+623+624+625+626+627+628-7416)	25	6,345,006	6,494,733	8,932,803	6,747,689	6,370,873
8.2. Other taxes, duties and similar expenses (ac.635)	26	757,931	208,546	189,655	222,241	197,654
8.3. Compensations, donations and disposed assets (ac.658)	27	891,167	1,621,533	1,186,211	216,576	330,967
Expenses with refinancing interests recorded by entities whose main activity is leasing (ac. 666)	28	0	0	0	0	0
Provisions (ln.30-31)	29	0	0	0	0	0
- Expenses (ac.6812)	30	0	0	0	0	0

Indicators	No. In.	Figures recorded during the reporting period				
		2006	2007	2008	2009	2010
- Incomes (ac.7812)	31	0	0	0	0	0
OPERATING EXPENSES - TOTAL (ln.11 la 15+18+21+24+29)	32	55,995,332	61,727,868	80,095,722	58,834,618	55,837,938
OPERATING PROFIT OR LOSS: - Profit (ln.10-32)	33	1,652,560	663,922	4,807,139	4,038,017	729,728
- Loss (ln.32-10)	34	0	0	0	0	0
9. Revenues from investments (ac.7611+7613)	35	0	0	0	0	0
- of which, revenues from related parties	36	0	0	0	0	0
10. Revenues from other investments and loans that are part of fixed assets (ac.763)	37	0	0	0	0	0
- of which, revenues from related parties	38	0	0	0	0	0
11. Interest revenues (ac.766)	39	63,687	18,931	4,225	6,039	2,753
- of which, revenues from related parties	40	0	0	0	0	0
Other financial revenues (ct. 762+764+765+767+768)	41	1,113,609	2,327,286	3,129,155	2,431,686	1,806,940
FINANCIAL REVENUES - TOTAL (ln.35+37+39+41)	42	1,177,296	2,346,217	3,133,380	2,437,725	1,809,693
12. Reversal of write-down of current assets (ln.44-45)	43	0	0	0	0	0
- Expenses (ac.686)	44	0	0	0	0	0
- Incomes (ac.786)	45	0	0	0	0	0
13. Interest expenses (ac.666-7418)	46	244,378	329,531	425,020	239,817	153,100
- of which, expenses caused by related parties	47	0	0	0	0	0
Other financial expenses (ac.663+664+665+667+668)	48	1,849,144	2,184,803	3,434,770	2,632,583	1,870,152
FINANCIAL EXPENSES - TOTAL (ln.43+46+48)	49	2,093,522	2,514,334	3,859,790	2,872,400	2,023,252
FINANCIAL PROFIT OR LOSS - Profit (ln.42-49)	50	-916,226	-168,117	-726,410	-434,675	-213,559
- Loss (ln.49-42)	51	916,226	168,117	726,410	434,675	213,559
14. CURRENT PROFIT OR LOSS: - Profit (ln.10+42-32-49)	52	736,334	495,805	4,080,729	3,603,342	516,169
- Loss (ln.32+49-10-42)	53	0	0	0	0	0
15. Extraordinary income (ac.771)	54	0	0	0	0	0
16. Extraordinary expenses (ac.671)	55	0	0	0	0	0
17. PROFIT OR LOSS FROM EXTRAORDINARY ACTIVITY: - Profit (ln.54-55)	56	0	0	0	0	0
- Loss (ln.55-54)	57	0	0	0	0	0
TOTAL REVENUES (rd.10+42+54)	58	58,825,188	64,738,007	88,036,241	65,310,360	58,377,359

Indicators	No. ln.	Figures recorded during the reporting period				
		2006	2007	2008	2009	2010
TOTAL EXPENSES (rd.32+49+55)	59	58,088,854	64,242,202	83,955,512	61,707,018	57,861,190
GROSS PROFIT OR LOSS:						
- Profit (ln.58-59)	60	736,334	495,805	4,080,729	3,603,342	516,169
- Loss (ln.59-58)	61	0	0	0	0	0
18. Tax profit (ac. 691)	62	351,352	394,656	1,043,316	597,912	141,273
19. Other taxes (ln.698)	63	0	0	0	0	0
20. NET PROFIT OR LOSS OF THE FINANCIAL YEAR:						
- Profit (ln.60-61-62-63)	64	384,982	101,149	3,037,413	3,005,430	374,896
- Loss (ln.61+62+63-60)	65	0	0	0	0	0

A) ALTMAN model

This model is discussed as a ‘prediction model for bankruptcy’, being developed by professor Altman in the United States of America in 1968 and subsequently improved in 1977. Through this model, professor Altman managed to forecast approximately 75% of bankruptcies with nearly two years before they happened.

The model is based on the following formula:

$$Z=1,2*x_1+1,4*x_2+3,3*x_3+0,6*x_4+0,999*x_5$$

x_1, x_2, x_3, x_4, x_5 are determined through²:

1. Business flexibility (x_1) = ratio between the working capital (net current assets) (WC) and total assets (TA)

$$x_1 = \frac{WC}{TA}$$

2. Self-financing rate of total assets (x_2) = ratio between reinvested profit (RP) and total assets (TA)

$$x_2 = \frac{RP}{TA}$$

3. Economic rate of return (x_3) = ration between profit before paying interests and taxes (PBPIT) and total assets (TA)

$$x_3 = \frac{PBPIT}{TA}$$

4. Debt ratio (x_4) = the extent to which the company’s debts (TD) are covered by paid-up capital (PUC)

$$x_4 = \frac{PUC}{TD}$$

5. Return on assets (x_5) = ratio between turnover (T) and total assets (TA).


$$x_5 = \frac{T}{TA}$$

Computation made with the help of the ALTMAN method for the financial statements of Saturn company is presented below:

Calculating indicators

x_1 - 1. Business flexibility (x_1)	Result of indicators/years				
	2006	2007	2008	2009	2010
$\frac{\text{Working capital(WC)}}{\text{Total assets(TA)}}$	0.26	0.24	0.29	0.43	0.44

² Achim Monica Violeta, ECONOMIC FINANCIAL ANALYSIS, RISOPRINT Publishing House, Cluj Napoca, 2009, p.412

x2 - 2. Self-financing rate of total assets(x₂)	$\frac{\text{Reinvested profit(RP)}}{\text{Total assets(TA)}}$	=	0.01	0.00	0.07	0.09	0.01
x3 - 3. Economic rate of return(x₃)	$\frac{\text{Profit before paying interests and taxes(PBPIT)}}{\text{Total assets (TA)}}$	=	0.03	0.02	0.11	0.11	0.02
PBPIT=gross result of the year+expenses with bank interests							
x4 - 4. Debt ratio (x₄)	$\frac{\text{Total debts(TD)}}{\text{Paid-up capital(PUC)}}$	=	3.63	3.75	3.78	2.03	2.23
x5 - 5. Return on assets (x₅)	$\frac{\text{Turnover (T)}}{\text{Total assets (TA)}}$	=	1.63	1.69	2.04	1.83	1.50
$Z=1,2*x_1+1,4*x_2+3,3*x_3+0,6*x_4+0,999*x_5$							
			2006	2007	2008	2009	2010
			4.22	4.31	5.12	4.06	3.43
			1	1	1	1	1

According to the ALTMAN diagnostic Table, the situation of the firm is as follows:

Score value	Ranking the companies
Z > 3	SOLVENT (1)
3 > Z >= 1,8	FINANCIAL DIFFICULTIES (2)
Z < 1,8	IMMINENT BANKRUPTCY (3)

The presented data show that the company is solvent during all the five analyzed years.

B) CONAN – HOLDER model

The model³ developed by the two authors falls within the statistically tested models. This model is applied for enterprises that have between 10 and 500 employees. It is based on a sample of 95 small and medium-sized enterprises, half of which went bankrupt between 1970 and 1975. The analyzed enterprises were statistically grouped and a score function applicable for industrial enterprises, construction companies, wholesale companies and transport firms was determined.

The model is based on the following formula:

$$Z=16*x_1+22*x_2-87*x_3-10*x_4+24*x_5$$

x₁, x₂, x₃, x₄, x₅ are determined through⁴:

1. Immediate liquidity rate (x₁) = ration between current assets minus inventory and current debts

$$x_1 = \frac{CA - I}{CD}$$

³ Conan, Holder- *Variables explicatives de performances et controle de gestion dans les P.M.I.*, Universite Paris Dauphine, 1979

⁴ Achim Monica Violeta, *ECONOMIC FINANCIAL ANALYSIS*, RISOPRINT Publishing House, Cluj Napoca, 2009, pag.412

2. Rate of financial stability (x_2) = ration between equity capital and total liabilities

$$x_2 = \frac{EC}{TL}$$

3. The financing level of sales from external sources (x_3) = ration between financial expenses and net turnover

$$x_3 = \frac{FE}{NT}$$

4. Remuneration of personnel (x_4) = ration between personnel costs and value added.

$$x_4 = \frac{PC}{VA}$$

5. Rate of return on value added (x_5) = ration between the gross result of the enterprise and value added

$$x_5 = \frac{GRE}{VA}$$

The computation made with the help of the CONAN-Holder method for the financial statements of Saturn company is presented below:

CALCULATING INDICATORS

		Result of indicators/years				
		2006	2007	2008	2009	2010
x1 – Immediate liquidity rate	$\frac{\text{Current assets-Inventory}}{\text{Current debts}}$	1.99	2.01	2.32	4.55	4.02
x2 – Rate of financial stability	$\frac{\text{Equity capital (permanent)}}{\text{Total liabilities}}$	0.45	0.46	0.52	0.72	0.70
x3 – The financing level of sales from external sources	$\frac{\text{Financial expenses}}{\text{Net turnover}}$	0.04	0.04	0.05	0.05	0.04
x4 – Remuneration of personnel	$\frac{\text{Personnel costs}}{\text{Value added}}$	0.32	0.35	0.29	0.33	0.36
x5 – Rate of return on value added	$\frac{\text{Gross result of the year}}{\text{Value added}}$	0.03	0.01	0.07	0.07	0.02
Z=16*x1+22*x2-87*x3-10*x4+24*x6		36.27	35.4	43.04	83.21	73.24

In the case of this model, the bankruptcy risk depends on Z's level, as follows:

Score value	Ranking the companies
Z > 9	SOLVENT
Z [4,9)	FINANCIAL DIFFICULTIES
Z < 4	IMMINENT BANKRUPTCY

Score value	Bankruptcy probability
$Z < 0$	$> 80\%$
$0 < Z < 1,5$	75% - 80%
$1,5 < Z < 4$	70% - 75%
$4 < Z < 8,5$	50% - 70%
$Z=9,5$	35%
$Z=10$	30%
$Z=13$	25%
$Z=16$	15%
$Z>16$	$<10\%$

Source: M. Batrancea, 2003:118

Because the value of Z is higher than 9, the company is solvent, and when the value of Z exceeds 16, the probability of bankruptcy is below 10%.

The informational valences of the score method shouldn't be overestimated, because discriminative analysis reduces the basic information by selecting the most significant rates that it considers to be constant in time, and the enterprise is an economic and social system that acts in a complex environment, with many more variables that influence its health or weakness. This is why it is recommended to use the score method simultaneously with the classic methods of diagnosing – financial balance analysis, profitability analysis, financial flows analysis, etc., and, in the end, the assessment of the enterprise's global risk.

C) CEMATT model

In order to substantiate the options regarding the restructuring solutions and the strategic plans to guide an enterprise during the current transition period towards market economy, the CEMATT analysis model is **conceived** as a tool of multi-criterion diagnosing of the company's state (Hada 1997).

The model has a heuristic structure because it refers to a procedure of searching for an unknown target by using criteria that will allow achieving a complete picture of the enterprise's state. The model involves assessment procedures and successive aggregation procedures of assessments.

The assessment mechanism is:

- For criterion 'i' of D_j , a number of points N_{ij} , $i=1,n$ and $j=1,6$ is established with the condition that N_{ij} belongs to aggregate $N=\{20,40,60,80,100\}$

The minimum in the aggregate, meaning 20, is the score awarded for a criterion that represents a total or almost total situation of maladjustment to the requirements of the market economy; the maximum element of aggregate N, meaning 100, represents the situation when a requirement is met at a high (international) level.

- For each criterion 'i' of D_j , a level of importance is established, to which an importance coefficient K_{ij} corresponds as follows:

- $K_{ij}= 5$ for a very important criterion (the consequences of not meeting this criterion are extremely severe at the level of the whole enterprise);

- $K_{ij}= 2$ for a major criterion (the consequences of not meeting this criterion are severe, but only at the level of certain sections or departments);

- $K_{ij}= 1$ for a secondary criterion (the consequences of not meeting this criterion have isolated effects).

For each analyzed diagnostic direction D_j , the aggregated score is calculated with the formula:

$$ND_j = \frac{\sum k_{ij} \times N_{ij}}{\sum k_{ij}}$$

ND_j is a weighted average of the scores awarded for each criterion of the D_j diagnostic, having as weighted coefficients the importance coefficients of the criteria included in D_j .

Based on the six aggregated scores obtained for each of the diagnostic analysis direction, the global performance estimator (total score) is calculated as an weighted average of the aggregated scores having P_j of D_j as weight coefficients, adopted so that the following condition is satisfied:

$$\sum P_j = 1$$

In order to compute the total number of points for the six diagnostic directions, the following formula is used:

$$S = \sum N_{dj} * P_j$$

The percentage share of the N_{ij} score awarded to criterion 'i' within the value that results for ND_j varies according to the importance criterion 'i' within the direction of analysis 'j' and is calculated as follows:

$$P_{nij} = 100 / \sum K_{ij} * K_{ij}$$

In order to establish the global diagnosis in accordance with the obtained scores, the rating is established according to the classification's summary.

Table 3. Summary of classification

Score	Rating	Recommended strategy for industrial restructuring
[0,20]	Masked bankruptcy	Finding some profit centres and starting a separating procedure between the trading companies
[21,40]	Critical situation	- Radical restructuring. Measures for overcoming the state of alarm. - Important restructuring. - Important changes in profiles/markets - Capital infusion.
[41,60]	Difficult balance	- Important restructuring. New short/average-term objectives - Commercial marketing actions - Management perfecting and a strict savings system - Capital inflow
[61,80]	Satisfactory adaptation	- Choosing strategic objectives - Freezing unprofitable deals - Capital inflow
[81,100]	Viability in competitive environments	- Adopting a new offensive firm strategy - Major restructuring is not necessary

The economic and financial diagnosing of the enterprise, as scope and depth, is organically conditioned by the indicators system and their informational capacity. 11 criteria are used for a period of five consecutive years in order to establish a financial diagnostic for Saturn Alba Iulia company, as follows:

Calculating Indicators

1. Economic profitability		YEARS				
		2006	2007	2008	2009	2010
$\frac{\text{Operating profit}}{\text{Total assets}}$	*100 =	4.80	1.89	12.15	11.98	2.09

2. Financial profitability								
	$\frac{\text{Net profit}}{\text{Equity capital}}$	*100	=	2.44	0.64	15.47	13.28	1.63
3. Productivity of capital								
	$\frac{\text{Turnover}}{\text{Net frozen assets}}$		=	8.61	7.86	8.95	6.30	5.64
4. The evolution of net borrowing								
	$\frac{\text{Total short-term debts}}{\text{Values achieved on short term}}$		=	0.82	0.87	0.85	0.46	0.56
5. Remuneration of the working factors								
	$\frac{\text{Total expenditure on wages}}{\text{Turnover}}$		=	0.21	0.23	0.19	0.23	0.24
6. Rates of financial autonomy								
	$\frac{\text{Equity capital}}{(\text{Equity capital} + \text{Long-term bank loans})}$		=	0.84	0.81	0.92	0.89	0.90
7. Liquid assets								
	$\frac{\text{Net current assets} + \text{prepayments}}{\text{Short-term debts}}$		=	1.62	1.57	1.79	3.23	2.95
8. Sales to current assets ratio								
	$\frac{\text{Current assets} + \text{prepayments}}{\text{Turnover}}$	*360	=	179.02	166.63	136.28	139.07	176.08
9. Low liquidity								
	$\frac{\text{Current assets} - \text{Inventory} + \text{prepayments}}{\text{Short-term debts}}$		=	1.22	1.14	1.17	2.17	1.80
10. Asset solvency								
	$\frac{\text{Equity}}{\text{Total liabilities}}$	*100	=	46.77	46.09	51.20	69.25	67.64
11. Immediate liquidity								
	$\frac{\text{Treasury}}{\text{Short-term debts}}$		=	0.09	0.03	0.01	0.34	0.01

Table 4. Indicators

No.crt	Indicators	U.M.	2006	2007	2008	2009	2010
1	Economic profitability	%	4.80	1.89	12.15	11.98	2.09
2	Financial profitability	%	2.44	0.64	15.47	13.28	1.63
3	Invested capital productivity	coef.	8.61	7.86	8.95	6.30	5.64
4	Net debt evolution	%	0.82	0.87	0.85	0.46	0.56
5	Remuneration of the working factor	coef.	0.21	0.23	0.19	0.23	0.24
6	Financial autonomy rate	coef.	0.84	0.81	0.92	0.89	0.90
7	Asset liquidity	coef.	1.62	1.57	1.79	3.23	2.95
8	Sales to current assets ratio	days	179.02	166.63	136.28	139.07	176.08

9	Low liquidity	coef.	1.22	1.14	1.17	2.17	1.80
10	Asset solvency	%	46.77	46.09	51.20	69.25	67.64
11	Immediate liquidity	coef.	0.09	0.03	0.01	0.34	0.01

The score for the variation of criteria is presented in the following Table, which shows the score for each criterion (20, 40, 60, 80, 100) depending on the established limits for the criterion's value.

Criterion	Score				
	20	40	60	80	100
ROA (to drop below 0.10)	<4	(4,10]	(10,15]	(15,20]	>20
ROE (not to drop below 0.5)	<2	(2,5]	(5,10]	(10,15]	>15
Invested capital productivity (not to drop below 2)	<2	(2,3]	(3,4]	(4,5]	>5
Net debt evolution (not to exceed 0.80)	>0,80	(0,60-0,80]	(0,40-0,60]	(0,20-0,40]	<0,20
Remuneration of the working factor (not to exceed 0.35)	>0,35	(0,30-0,35]	(0,25-0,30]	(0,20-0,25]	<0,20
Financial autonomy rate (not to drop below 0.50)	<0,50	(0,50-0,60]	(0,60-0,70]	(0,70-0,80]	>0,80
Asset liquidity (not to drop under 1.30)	<1,30	(1,30-1,40]	(1,40-1,50]	(1,50-1,60]	>1,60
Sales to current assets ratio	>120	(90-120]	(60-90]	(30-60]	<30
Low liquidity (not to exceed 1)	<1	(1-1,20]	(1,2-1,40]	(1,40-1,60]	>1,60
Asset solvency	<25	(25-50]	(50,75]	(75-100]	>100
Immediate liquidity	<0,25	(0,25-0,50]	(0,50-0,75]	(0,75-1,00]	>1

The score method is applied when establishing the economic and financial diagnostic and the score is obtained for 5 years, namely 2006-2010, as seen in the Table below:

Aggregated Score

No. crt	Coefficient of importance	2006		2007		2008		2009		2010	
		Calculated value	Score	Calculated value	Score	Calculated value	Score	Calculated value	Score	Calculated value	Score
1	2	4.80	40	1.89	20	12.15	60	11.98	60	2.09	20
2	5	2.44	40	0.64	20	15.47	100	13.28	80	1.63	20
3	1	8.61	100	7.86	100	8.95	100	6.30	100	5.64	100
4	5	0.82	20	0.87	20	0.85	20	0.46	60	0.56	60
5	2	0.21	80	0.23	80	0.19	100	0.23	80	0.24	80
6	1	0.84	100	0.81	100	0.92	100	0.89	100	0.90	100
7	1	1.62	100	1.57	80	1.79	100	3.23	100	2.95	100
8	1	179.02	20	166.63	20	136.28	20	139.07	20	176.08	20
9	5	1.22	60	1.14	40	1.17	40	2.17	100	1.80	100
10	1	46.77	40	46.09	40	51.20	60	69.25	60	67.64	60
11	5	0.09	20	0.03	20	0.01	20	0.34	40	0.01	20

$$\text{for 2006} = \frac{2*4,80 + 5*2,44 + 1*8,61 + 5*0,82 + 2*0,21 + 1*1,00 + 1*1,62 + 1*179,02 + 5*1,22 + 1*46,77 + 5*0,09}{2+5+1+5+2+1+1+1+5+1+5} =$$

$$= 44.83\%$$

Aggregated score	2006	2007	2008	2009	2010
	44.83	35.86	55.17	71.03	54.48

The total score on each year was positively influenced by the financial autonomy rate and the return on equity rate for which there were maximum scores during all the analyzed years.

The positive influence was also recorded for the asset liquidity indicator for which the computed score was 100 points in the years 2006, 2008, 2009 and 2010, with the exception of 2007 when the score was 80. Thus, the current obligations of the company are fully covered by the working capital.

4. Conclusions

For the year 2010, the company recorded low scores of 20 points for indicators 1, 2, 8, 11 due to the lack of orders.

It should be noted that in 2009 there were lower scores for the Sales to current assets ratio (20 points) and for immediate liquidity (40 points). For the rest of the indicators, the computed scores were 60 points.

The score on each year shows that the activity got better year after year, with the exception of 2007 when from a score of 44.38 computed for 2006, it dropped to 35.86. In 2010, the score was 54.48, which shows a state of 'difficult balance' according to the assessment Table. The year 2010 reflects the influence of the global economic crisis, which impacted the activity of Saturn Alba Iulia company by reducing orders for exported products.

The year 2008 and 2009 were very good in terms of the economic and financial results, the computed scores being 55.17 for 2008, and 71.03 for 2009.

Based on the presented case study, the CEMATT model is the method that meets the analysis necessities of the Romanian economy.

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FISCAL SUSTAINABILITY, PUBLIC DEBT, AND ECONOMIC GROWTH: THE CASE OF INDONESIA

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Abstract

This paper is designed to analyze the impact of public debt on economic growth in the case of Indonesia over the period of 1999-2009. First, we explore the literature of the debt dynamics as well as fiscal sustainability. Second, we develop a fiscal model of economic growth. Finally, we estimate it empirically. Based on the quarterly data analysis, we found that the domestic debt does not have any contribution on economic growth. Even the external public debt affects negatively on economic growth. We conclude that those findings are associated with the cost of debt services and the efficiency of debt usage. In order to maintain fiscal sustainability, it is therefore recommended that the country should rely on internal loans and borrow externally, when necessary only for real productive projects. In addition, the other domestic financial resources should be mobilized in order to get the cheaper debts.

Keywords: deficit, public debt, fiscal sustainability, economic growth

JEL Classification: E62, H62, H63, H68

1. Introduction

Fiscal sustainability has been a subject of intensive discussion among the macro economists in recent years both in developed and developing countries. The central issue of the theory and empirics of public finance is whether there is a tendency for the fiscal deficits to grow faster than the increase in public debt so that the debtor countries become insolvent. Or instead, are there tendencies for the debt services to get bigger, so that the primary balance surplus tends to tighten over time? And the most important question is whether the existing primary balance surplus can boost economic growth?

The recent sharp increase in fiscal deficits and public debt in many countries raises a number of important issues regarding their impact on long-term interest rates burden. The unsustainable state budget could influence the financial stability in several ways. When the deficit is financed by domestic resources, it could become financial repression and crowding out effect indicated by the low interest rates, saving decline, and unproductive investment (McKinnon 1973, Shaw 1973). Similarly, the foreign financed budget deficit is characterized by persistent exchange rate depreciation, balance of payment distress, and high inflation (Fry 1988).

The relationship between fiscal deficits, public debt, and economic growth is a complex one at least in theoretical strand. There is no general conclusion among Neoclassical, Keynesian, and Ricardian approach to budget deficit. The Neoclassical model argued that public debt to meet fiscal deficit might reduce national output (Bernheim 1989). Keynesian school of thought, on the contrary, suggested that public debt to meet fiscal deficit might stimulate national output (Wray 1989). Meanwhile, Ricardian paradigm considered that public debt to meet fiscal deficit might be neutral to national output (Barro 1974, 1989).

In developing countries, the external debt has steadily increased in recent decades, making the analysis of the role of external debt in financing the development process particularly important. Therefore, the question of adequate 'exit-strategies' represents probably one of the most important questions in public finance to be resolved in the coming years. Indonesia provides a unique opportunity to examine the nature of economic growth and debt. Given the significance of huge debt stock accumulated by the previous regimes, whether the state budget can finance all spending in the long term without losing budgetary functions to stimulate economic growth is a key political and economic issue.

The main objective of this paper is to reassess the effect of fiscal deficits and public debt on long-term economic growth in the case of Indonesia. The remainder of the paper is organized in six sections. Section II assesses the literature concerning possible responses of the economic growth to changes in the debt; Section III highlights the Indonesia's state budget; Section IV discusses the relation between fiscal sustainability, debt dynamic, and economic growth; and Section V proposes the analytical model for Indonesia followed by its empirical results. Section VI presents the empirical results. Finally, some concluding remarks and implications are drawn.

2. Literature Review

A key channel through which large fiscal deficits and debt could be expected to have an impact on long-term economic growth, in a broader sense, can be analyzed through three channels (Koeda 2006). The first channel is based on the aggregate production function connecting gross domestic product to debts, capital accumulation, and human resources. This proposition can be traced back to Harrod (1939) and Domar (1946) and Solow (1956) models. In their view, debt is considered as one of required inputs to produce national output. The impact of debt on economic growth could be inferred from marginal product of debt and substitutability, complementarily, or even independently among inputs.

The second one is based on the indirect impact on interest rates, national savings, and then aggregate demand. In the standard neoclassical model, fiscal deficits (other things given) create an excess supply of government debt, leading to higher real interest rates (Bernheim 1989). The yield curve is also expected to become positively sloped in anticipation of continuing large fiscal deficits. In the Keynesian view, however, this will increase the quality of private investment so that the interest rates should not lead to be higher and then economic growth remains increasing (Wray 1989). Ricardian paradigm, in other hand, proposed that the public debt is considered as deferred-tax. In the long-term, the impact of deficit on interest rates, national savings, and then aggregate demand will be unchanged (Barro 1974, 1989).

The third channel is based on the consequence of debt. It works through a liquidity constraint where debt service obligations reduce export earnings available for expenditures and so impacts negatively on growth. One of the theories connecting external debt and economic development is the debt overhang theory. Krugman (1989) sees debt overhang as a situation in which the expected repayment on foreign debt falls short of the contractual value of the debt and showed that there is a limit at which accumulated debt stimulates investment and growth. The same way, Borenszten (1990) argued that the debt overhang crisis is a situation in which the debtor country benefits very little from the returns on any additional investment because of the debt service obligation.

These three channels produce a debt-Laffer curve, which shows that there is a limit at which debt accumulation stimulates growth. When this limit is reached, further debt accumulation impacts negatively on growth. For internal debt, Lerner's model postulates that internal debt creates no burden for the future generation members as the future generation simply owes it to each other. When the debt is paid off, there is a transfer of income from one group of citizens to another. However, the future generation as a whole is not worse off in the sense that its consumption level is the same as it would have been. However, Reinhart and Rogoff (2010) noted that the relationship between government debt and real GDP growth is weak for debt/GDP ratios below a threshold of 90 percent of GDP.

Focusing on emerging countries, this is different for the external debt because if borrowed fund is used to finance current consumption, the future generation certainly bears a burden. This is because its consumption level is reduced by an amount equal to the loan plus the accrued interest that must be paid to the foreign lender. If, however, the loan is used to finance capital accumulation, the outcome depends on the projects' productivity. If the marginal return on the investment is greater than the marginal cost of funds obtained abroad, the combination of the debt and capital expenditure actually makes the future generation better off. If, however the projects return is less than the marginal cost, the future generation is worse off.

Capital flight, in the context of external indebtedness has three major consequences. In the first instance, any amount of money set away to foreign countries cannot contribute to domestic investment. In this way, capital flight is a diversion of domestic savings away from domestic real investment. In addition, income and wealth, which are held abroad, is outside the purview of domestic authorities and therefore cannot be taxed. This means that potential government revenue is reduced as well as the capacity of government to service its debts.

Furthermore, income distribution is negatively affected by capital flows. The poor citizens are subjected to austerity measures in order to pay for external debt obligations to external creditors who in turn pay interest to citizens from these countries with assets abroad. In line with these, Were (2001) finds that Kenya has a debt overhang problem and that the country's external debt has a negative impact on economic growth and private investment. Similarly, Iyoha (1999) found that mounting external debt depresses investment through both a 'disincentive' effect and a 'crowding out' effect.

Most of the researches conducted in Indonesia have been devoted to assess the economic impacts of external debt (see for examples: Santoso, 1992; Kuncoro, 1999; and Saleh, 2002). They found that external debt has marginal impact on economic growth regarding the inadequate domestic revenues generated by the debt. PPE UGM and BAF (2004) and Kuncoro (2011) conclude that Indonesia's foreign debt has been large because the borrowing costs are cheaper than the cost of domestic debt. However, the state budget has been relatively safe to be default.

Soelistijaningsih (2002) obtains that the external debt burden could be reduced by diversifying the currency. This result is supported by the findings of Mark (2004). The state budget sustainability can only be maintained if there is no heavy depreciation. Ulfa and Zulfadin (2004) obtain ambiguous results. Some fiscal policies (i.e. budget reforms) reduced the sovereign debt. On the other hand, some fiscal policies (i.e. blanket guarantee) enlarged the contingent liabilities.

This paper complements and extends the existing literature by exploring in particular the effects of large fiscal deterioration and initial fiscal conditions, the impact of countries' institutional set up, and the likely spillovers from global financial markets. Although there is a significant existing literature exploring the relationship between deficits, public debt, and economic growth, there is a diversity of findings, and several of the specific issues explored in this paper have not been examined before. First, it explores both domestic and foreign debts. Second, it also analyses economic growth based on fiscal sustainability point of view instead of aggregate production function.

3. Indonesia's State Budget: Overview

Since the Old Order regime, Indonesia has used foreign borrowing to finance development. The foreign debt was utilized during the first period of 1966 to reconstruct economy after political turbulence. After that, the New Order regime had a permanent donor countries grouped in the IGGI (Intergovernmental Group on Indonesia). Every year, the IGGI provided fund (from ADB, World Bank, IMF, UNDP, and some major developed countries) to finance development expenditures designed in the state budget.

During oil boom in 1970s the foreign debt increased unevenly to foster economic growth. The higher oil price the higher debt taken. As one of the oil exporting countries (at that time), Indonesia had a windfall profit as 'collateral' to easily obtain new soft loan from the creditor countries (Kuncoro, 1997). The high foreign debt and the oil revenue, in fact, had been successfully promoting economic growth. In that period, the economic growth rate booked the highest record, on the average 20 percent a year.

Surprisingly, declining oil prices in the first half of the 1980s resulted in the rapid accumulation of debt. World economic recession and trade protection imposed by most countries were the main causes. Percentage of total external debt on GDP increased from 26.8 percent in 1980 to 53.6 percent in 1986. In that period, Indonesia's government, in one hand, introduced a new tax system to boost domestic revenues. On the other hand, Indonesia's government reduced substantial central expenditures and re-switched numerous development programs (Wuryanto 1996).

Furthermore, in the late 1980s and mid 1990s, during Indonesia's economic boom, the long-term foreign debt was incurred by the especially state-owned and private enterprises. The government debt increased due to PERTAMINA (oil and gas state-owned company) was largely expanded. BULOG (Logistic Agency) took foreign debt to realize food self-resilience. As a result, the debt service ratio in the 1980s, especially in 1988 and 1989, rose to an average 40 percent. In 1992, the IGGI was removed to be the CGI (Consultative Group on Indonesia).

When the Asian financial crisis, in the mid 1997, the external debt increased significantly from more than USD 136 billion in 1997 to more than USD 151 billion in 1998, mainly due to the depreciation of Rupiah. Since that, Indonesia has experienced the decrease in government revenue and the increase in government spending to undertake the socio-economic impacts. As a result, the Indonesian government collapsed under heavy debt burden to cover deficit the state budget. The government debt increased to three to four-fold and almost three-quarters of those is domestic debt for bank restructuring (Boediono 2009).

In the reformation era, government and parliament made a political decision that the most deficits should be financed by domestic financial resources. Accordingly, the CGI was disbanded in 2007. As a result, the amount domestic debt stock has been ten times (100 trillion in 1998 to 1.000 trillion Rupiah in 2009). Only in one decade, the domestic debt has been higher than the foreign debt (Figure 1). Consequently, the public debt services have been sky rocketing (Figure 2). The domestic debt service payment was two-fold than that of foreign debt.

Most government external debts were due in early 2000s. As a result, the interest rate and amortization payments were about 40 percent of the total outlay. The other important expenditures were subsidies for fertilizer and energy (20 percent) and transfer to lower-layer government (26 percent). Those outlays composition above, of course, severely limited to the fiscal space. The state budget problems then shifted from the stimulus to fiscal sustainability (Rahmany 2004). Conceptually, the state budget is said to be sustainable if it has the ability to finance all spending in the long term without endangering budgetary functions (Langenus 2006, Yeyati, and Sturzenegger 2007).

The issue of the sustainability is an integral part of the discussion of the government's long-term ability to repay debt (Brix, and Mody 2002). To maintain the fiscal solvency, the surplus of the state budget

is a must (Chalk, and Hemming 2000). Even though the debt ratio has been decreasing, the new financing from both foreign and domestic financial resources are still required in forthcoming years to meet the expenditure needs. The main problem of the Indonesian budget sustainability is the existing large deficit. The Law No. 17/2003 Article 12 states that deficit and the total debt is no more than 3 and 60 percent respectively. The question is then how to keep the budget deficit at a safe level so that the deficit can be financed. In this case, is there any systematic explanation of variations in economic growth over time in Indonesia? The next sections will examine the influence of fiscal variables on economic growth in Indonesia over the period of 1999-2009.

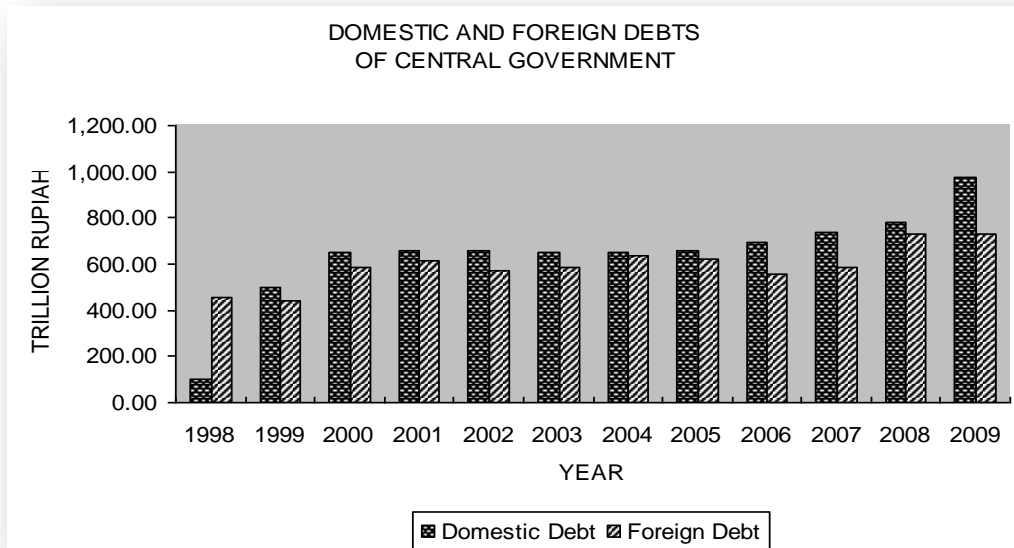


Figure 1. Central Government Public Debt

Source: Debt Management Office, Ministry of Finance

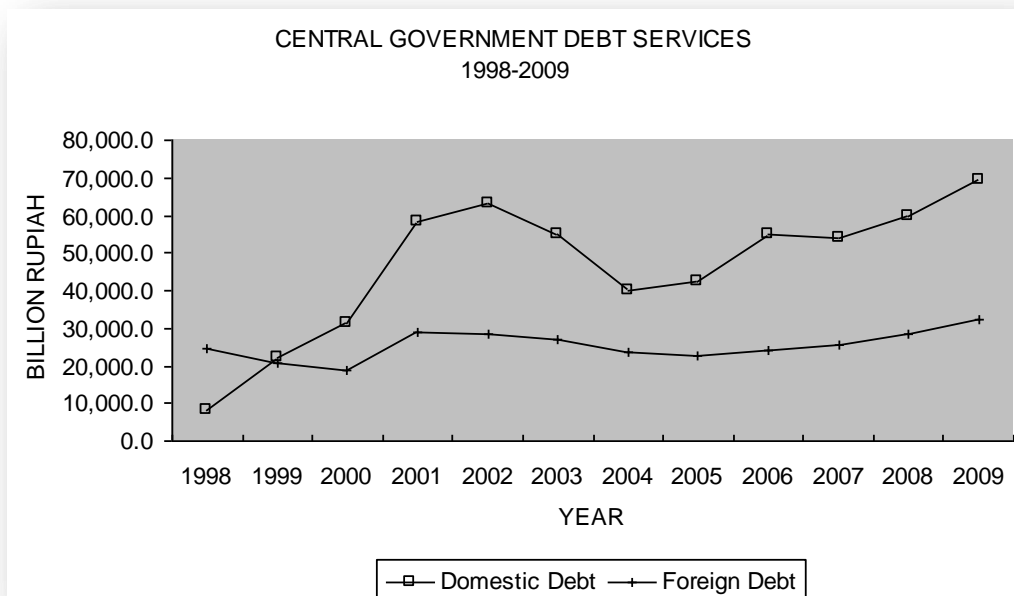


Figure 2. Central Government Debt Services

Source. Financial Notes and Budget State, Ministry of Finance Republic of Indonesia

4. Debt Dynamics

Theoretically, the amount of debt accumulation of a country in particular time can be traced back to the debt dynamics. The debt dynamics solely also explain the fiscal sustainability. In public finance literature, there are three approaches dealing with fiscal sustainability. The first is an accounting approach which is based on the rules that connect the options of financing government spending (G). If the domestic revenue, R , is not sufficient to cover G , the available financing option is debt (D) and money printing (seigniorage, S).

$$(R_t - G_t) = D_t + S_t \quad (1)$$

The debt accumulation in the next period ($t + 1$) will be D itself plus the interest rate (r):

$$D_{t+1} = (1 + r) D_t + (R_t - G_t) + S_t \quad (2)$$

The term of $(R - G)$ is the primary balance (PB), total government expenditures excluding the interest rate payments. It can be rewritten as

$$D_{t+1} - D_t \equiv \Delta D_t = r D_{t-1} - PB_t + S_t \quad (3)$$

According to this approach, the state budget sustainability can be achieved if there is no debt. Even if the government takes debt, the fiscal sustainability can be maintained as far as the additional debt must be proportional to the PB surplus (Dihn, 1999).

Equation (3) if disclosed further in the relative form to national income (Y) will be

$$\Delta [D / Y]_t = r [D / Y]_{t-1} - [PB / Y]_t + S_t \quad (4a)$$

$$\Delta RD_t = r RD_{t-1} - RPB_t + S_t \quad (4b)$$

In this context, the fiscal sustainability holds if the current primary balance position increases greater than the increase in the debt ratio (Ouanes and Thakur, 1997).

The second approach to the fiscal sustainability is solvency. Based on (4), dividing to Y requires that the rate of growth of Y should be taken into account. If the income increases constantly (suppose at g percent overtime), the additional debt will be

$$\Delta RD_t = \frac{r - g}{1 + g} RD_{t-1} - RPB_t + S_t \quad (5)$$

When there is no new additional debt ($\Delta RD_t = 0$), then

$$RPB_t = \frac{r - g}{1 + g} RD_{t-1} + S_t \quad (6)$$

In this case, the budget surplus is required to attain fiscal solvency if the real rate of interest exceeds the output growth, i.e., $(r-g) > 0$. The public sector has to make debt service payment at least equal to PB , or equivalently, it should have a primary surplus equal to PB . A primary fiscal surplus less than that amount (or a primary fiscal deficit) in that case implies perpetual public sector borrowing and debt accumulated indefinitely. For a country whose rate of output growth exceeds the real rate of interest, $(r-g) < 0$, incurring a primary deficit is till consistent with solvency. However, a deficit higher than PB implies that the country is moving away from a fiscal solvency position.

The last one is present value approach. Based on (2), one can impose discount factor to re-examine the fiscal sustainability:

$$D_t = \sum \frac{1}{(1+r)^{1+k}} \{ D_{t+1+k} - PB_{t+k} + S_{t+k} \} \quad (7)$$

The limit value for an infinite time of the first term in equation (7) will be asymptotically equal to zero. The equation remains

$$D_t = \sum \frac{1}{(1+r)^{1+k}} \{ -PB_{t+k} + S_{t+k} \} \quad (8)$$

Equation (8) states that the amount of government debt at a given time must equal the present value of the primary balance deficit in the future (Cuddington 1996). This means that the debt growth should be lower than the interest growth rate in order to be sustainable (Buiter 2002).

5. The Proposed Model for Indonesia

Both the theoretical consideration and empirical evidence above provide the same basic idea that fiscal sustainability requires controlling interest rate, fiscal deficit, depreciation, primary balance surplus, and the change in current debt level. Unfortunately, there is no study in Indonesia so far that integrates all of the economic factors. This study closes the fiscal policy empirical gap in Indonesia by synthesizing them.

Abstracting from monetary financing that is by the law forbidden in Indonesia the general government budget deficit is the sum of the primary deficit and of debt service. To finance the deficit the government must borrow and issue new debt ΔD :

$$\Delta D_t = G_t - T_t + r D_t \quad (9)$$

Dividing both sides of (9) by nominal GDP Y :

$$\Delta (D/Y)_t = (G/Y)_t - (T/Y)_t + r (D/Y)_t \quad (10)$$

Taking into account that $\Delta Y/Y = g$ and inserting for $\Delta D/Y$ into (10) we obtain:

$$\Delta (D/Y)_t + g (D/Y)_t = (G_t - T_t)/Y_t + r (D/Y)_t \quad (11)$$

and rearranging:

$$\Delta (D/Y)_t = (G_t - T_t)/Y_t + r (D/Y)_t - g (D/Y)_t \quad (12)$$

The change in the debt-GDP ratio (left side) equals to the primary budget deficit-GDP ratio (the first item on the right side) and the debt service-GDP ratio (the second item) adjusted for GDP growth rate (the third item). Isolating the economic growth rate on the left side:

$$g (D/Y)_t = \Delta (D/Y)_t + (T_t - G_t)/Y_t - r (D/Y)_t \quad (13)$$

From (13) is evident that to stabilize the debt-GDP ratio, $\Delta(D/Y) = 0$, the primary balance surplus must be able to drive economic growth.

Last but not least, we can express the economic growth in nominal terms:

$$g (D/Y)_t = (T_t - G_t)/Y_t + r (D/Y)_t + \pi (D/Y)_t + \Delta (D/Y)_t \quad (14)$$

where π is the inflation rate. In short, the equation is

$$g = f (RPB , r , \pi , \Delta RD) \quad (15)$$

Inflation enters implicitly into equation (15) in two ways: through the nominal interest rate via the usual Fisher effect and through the growth rate of nominal GDP. Thus, inflation worsens the debt dynamics by necessitating higher nominal interest rates to provide investors a given real return, and improves it by raising the nominal growth rate.

Another important determinant of the debt dynamics that appears in equation (15) is the primary fiscal balance. In general, large primary deficits are part of the story behind the accumulation of public debts -- although even once primary adjustment has taken place these imbalances can take on a life of their own due to large outstanding debts and high interest rate spreads.

It is well known that the change in the debt level can be larger or smaller than the government deficit. This difference between the change in the outstanding debt stock and the yearly deficit flow is known as the stock-flow adjustment (SFA). The analysis of SFA has become more important as the budgetary surveillance may have provided incentives for shifting items from the deficit to the SFA (Izak 2008). A high negative SFA shows the tendency to improve temporarily the debt development in some years. Therefore, it is reasonable to incorporate them into the proposed model:

$$g = f(\text{RPB}, r, \pi, \Delta \text{RD}, \text{RDEF}, \text{Trend}) \quad (16)$$

Trend is incorporated into the model to capture some technological factors. Regarding to the types of debt, equation (16) is estimated for domestic debt, foreign debt, and total debt.

Unlike the previous studies in Indonesia (which generally used annual data), the model are estimated with quarterly data during the post-crisis period (1999 – 2009). The data for this study have already been available on a quarterly basis except the primary balance as well as deficits. The data is then interpolated linearly from annual basis to fit the other data on the model. In general, the data obtained from IMF, World Bank, Central Bank of Indonesia, Ministry of Finance (i.e. Debt Management Office), and Central Agency of Statistics.

Variables that will be used are specified as follows. Debt that is analyzed here is the central government debt only (excluding Central Bank of Indonesia, state-owned enterprises, local government-owned enterprises, or local government debts). The average interest cost of public debt is the ratio of general government interest expenditure to the stock of debt outstanding at the end of previous period. Foreign debt is denominated in US dollar and then transformed into Rupiah using official exchange rate. Depreciation is calculated as a percentage change of the Rupiah against the US Dollar. Similarly, economic growth is calculated as the percentage change in GDP at constant prices in 2000. Inflation rate is derived from the relative change in GDP deflator. The latest is also used to convert all variables into the real values.

6. Results and Discussion

Table 1 presents the basic statistics including mean, median, and extreme values. The mean and median values of nominal interest rate for total debt (IRTOT), primary balance ratio (RPB), overall deficit ratio (RDEF), and total debt ratio (RDTOT) are similar with each other. Those preliminary indicate the normal distribution. More precisely, the null hypotheses that those series data is normally distributed can be accepted in 95 percent confidence level using the JB (Jarque-Bera) test.

Table 1. Descriptive Statistics

	IRTOT	INF	EG	DEP	RPB	RDEF	RDTOT
Mean	13.6870	4.1795	1.0514	0.7252	1.7726	-1.3420	23.0818
Median	13.7024	2.6050	2.0500	1.0050	1.6607	-1.3141	22.5210
Maximum	25.0292	111.0000	16.2900	24.6800	4.6150	1.2482	38.7533
Minimum	5.3663	-13.3300	-38.9600	-22.5600	-0.0116	-4.6197	11.7140
Std. Dev.	3.6403	16.9809	7.4822	8.5993	1.0594	1.1633	8.6543
J-B test	2.6217	2405.8340	621.7590	2.3284	0.7036	2.0566	3.4430
Prob.	0.2696	0.0000	0.0000	0.3122	0.7034	0.3576	0.1788
Skewness	0.3325	5.7944	-3.2346	-0.0496	0.3088	-0.4384	0.3286
Kurtosis	3.9939	37.3216	20.2421	4.1226	2.9503	3.5942	1.7974
CV	26.60%	406.29%	711.67%	1185.74%	59.76%	-86.68%	37.49%

The inflation (INF) and economic growth rates (EG), on the other hand, are not performed the bell-shaped distribution. The lower tail of the economic growth rate distribution is thicker than the upper tail (indicated by the negative value of skewness) and the tails of the inflation rate distribution are thicker than the normal (indicated by the kurtosis coefficient greater than 3).

The Table also delivers standard deviation of all variables under study. Statistically, a set data is said to be volatile if its CV (coefficient of variation, e.g. ratio of standard deviation to mean) is more than 50 percent. Based on the empirical rule, inflation, depreciation (DEP), and economic growth rates are the most volatile indicated by the highest CV.

Does the high volatility of the data mean non stationary? Table 2 shows the results of Augmented Dickey-Fuller and Phillips-Perron unit root tests for the underlying data series in both levels and first differences. The tests are conducted for 4 lag length and constant without trend. The null hypothesis of existence of unit root cannot be rejected for each of the variables (except the three types of debt) in the level and thus it is concluded that the series are stationary even at the 99 percent level of significance. Regarding

the three types of debt, they become stationary after the first differencing i.e. all the three series are $I(1)$. The non-rejection of the null hypotheses of unit roots to the three types of debts may be the result of shifting deterministic trend.

Table 2. Unit Roots Tests

Variable to be Tested	ADF		PP	
	Level	First Difference	Level	First Difference
RDD	-2.16695	-5.98128	-1.93178	-3.16913
RDF	-1.01394	-9.30373	-1.54154	-9.56435
RDTOT	-1.68839	-3.83114	-0.42020	-6.61045
EG	-4.65644	-4.32276	-34.00936	-34.57056
DEP	-10.36004	-2.90595	-10.19797	-23.61606
IRD-INF	-18.18338	-9.23583	-14.43330	-54.98620
IRF-INF	-28.05540	-37.65963	-20.71344	-40.15417
IRTOT-INF	-22.67623	-26.61991	-16.78454	-52.62805
INF	-31.99690	-40.19705	-24.25182	-48.79097
RPB	-2.90723	-5.84746	-2.28904	-7.97459
RDEF	-3.89751	-4.63906	-2.68776	-4.71217

Stationary is required to perform co-integration (Engle and Granger 1987). Table 3 displays the results of Johansen’s co-integration rank test. Rank order for 5 variables in the economic growth for domestic debt model (excluding depreciation rate) has at least 3 co-integrated variables in 95 percent confidence level. The economic growth for foreign debt and for total debt models (including depreciation rate) has co-integrated for 4 variables rank. They imply that the all variables have a long-run relationship. As a consequence, they can be run to find out the parameter estimates using empirical data.

Table 3. Multiple Co-integration Tests

Domestic Debt		Foreign Debt		Total Debt	
Hypothesized No. of CE(s)	Trace Statistic	Hypothesized No. of CE(s)	Trace Statistic	Hypothesized No. of CE(s)	Trace Statistic
None **	112.6562	None **	174.2676	None **	173.7139
At most 1 **	72.6577	At most 1 **	122.3775	At most 1 **	112.3137
At most 2 **	42.4646	At most 2 **	76.2826	At most 2 **	65.5879
At most 3 *	18.1201	At most 3 **	45.7529	At most 3 **	36.6501
At most 4	1.2064	At most 4 *	17.0917	At most 4 *	17.5849
		At most 5	2.8776	At most 5	1.9486

*(**) denotes rejection of the hypothesis at the 5% (1%) level

The following section presents empirical results for a quarterly time series data for 1999 to 2009 to avoid uneven depreciation rates as in economic crisis in 1997. Table 4 highlights estimates of equation (16) for the three models specification, namely domestic debt, foreign debt, and total debt. Regression (16) is individually estimated with ordinary least squares (OLS) because there is no simultaneous relationship among variables in the model.

The values of R^2 (around 0.86) in the regression estimates indicate that our model adequately explain the influence of debt using the variables given above on growth in Indonesia. The value of Durbin-Watson

(DW) Statistic in the three regression results are 2.18, 2.09, and 2.04 which shows that the variables are not serially correlated. Most of the t-statistics confirm that the coefficients of our model are significant at 5 percent level of significance. The F-Statistics are [48.05, 39.60, and 40.87] thereby confirming that all the variables (debt and fiscal variables) in our model sufficiently explain the effect of debts on economic growth in Indonesia.

Table 4. OLS Estimates for Economic Growth (1999-2009)

Independent Variables	Domestic Debt		Foreign Debt		Total Debt	
	Coeff.	t-stat	Coeff.	t-stat	Coeff.	t-stat
C	10.8851	4.4545	5.3320	2.3760	9.8509	4.4964
DEP	-	-	0.2723	1.8197	0.0266	0.3067
IR-INF	0.4025	14.9641	0.4981	12.1670	0.4438	14.0165
RPB	-3.1771	-5.5664	-1.7784	-3.5726	-2.6696	-4.7807
RDEF	2.5922	4.7952	1.2636	2.4320	2.1364	4.0662
Δ (RD)	-0.4214	-0.7368	-2.2103	-2.5714	-0.7015	-1.6658
TREN	-0.2857	-5.0125	-0.1298	-2.6448	-0.2517	-4.9307
R-sq		0.8634		0.8653		0.8689
SEE		2.9414		2.9607		2.9205
F		48.0476		39.6036		40.8725
DW		2.1797		2.0877		2.0370
N		44		44		44

The diagnostic tests can be found on request

The estimation results show that the economic growth of domestic public debt is more efficient than foreign debt. This is indicated by constant term. On the average the economic growth due to domestic debt is about 10 percent compared to foreign debt (about 5 percent). Overall, the average of economic growth is about 9 percent. This finding is in line with the result of BAF and PPE UGM (2004) and Kuncoro (2011) studies. The higher efficiency of domestic debt is a source of explanation why the Indonesia's government domestic debt becomes massively accumulated in recent years.

The exchange rate depreciation makes the GDP growth slightly increase. Even though the impact of monetary crisis 1997 has been getting lower, the effect of depreciation rate is still quite material. The magnitude of its effect is about 26 percent decrease of economic growth for 100 percent depreciation. It is noTable that most of outstanding foreign debt is denominated in US dollar. This finding is supported to the studies of Soelistijningsih (2002) and Mark (2004) that currency diversification can help the government to decrease the sovereign debt burden in order to stimulate domestic economic activities.

The real interest rate (IR-INF) tends, as predicted, to induce the economic growth and the effect is statistically highly significant in the three model specifications. For example, increasing the interest rate by 1 basis point increases the real economic growth by about 0.4 (for domestic debt) to 0.5 (for foreign debt) percent. Further statistical test proves that those coefficients are even greater than unity: the change 1 basis point of real interest rates leads to higher increase in economic growth. They imply that, as stated previously, the fiscal sustainability has not achieved yet. One of the fiscal sustainability requirements is that the interest rate grows higher (or at least equals) than that of economic growth.

The other requirement to achieve fiscal sustainability is primary balance surplus availability. The ratio of primary balance surplus to GDP has a negative impact on economic growth for about 3.1 to 3.4 percent. This is the evidence that fiscal adjustment (reduce expenditures to depress deficit) subjected to provide sufficient primary balance surplus will associate with the low (even negative) economic growth. In line with that, budget deficit has also an adverse impact on economic growth (since the deficit ratio is measured by negative value). Those imply an existence of fiscal replacement from deficit to primary balance surplus.

Furthermore, both flow and stock variables have an impact: using the change in public debt as an explanatory variable suggests that an increase in the external debt ratio of 1 percentage of GDP significantly leads to a decrease in economic growth of around 2.21 percent. Unfortunately, the model specification of domestic debt and total debt present the insignificant influence. Compared to the coefficient of RDEF in the

second model, the initial level of fiscal deficit ratio also has a similar and statistically significant impact, although its size varies over time (1.26 percent). It seems that the Indonesia's government has been conducting prudent fiscal policy, i.e. the change in debt is proportional to meet the fiscal deficit in order to maintain reasonable external debt services.

The results above confirm the relevance of fiscal variables to economic growth. For all three specifications, a government running budget deficit faces significantly lower GDP growth. This is also confirmed by trend coefficients. For a government with a large debt, like Indonesia, this would provide an important additional reason for fiscal adjustment. When the primary balance is regarded as a target for fiscal adjustment to secure fiscal sustainability the government should run a sufficiently large primary surplus to ensure that it has a positive or zero net wealth. The differential interest rate-economic growth together with the debt-GDP ratio determines the primary surplus government needs to run to prevent a change in the ratio. As the economic growth greater than real interest rates, the Indonesia's government cannot run a primary deficit to avoid high inflation (and in turn depreciation) with putting upward pressure on the debt-GDP ratio. As a result, the government has a sustainability constraint.

7. Concluding Remarks

This paper focuses on periods of fiscal adjustments in the case of Indonesia. It shows that historically, governments have employed different fiscal adjustment strategies when confronted with high deficits and rising debt. Accordingly, these measures not only differ in duration, size, and composition, but also in their success. Controlling for various economic, fiscal, and political factors, we find that the size and the composition of a fiscal adjustment significantly affect real economic growth.

The other factors influencing the GDP growth in real terms and analyzed from quarterly data during 1999 to 2009 in this paper are primary balance, overall deficit, depreciation rate, and the change in debt level. The negative overall balance, cheaper cost of foreign debt, and higher efficiency usage of domestic debt have been contributing to the increase of huge debt. Meanwhile, the change in debt level has an adverse significant contribution to GDP growth. These results are significant and are robust to a variety of specifications and alternative models.

In the longer term, the central government should carefully manage her debts including re-profile, re-schedule, and re-structure them in order to spread the excess burden in the future to maintain sustainability as well as solvency. It is therefore, recommended that the country should as much as possible borrow internally whenever the need arises. If, however, there is any reason to borrow externally, such loans should be channeled to real productive projects that are capable of contributing positively instead of to consumables.

The evidence shows that large deficits and debt can have a marked adverse impact on implicit real economic growth, but that a variety of domestic and international factors are likely to determine the magnitude of this impact. They are quite vulnerable. However, they can systematically explain well the real economic growth rates. On the other hand, a budget consolidation that predominantly relied on tax increases, or on modest and gradual measures – even it was successful and led to lower deficits and debt levels – did not have an influence on GDP growth rates. Since financial markets participants cannot foresee whether the adjustment will be successful and carried out as announced, they will continue to demand higher yields unless the government sends a clear signal by cutting expenditure.

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HEDGE RATIO AND HEDGING EFFICIENCY: EVIDENCE FROM INDIAN DERIVATIVE MARKET

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Abstract

This paper examines the hedge ratio & hedging effectiveness of S&P CNX Nifty stock index futures, Gold futures and Crude Oil futures contract of Indian derivative market for the period September 2008 to September 2010 by using conventional OLS, VAR, VECM and VAR-MGARCH models. This paper also compares the performance of time varying hedge ratios with constant hedge ratios by considering alternative models for estimating a hedge ratio that minimizes the variance of returns and takes care of time-variance. The result suggests that VAR-MGARCH model estimates of time varying hedge ratio provide highest variance reduction as compared to other models. These findings are encouraging to risk managers dealing with Indian Derivative markets.

Keywords: hedging, hedging effectiveness, OLS, VAR, VECM, M-GARCH

JEL Classification: G13, G17, C5

1. Introduction

The volatile financial market has taken financial risk as centre point in every sphere of economic activity. Therefore, hedging of risk has become a very important concern in worldwide today. A hedge is effective if the price movements of the hedged item and the hedging derivative approximately counterbalance each other. A crucial input in the hedging of risk is the optimal hedge ratio. Numerous studies point out that the expected relationship between economic or financial variables may be better captured by a time varying parameter model rather than a fixed coefficient model. So the optimal hedge ratio can be a time varying rather than constant. The optimal hedge ratios estimated by means of the Generalized Autoregressive Conditional Heteroscedasticity (GARCH) models is time varying, because these models take into consideration the time-varying distribution of the cash and futures price changes. Finally, most recent papers use other more complicated methods i.e. vector auto regression (VAR), VECM or Bivariate Generalized Autoregressive Conditional Heteroscedasticity (BGARCH) models to estimate the hedging performance and hedging effectiveness by using time varying hedge ratios (Park, and Switzer 1995, Holmes 1995, Lypny, and Powella 1998, Kavussanos, and Nomikos 2000, Choudhry 2004, Floros, and Vougas 2006, Bhaduri, and Durai 2008). Since there is a mixed result noticed and disagreement as to different models whether hedging is effective for price discovery role, the question needs to be investigated empirically and policy makers in India may also like to know its impact so that future policy changes can be implemented.

2. Literature review

There is a significant amount of empirical research on the calculation of the optimal hedge ratio (*see*, for example, Cechetti *et al.* 1988, Myers, and Thompson 1989, Baillie, and Myers 1991, Kroner, and Sultan 1991, Lien, and Luo 1993, and Park, and Switzer 1995). Lim (1996), in a study of the Nikkei 225 futures contracts hedging performance provided evidence supporting the superiority of the ECM method. Rossi and Zucca (2002) provided support for the superiority of the GARCH hedge ratios over the OLS ones in their study. Bystrom (2003), however, in a study of the hedging effectiveness of the electricity futures contracts in Norway from January 1996 to October 1999, found that the OLS hedge ratio performed slightly better. Choudhary (2004) investigated the hedging effectiveness of Australian, Hong Kong, and Japanese stock futures markets and found that time-varying GARCH hedge ratio outperformed the constant hedge ratios in most of the cases, inside-the-sample as well as outside-the-sample. Floros and Vougas (2004) estimated hedge ratios, using data on the Greek stock and futures market – 1999 to 2001, based on the OLS, ECM, VECM and BGARCH models and found the ECM and VECM to be superior over the OLS model. Bhaduri and Durai (2008) found similar results while analyzing the effectiveness of hedge ratio through mean return and variance reduction between hedge and unhedged position for various horizon periods of NSE Stock Index Futures. Roy and Kumar (2007) studied hedging effectiveness of wheat futures in India using least square method and found that hedging effectiveness provided by futures markets was low. Olgun and Yetkiner (2009) compare the effectiveness of constant hedge ratio estimates (obtained through OLS and VECM methods) and time-varying hedge ratio estimates (obtained via M-GARCH method) for future

contracts of ISE-30 index of Turk DEX. The study concludes that time varying hedge ratios outperform the constant ratios for both in-sample and out-of-sample datasets and provide the minimum variance values.

Though global economy remains at substantial risk currently and there is a significant deterioration in the global economic outlook due to over economic slowdown in the US, Europe and Asia, but however India is not affected by the crisis and has maintained its high economic growth during the period. As a result, demand for investment funds is growing significantly. In an emerging market like India, the growth of capital and commodity future market is depending on effectiveness of derivatives in managing risk. Today India is one of the fastest growing emerging economies in the world. Against the backdrop of expansion activity in the Indian stock market, the importance of ensuring healthy and orderly conditions in the market becomes more urgent. To our knowledge there is no study which dealt with hedging issue in India recently. This motivates us for exploring research in Indian derivative Market. Therefore, this study has undertaken to determine the hedging ratio and hedging effectiveness of financial derivative and commodity derivative during world financial crisis periods to position country's exposure to the outer world which could be most readily felt. We have raised two research questions. First, the present study explores the effect of long-run relationship between the spot price and the futures price by using Johansen's (1991) co integration test. Secondly, we investigate and compare the effectiveness of constant hedge ratio through OLS, VAR and VECM models and time-varying hedge ratio through VAR-MGARCH model for estimating hedge ratio that minimizes the variance of returns and takes care of time-variance. Therefore, the present work offers a value addition to the existing literature and new insights to investors, traders, speculators, policy makers and the opinion makers for the efficient functioning of derivative markets.

The remaining of this paper is structured as follows: the next section describes the literature review Section three introduce the methodology and data used in the study. Section four presents the empirical results of the study. Concluding observation is presented in final section.

3. Time series data and methodology

The required time series data is based on spot and futures prices of S&P CNX Nifty Index Futures, Gold futures & Crude futures have been collected from www.nse.com & www.ncdex.com for a period of two years from September 2008 to September 2010. We have chosen the data period 2008 to 2010 because during this period Indian stock markets have exposed to weak and volatile trend in international equity markets, decline in commodity prices, open to credit market crisis in the United States and sharp fell in Asian market. These changes have affected the movement in index and magnitude of volume trades in the market in different ways. At this transitional stage, it is necessary to assess the level of efficiency of the Indian derivative market in order to establish its longer term role in world economy. S&P CNX Nifty is a well-diversified 50 stock index accounting for 23 sectors of the economy. It is used for a variety of purposes such as historical comparison of returns on money invested in the stock market against other forms of investment such as gold or debt. It is also taken to be an indicator of the performance of the overall economy or a particular sector of the economy. The other two contracts are commodity futures traded on the Multi Commodity Exchange of India Ltd, i.e. Gold futures & Crude futures. Three future contracts trading during this time horizon have been analyzed & compared. Similarly one Gold futures contract for the period February 2009 to October 2010 & one Crude futures contract for the period May 2009 to September 2010 have been considered for the study.

Daily returns for S&P CNX Nifty (spot and future) are calculated by the following equations:

$$R_{s,t} = \left(\ln \frac{S_t}{S_{t-1}} \right)$$

$$R_{f,t} = \left(\ln \frac{F_t}{F_{t-1}} \right)$$

Where R_s and R_f represent daily spot and futures returns respectively. Closing values of S&P CNX Nifty index are shown by S_t for spot, and F_t for future, on the corresponding day t .

The impact of commodity price, stock market volatility has to be examined by using a suitable and appropriate model. It is well-accepted fact that many financial time series contain a unit root, i.e. the series are non-stationary and it is generally acknowledged that stock index series might not be exception. Therefore, prior to modeling any relationship, non-stationarity must be tested. Stationarity means that the

mean and variance of the series are constant through time and the auto covariance of the series is not time varying. Therefore, the first step is to test the order of integration (I) of the variables. Integration means that past shocks remaining undiluted affects the realizations of the series forever and a series has theoretically infinite variance and a time-dependent mean. To test the stationarity, Dickey and Fuller (ADF, 1979, 1981), and Kwiatkowski, Phillips, Schmidt and Shin (KPSS, 1992) model is used. If all of the series are non-stationary in levels, it should be stationary in first difference with the same level of lags. For appropriate lag lengths, we use the Akaike Information Criterion (AIC) and Schwartz Bayesian Criterion (SBC).

Hedge Ratio and Hedging Effectiveness:

Several models have been used to estimate hedge ratio and hedging effectiveness such as conventional OLS model, Vector Autoregressive regression (VAR) model, Vector Error Correction model (VECM), Vector Autoregressive Model with Bivariate Generalized Autoregressive Conditional Heteroscedasticity model (VAR-MGARCH). The OLS, VAR and VECM models estimate constant hedge ratio whereas time varying optimal hedge ratios are calculated using VAR-MGARCH.

The basic idea of hedging through futures market is to compensate loss/ profit in futures market by profit/loss in spot markets. The optimal hedge ratio is defined as the ratio of the size of position taken in the futures market to the size of the cash position which minimizes the total risk of portfolio.

The return on an unhedged and a hedged portfolio can be written as:

$$R_U = S_{t+1} - S_t \tag{1}$$

$$R_H = (S_{t+1} - S_t) - H(F_{t+1} - F_t) \tag{2}$$

Variances of an unhedged and a hedged portfolio are:

$$Var(U) = \sigma_s^2 \tag{3}$$

$$Var(H) = \sigma_s^2 + H^2\sigma_F^2 - 2H\sigma_{S,F} \tag{4}$$

Where S_t & F_t are natural logarithm of spot & future prices, H is the hedge ratio, R_H & R_U are return from unhedged & hedged portfolio, σ_s & σ_F are standard deviation of the spot & futures returns & $\sigma_{S,F}$ is the covariance. In principle, a hedge is highly effective if the changes in fair value or cash flow of the hedged item and the hedging derivative offset each other. It is defined as the ratio of the variance of the unhedged portfolio over the variance of the hedged portfolio

$$HedgingEffectiveness(E) = \frac{Var(U) - Var(H)}{Var(U)} \tag{5}$$

Conventional Regression Model (OLS Model)

The OLS regression model essentially relates the returns on spot price (dependent) with the return on future prices (independent) as the interaction between spot and future prices is perceived the key principle of hedging. This model is just a linear regression of change in spot prices on changes in futures prices. The Minimum-Variance Hedge Ratio is calculated as the slope coefficient of the OLS regression. It is the ratio of covariance of (spot prices, futures prices) and variance of (futures prices). The R-square of this model indicates the hedging effectiveness. The OLS equation is given as:

$$\Delta R_{S,t} = \alpha + H\Delta R_{F,t} + \varepsilon_t \tag{6}$$

Where, $\Delta R_{S,t}$ and $\Delta R_{F,t}$ are spot and futures price change and the slope coefficient H is the optimal hedge ratio and ε_t is the error term in the OLS equation. The advantage of this model is the ease of implementation. However, for calculating hedge ratios, this method does not take account of conditioning information and ignores the time varying nature of hedge ratios. It also does not consider the futures returns as endogenous variable and ignores the covariance between error of spot and futures returns.

Vector auto regression (VAR)

The vector auto regression (VAR) is commonly used for forecasting systems of interrelated time series and for analyzing the dynamic impact of random disturbances on the system of variables. The VAR approach sidesteps the need for structural modelling by treating every endogenous variable in the system as a function of the lagged values of all of the endogenous variables in the system. The bivariate VAR Model is preferred over the simple OLS estimation because it eliminates problems of autocorrelation between errors and treats futures prices as endogenous variable. The VAR model is represented as

$$R_{st} = \alpha_s + \sum_{i=1}^k \beta_{si} R_{st-i} + \sum_{j=1}^l \gamma_{Fj} R_{Ft-j} + \varepsilon_{St} \tag{7}$$

$$R_{Ft} = \alpha_F + \sum_{i=1}^k \beta_{Fi} R_{Ft-i} + \sum_{j=1}^l \gamma_{sj} R_{st-j} + \varepsilon_{Ft} \tag{8}$$

The error terms in the equations, ε_{St} , and ε_{Ft} are independently identically distributed (IID) random vector. The minimum variance hedge ratio are calculated as

$$H = \frac{\sigma_{SF}}{\sigma_F^2} \tag{9}$$

Where $Var(\varepsilon_{st}) = \sigma_s$, $Var(\varepsilon_{ft}) = \sigma_f$ (9.1)

$Cov(\varepsilon_{st}, \varepsilon_{ft}) = \sigma_{SF}$ (9.2)

The VAR model does not consider the conditional distribution of spot and futures prices and calculates constant hedge ratio. It does not consider the possibility of long term integration between spot and futures returns.

Vector Error Correction Model (VECM)

If two prices are co-integrated in long run then Vector Error Correction Model (VECM) is more appropriate which accounts for long-run co-integration between spot and futures prices (Lien & Luo, 1994; Lien, 1996). It can eliminate serial correlation in residuals and helps to capture both short-run and long-run interactions between spot and future returns. If the futures and spot series are co-integrated of the order one, then the Vector error correction model of the series is given as:

$$R_{s,t} = \alpha_s + \sum_{i=1}^k \beta_{si} R_{s,t-i} + \sum_{i=1}^k \gamma_{s,i} R_{f,t-i} + \eta_s E\alpha_{t-1} + \varepsilon_{st} \tag{10}$$

$$R_{f,t} = \alpha_f + \sum_{i=1}^k \beta_{fi} R_{s,t-i} + \sum_{i=1}^k \gamma_{f,i} R_{f,t-i} + \eta_f E\alpha_{t-1} + \varepsilon_{ft} \tag{11}$$

$$E\alpha_{t-1} = S_{t-1} - (a + bF_{t-1}) \tag{12}$$

Where β_{si} , β_{fi} , γ_{fi} , η_{fi} are VECM parameters and α_s and α_f indicate constant terms in the equation. $E\alpha_{t-1}$ represents lag-one error correction term .the optimal hedge ration H is derived from the VECM as follows

$$H = \frac{Cov(\varepsilon_{st}, \varepsilon_{ft})}{Var(\varepsilon_{ft})} \tag{13}$$

Where ε_{st} and ε_{ft} are white noises from the VECM equation.

VAR-MGARCH Model

The time series data of return of spot and future possesses time varying heteroscedastic volatility structure or Auto Regressive Conditional Heteroscedasticity (ARCH)-effect. Due to ARCH effect in the returns of spot and futures prices and their time varying joint distribution, the estimation of hedge ratio and hedging effectiveness may turn out to be inappropriate. The MGARCH model considers the ARCH effect of the time series and calculate time varying hedge ratio. A bivariate GARCH (1, 1) model is given by:

$$R_{st} = \alpha_s + \sum_{i=1}^k \beta_{si} R_{st-i} + \sum_{j=1}^l \gamma_{Fj} R_{Ft-j} + \varepsilon_{st} \tag{14}$$

$$R_{Ft} = \alpha_F + \sum_{i=1}^k \beta_{Fi} R_{Ft-i} + \sum_{j=1}^l \gamma_{sj} R_{st-j} + \varepsilon_{Ft} \tag{15}$$

$$\begin{bmatrix} h_{ss} \\ h_{sf} \\ h_{ff} \end{bmatrix} = \begin{bmatrix} C_{ss} \\ C_{sf} \\ c_{ff} \end{bmatrix} + \begin{bmatrix} \alpha_{11} & \alpha_{12} & \alpha_{13} \\ \alpha_{21} & \alpha_{22} & \alpha_{23} \\ \alpha_{31} & \alpha_{32} & \alpha_{33} \end{bmatrix} \begin{bmatrix} \varepsilon_s^2 \\ \varepsilon_s \varepsilon_f \\ \varepsilon_f^2 \end{bmatrix}_{t-1} + \begin{bmatrix} \beta_{11} & \beta_{12} & \beta_{13} \\ \beta_{21} & \beta_{22} & \beta_{23} \\ \beta_{31} & \beta_{32} & \beta_{33} \end{bmatrix} \begin{bmatrix} h_{ss} \\ h_{sf} \\ h_{ff} \end{bmatrix}_{t-1} \tag{16}$$

Where, h_{ss} and h_{ff} are the conditional variance of the errors ε_{ss} and ε_{ff} and h_{sf} is the covariance. The model considers only diagonal elements of α & β matrix and the correlations between conditional variances are assumed to be constant. The diagonal representation of the conditional variances elements h_{ss} and h_{ff} and the covariance element h_{sf} is presented as

$$h_{ss,t} = C_{ss} + \alpha_{ss} \varepsilon_{s,t-1}^2 + \beta_{ss} h_{ss,t-1} \tag{16.1}$$

$$h_{sf,t} = C_{sf} + \alpha_{sf} \varepsilon_{s,t-1} \varepsilon_{f,t-1} + \beta_{sf} h_{sf,t-1} \tag{16.2}$$

$$h_{ff,t} = C_{ff} + \alpha_{ff} \varepsilon_{f,t-1}^2 + \beta_{ff} h_{ff,t-1} \tag{16.3}$$

Using the above equations, time varying hedge ratio is calculated as follows:

$$H = \frac{h_{sft}}{h_{fft}} \tag{17}$$

4. Empirical results and analysis

Diagnostic Tests:

Table 1. Descriptive Statistics

	Spot Returns	Futures Returns
Mean	0.002075	0.002024
Median	0.002104	0.002273
Maximum	0.033978	0.036208
Minimum	-0.060216	-0.061862
Std. Dev.	0.017660	0.018319
Skewness	-0.744610	-0.715347
Kurtosis	4.568077	4.461760
Jarque-Bera	12.27619	10.98201
Probability	0.002159	0.004124

Table 1 depicts various summary statistics related to univariate spot and future daily return Series. All returns are calculated as the first difference of the log of the daily closing price. The result shows that daily spot and future return have positive kurtosis and high Jarque – Bera statistics which implies that the distribution is skewed to the right and they are leptokurtic (heavily tailed and sharp peaked), i.e., the frequency distribution assigns a higher probability to returns around zero as well as very high positive and negative returns. The Jarque – Bera statistic test indicates that the null hypothesis of normality is rejected and shows that all the series exhibit non-normality and indicates the presence of Heteroscedasticity. Hence, VAR-MGARCH model is the suitable for testing of hypothesis.

Time series of spot and futures prices of these assets are given in Figure 1.

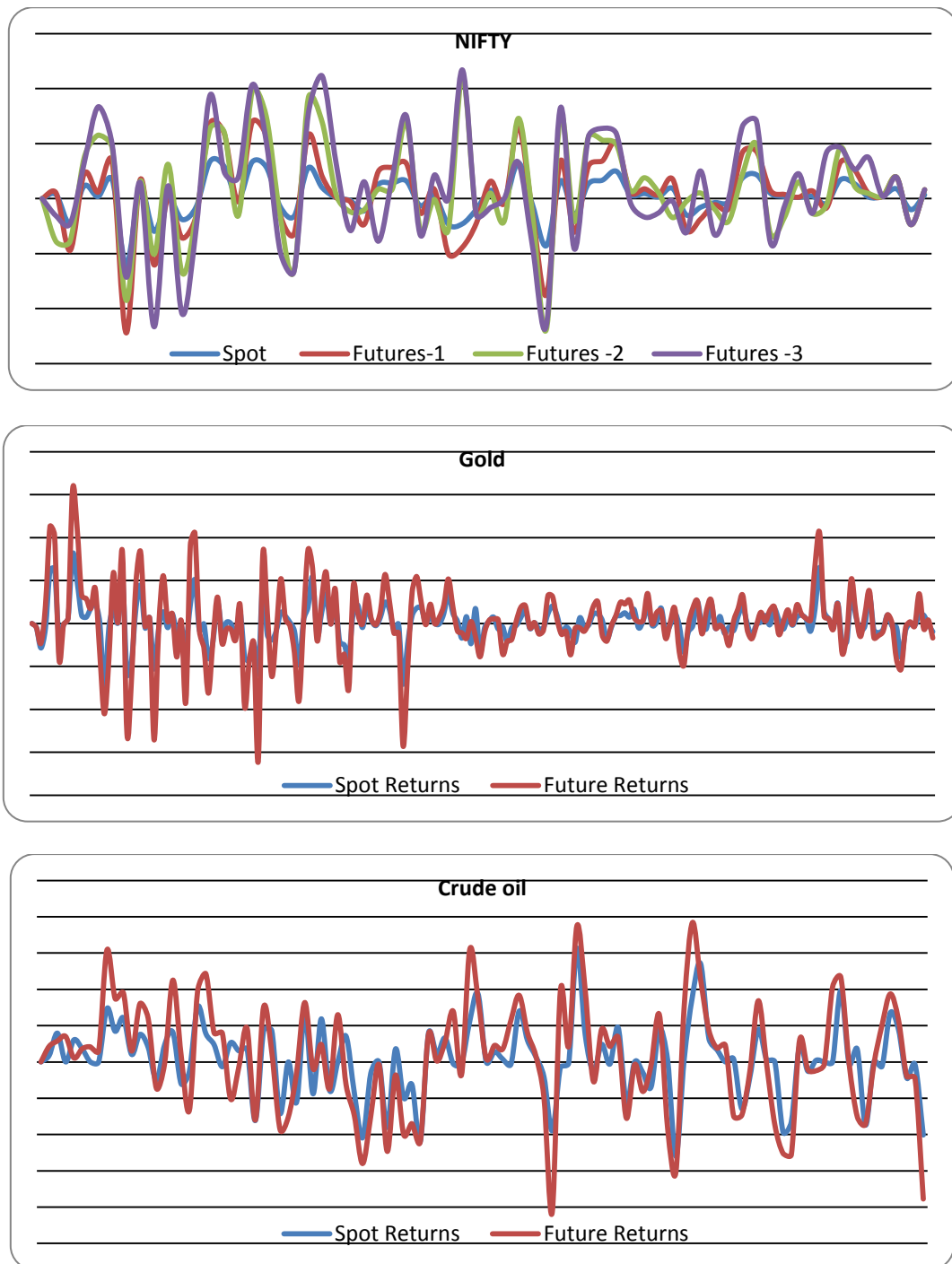


Figure 1

Tests of unit Root and co integration:

Table 2. Test of Unit Root

Asset	Price Series	ADF (t stat)	KPSS (LM stat)	Return Series	ADF (t stat)2	KPSS (LM stat)3
Nifty	Spot 1	-0.693	0.806*	Spot 1	-7.721*	0.091
	Spot 2	-1.409	0.862*	Spot 2	-7.387*	0.192
	Spot 3	-1.453	0.283	Spot 3	-7.112*	0.166
	Future 1	-0.757	0.800*	Future 1	-7.788*	0.09

Asset	Price Series	ADF (t stat)	KPSS (LM stat)	Return Series	ADF (t stat)2	KPSS (LM stat)3
Gold	Future 2	-1.394	0.860*	Future 2	-7.238*	0.189
	Future 3	-1.488	0.322	Future 3	-7.36*	0.181
	Spot 1	-2.041	0.413***	Spot 1	-12.122*	0.077
Crude oil	Future 1	-2.259	0.394***	Future 1	-10.817*	0.085
	Spot 1	-2.568	0.558**	Spot 1	-8.938*	0.158
	Future 1	-2.564	0.358***	Future 1	-9.200*	0.166

For the test of unit root, the present study employees the Augmented Dickey Fuller test and KPSS test presented in the Table 2. On observing the outputs of ADF and KPSS tests, it is seen that the ADF test statistic and KPSS test statistics for all is less than the critical values at 1%, 5% and 10% confidence level. Both ADF & KPSS test statistics confirm that all prices have unit root (non-stationary). So, the null hypothesis is rejected and the data is found to be stationary.

Table 3. Johansen Co-integration Tests of Spot & Future Prices

Asset	Hypothesized No.of CE(s)	Spot-Future 1		Spot-Future 2		Spot-Future 3	
		Eigen value	Trace Statistic	Eigen value	Trace Statistic	Eigen value	Trace Statistic
Nifty	None	0.570*	68.41*	0.536*	53.715*	0.494*	49.517*
	At most 1	0.224*	16.025*	0.142	10.703	0.119	10.634
	At most 2	0.005	0.307	0.037	2.136	0.058	3.416
Gold	None	0.348*	91.356*	-	-	-	-
	At most 1	0.032	6.596	-	-	-	-
	At most 2	0.001	0.112	-	-	-	-
Crude	None	0.299*	45.400*	-	-	-	-
	At most 1	0.070	7.755	-	-	-	-
	At most 2	0.000	0.040	-	-	-	-

*(**) denotes rejection of the hypothesis at the 5 %(1%) level

The co-integration between spot & future prices is tested by Johansen’s (1991) maximum likelihood test. The results of co-integration are presented in Table 3. It is observed that spot and futures prices have one co-integrating vector and they are co integrated in the long run.

OLS Regression Model Estimates:

Table 4. OLS regression model estimates

	Nifty			Gold	Crude
	Future1	Future2	Future3		
α	0.000131	8.43E-05	0.000275	0.000125	0.001229
β (Hedge Ratio)	0.960392	1.004102	0.91802	0.641299	0.368029

R square	Nifty			Gold	Crude
	Future1	Future2	Future3		
	0.992459	0.992213	0.985597	0.48375	0.106164

The model estimated using the ordinary least squares presented in Table 4. The hedge ratio is estimated from the coefficient while the R square value gives the hedge effectiveness. Table 4 depicts that the hedge ratio is more than 95% for all future contracts but it is relatively less for Gold & Crude Oil future contract. Similarly the hedge effectiveness is also more for future contract and considerably less for Gold and Crude Oil. Thus, the hedge provided by the future contract can be said to be much more effective than Gold and Crude Oil.

VAR Estimates

Table 5. Estimates of VAR Model (Spot Price)

	Nifty			Gold	Crude
	Future1	Future2	Future3		
α	0.002507	0.006764	0.000784	0.00041	0.000674
β_1 (Coeff of future return)	1.566934	0.158835	0.627944	0.572182	0.726154
β_2	0.871891	-0.34217	0.405537	0.197028	0.487722
γ_1 (Coeff of spot return)	-1.623659	-0.118163	-0.652438	-0.33424	-0.303482
γ_2	-0.80427	0.162929	-0.337057	-0.276695	-0.171186

Table 6. Estimates of VAR Model (Future Prices)

	Nifty			Gold	Crude
	Future1	Future2	Future3		
α	0.002501	0.00649	0.000508	0.000536	0.001122
β_1 (Coeff of spot return)	-1.088982	0.590369	-0.176118	0.102024	0.151133
β_2	-0.773811	0.643391	-0.189675	-0.164656	-0.117291
γ_1 (Coeff of future return)	1.035386	-0.539897	0.160383	0.03476	0.054578
γ_2	0.831067	-0.795142	0.258334	-0.062715	-0.094705

Table 7. Estimation of Hedge Ratio & Hedging Effectiveness

	Nifty			Gold	Crude
	Future1	Future2	Future3		
Akaike Information Criterion	-15.40633	-13.75685	-13.57736	-14.06201	-10.80385
Schwarz Criterion	-15.06028	-13.39518	-13.21893	-13.89535	-10.5511
Covariance	0.00034	0.000913	0.000594	0.0000577	0.000114

	Nifty			Gold	Crude
	Future1	Future2	Future3		
Variance (ϵ_F)	0.000355	0.000907	0.00065	0.0000923	0.000316
Variance (ϵ_S)	0.000327	0.000924	0.000549	0.0000636	0.000242
Hedge Ratio	0.957746479	1.006615215	0.913846154	0.625135428	0.36075949
Variance (H)	0.00000137	0.00000496	0.00000618	0.00002753	0.00020087
Variance (U)	0.000327	0.000924	0.000549	0.0000636	0.000242
Hedging Effectiveness	0.995822	0.994632	0.988752	0.567143	0.169945

The estimates of the parameters of the spot and future equations as obtained using the VAR model is exhibited in Table 5 and Table 6. Table 7 illustrates the estimates of hedge ratio & the hedging effectiveness of the various future contracts using VAR Model. It is observed from Table 7 that Hedge Ratio and Hedging Effectiveness estimated from VAR model are higher than OLS model and perform better in terms of reducing variance. Hedging effectiveness of gold futures has increased from 0.483 to 0.567 and similarly from 0.106 to 0.169 for Crude Oil. In the similar way improvement is also seen in hedge ratios for all future contracts over the OLS model estimations from Table 4.

VECM Estimates

Table 8. Estimates of VECM Model (Spot Prices)

	Nifty			Gold	Crude
	Future1	Future2	Future3		
α	0.000670	0.007018	-0.001077	0.000355	0.000603
β_S	0.002577	-0.001814	0.002148	-0.000382	-0.000435
β_{S1}	0.197293	0.074956	0.228981	0.267692	0.167743
β_{S2}	-1.178746	-	-	-	-
γ_f	-0.002471	0.001490	-0.002284	0.000312	0.000341
γ_{f1}	-1.193782	0.097722	-0.319722	-0.181328	-0.494470
γ_{f2}	1.179630	-	-	-	-
R^2	0.511477	0.502177	0.482248	0.557721	0.673779

Table 9. Estimates of VECM Model (Futures Prices)

	Nifty			Gold	Crude
	Future1	Future2	Future3		
α	-0.000117	0.007070	-0.001161	0.000469	0.001013
β_F	0.002545	-0.001662	0.002409	-0.000330	-0.000237
β_{F1}	-3.243944	-0.420056	0.076787	0.160001	0.118698
β_{F2}	-1.425728	-	-	-	-
γ_S	-0.002411	0.001338	-0.002564	0.000241	0.000044
γ_{S1}	2.464699	0.565113	-0.169385	0.073852	0.089559
γ_{S2}	1.422410	-	-	-	-
R^2	0.514365	0.493618	0.493223	0.485540	0.471927

Table 10. Estimation of Hedge Ratio & Hedging Effectiveness

	Nifty			Gold	Crude
	Future1	Future2	Future3		
Akaike Information Criterion	-8.633791	-2.309207	-7.105979	-2.622862	-0.84163
Schwarz Criterion	-6.818692	-1.296531	-6.102375	-2.156214	-0.133907
Covariance ($\varepsilon_F, \varepsilon_S$)	0.000379	0.000924	0.000611	0.0000566	0.000114
Variance (ε_F)	0.000396	0.000916	0.000669	0.00009160	0.000318
Hedge Ratio	0.957070707	1.008733624	0.913303438	0.61790393	0.358490566
Variance (ε_S)	0.000365	0.000934	0.000565	0.00006240	0.000243
Variance (H)	0.00000227	0.00000193	0.00000697	0.00002743	0.00020213
Variance (U)	0.000365	0.000934	0.000565	0.00006240	0.000243
Hedging Effectiveness, E	0.99378027	0.99793348	0.98766089	0.56047055	0.16818076

Using the same approach as in case of VAR model, errors are estimated and hedging effectiveness and hedge ratio are calculated for VECM model are presented in Table 8 and 9. Table 10 illustrates the estimates of hedge ratio & the hedging effectiveness of the various future contracts. Although VECM model does not consider the conditional covariance structure of spot and futures price, but it is treated as best specified model for the estimations of constant hedge ratio and hedging effectiveness. Table 10 exhibits that that the Akaike Information Criterion (AIC) & Schwarz Criterion (SIC) are negative and within the accepted range. On comparing the results from VECM Model & the previous OLS & VAR Models, it is observed that the Hedge Ratio and Hedging Effectiveness estimated from VECM model are higher than the OLS method. However the results seem to be almost similar in value to those estimated using the VAR model.

VAR-MGARCH Model

Table 11. GARCH estimates of the VAR-MGARCH (1, 1) model

	Coefficient	Std. Error	z-Statistic	Prob.
C_{ss}	0.000489	0.00053	0.92103	0.357
C_{sf}	0.000482	0.00049	0.9897	0.3223
C_{ff}	0.000482	0.00047	1.02965	0.3032
α_{11}	0.006534	0.13467	0.04852	0.9613
α_{22}	0.014833	0.13924	0.10653	0.9152
α_{33}	0.024062	0.14413	0.16695	0.8674
β_{11}	0.553615	0.50691	1.09213	0.2748
β_{22}	0.562623	0.45058	1.24867	0.2118
β_{33}	0.565772	0.41833	1.35246	0.1762

Table 12. Estimation of Hedge Ratio & Hedging Effectiveness

	Nifty			Gold	Crude
	Future1	Future2	Future3		
Covariance (ϵ_F, ϵ_S)	0.00031	0.00085	0.00054	0.00006	0.00012
Variance (ϵ_F)	0.00033	0.00084	0.00059	0.00009	0.00030
Hedge Ratio	0.96012	1.01185	0.91737	0.66408	0.39604
Variance(ϵ_S)	0.00030	0.00087	0.00050	0.00007	0.00024
Variance (H)	0.00000	0.00000	0.00000	0.00003	0.00019
Variance (U)	0.00030	0.00087	0.00050	0.00007	0.00024
Hedging Effectiveness, E	0.99840	0.99898	0.99611	0.56818	0.19802

VAR-MGARCH model is used to modify the estimation of hedge ratio for time varying volatility and to incorporate non-linearity in the mean equation. Errors of the VAR and VECM models are analyzed for presence of ‘ARCH effect’ and it is found that the errors have time varying volatility.

VAR models with bivariate Diagonal GARCH (1, 1) are used and results are presented in Table-11& 12. The estimated hedge ratios range from a minimum of 0.565 to a maximum of .999. The mean value for time varying hedge ratio series is determined as 0.78.

Table 13. Comparison of hedge ratio estimates by different models

	Nifty			Gold	Crude
	Future1	Future2	Future3		
OLS	0.960392	1.004102	0.91802	0.641299	0.368029
VAR	0.957746479	1.006615215	0.913846154	0.625135428	0.36075949
VECM	0.957070707	1.008733624	0.913303438	0.61790393	0.358490566
VAR-MGARCH	0.96012	1.01185	0.91737	0.66408	0.39604

Table 14. Hedging Effectiveness Results of Different Models

	Nifty			Gold	Crude
	Future1	Future2	Future3		
OLS	0.992459	0.992213	0.985597	0.48375	0.106164
VAR	0.995822	0.994632	0.988752	0.567143	0.169945
VECM	0.99378027	0.99793348	0.98766089	0.56047055	0.16818076
VAR-MGARCH	0.99840	0.99898	0.99611	0.56818	0.19802

The Table 13 and Table 14 presents hedge ratio estimates and hedging effectiveness of different models. Constant hedge ratio obtained from OLS, VAR, VECM and average of time varying hedge ratio obtained from VAR-MGARCH model is compared in Table 13. It is observed that hedge ratio of VAR-MGARCH model is high and hedging effectiveness provide greater variance reduction than other models. The Hedge effectiveness improves progressively from OLS to MGARCH. For NIFTY futures, MGARCH is only marginally better as VAR and VECM model provide almost 99% hedge efficiency. Gold is relatively a less volatile commodity. Hence, the improvement in hedge efficiency is minimal. However, for Crude, the

improvement is significant, when MGARCH is used. Hence, MGARCH provides us the best estimates for hedging. Hence, it emphasizes that VAR MGARCH model is the most appropriate model to estimate risk-minimizing hedge ratios for NIFTY index, Gold futures and Crude futures in Indian market. So it is observed from the overall analysis that the hedging effectiveness of Indian futures markets is very good and has increased in recent period.

5. Concluding observation

This paper examined the hedge ratios and hedging effectiveness of the S&P CNX Nifty, gold futures, crude futures by using alternative models, both constant and time varying, over the period from September 2008 to September 2010. The findings of the study suggest that in terms of risk reduction the VAR-MGARCH is the appropriate method for estimating optimal hedge ratios as it provides better results than the conventional OLS method, VAR & the VECM models. This study also concludes that time-varying hedge ratio seems more realistic than constant hedge ratio. Our results are consistent with findings of Choudhary (2004) and Olgun & Yetkiner (2009). This study may help investors and regulators to figure out more exact solutions to their favorable portfolio selection and manage financial risks without settling their spot position. But however future research can be done by focusing on high-frequency data which might present more pragmatic results in the spot and future markets.

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THE MACROECONOMIC VARIABLES AND STOCK RETURNS IN PAKISTAN: THE CASE OF KSE100 INDEX

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Abstract

The stock market is a barometer of a country's economy. The stock market of Pakistan was initiated in the year 1947 at Karachi and KSE100 index was introduced in 1991. The intent of this study was to explore long run, and short run dynamics relationships between KSE100 index and five macroeconomic variables. In order to investigate the long run and short run relationships. Johansen cointegration technique and VECM was applied. The study used monthly data for analyzing KSE100 index. The results revealed that in the long run, there was a positive impact of inflation, GDP growth, and exchange rate on KSE100 index, while money supply and three months treasury bills rate had negative impact on the stock returns. The VECM demonstrated that it takes more than four months for the adjustment of disequilibrium of the previous period. The results of variance decompositions exposed that among the macroeconomic variables inflation explained more variance of forecast error.

Keywords: stock returns, cointegration, macroeconomic variables, variance decompositions, VECM

JEL Classification: E22, E32, E43, E52, G01, G11, G12

1. Introduction

The stock market is a mirror of an economy. The Karachi stock exchange (KSE) was established in 1947. The KSE100 Index was introduced in November, 1991. The KSE100 Index consists of 100 companies. These companies are selected on the basis of market capitalization and sector representation. These companies encompass nearly 80 percent of the total market capitalization at Karachi Stock Exchange. The Karachi stock market remained very impulsive for the last sixty months. In this period, three financial disasters were observed. First, KSE100 index dropped nearly fourteen hundred points in the first quarter of the year 2005. Secondly, stock market was crashed in June 2006 when KSE100 index loosed fifteen hundred points. In the last nine months of the year 2008, highly intensive crash was observed. In this period, KSE100 index lost ten thousand points. The Board of Directors of Karachi stock exchange decided to place a floor in August 2008 which was removed in December, 2008. The major source of this volatility was political uncertainty and instability for this disaster in the stock market. Hold of speculators and bad governance in the stock market played vital role in first two crises. Hence, it was necessary to determine the economic factors by studying the behavior of stock market to plan a strategy that could protect the investors of stock markets

Varying evidences of relationship between macroeconomic variables and stock returns widely documented in the existing literature. Several studies explored the predictability of many macroeconomic variables such as exchange rate, inflation, foreign direct investment, real output, money supply, foreign reserves, prices of real estate, terms of trade, and value of trade balance on stock prices. Due to variations in results, it was found difficult to determine which specific macroeconomic variable could be consistent indicator of stock returns.

In the past, several studies were conducted using different macroeconomic variables. The studies *inter alia* included Bhattacharya and Mukherjee (2003), Smyth and Nandha (2003), Aquino (2004), Homma *et al.* (2005), Aquino (2005), Hartmann and Pierdzioch (2007), Dogan and Yalcin (2007), Ratanapakorn and Sharma (2007), Cook (2007), Shabaz *et al.* (2008), Alagidede (2008), and Humpe and Macmillan (2009). All the studies found contrasting results about macroeconomic indicators. Very few studies such as Farooq and Keung (2004), Nishat and Shaheen (2004) were conducted in Pakistan. It is therefore, seemed important to under take such a study keeping in view

of the volatility of KSE. The intent of the paper was to explore long run and short run relationships between macroeconomic variables and stock prices in Karachi Stock Exchange.

The rest of the paper is planned as follows. Section 2 demonstrates data and methodology to explore the long run and short run relationships between macroeconomic variables and stock returns. The empirical results are discussed in section 3, and conclusion is explained in Section 4.

2. Data and Methodology

Monthly data was used to discover the association between the macroeconomic variables and KSE100. The macroeconomic variables i.e. money supply (M_2), consumer price index, three-month bills rate, industrial production index, and real effective exchange rate were used in this study. The data was obtained from Annual Reports of Karachi stock exchange, monthly bulletins of State Bank of Pakistan, International Financial Statistics (IFS) and Publications of the Federal Bureau of Statistics, Islamabad. The data about the real effective exchange rate, consumer price index, and three months treasury bills rate were retrieved from IFS CD-Rom. The study used the data from November 1991 to June 2008 to discover the relationship between macroeconomic variables and KSE100 index. In this study, all variables are used in log form and the portrayals of variables were as under:

- KSE100 = KSE100 index
- CPI = Consumer price index
- IP = Industrial production
- REER = Real effective exchange rate
- M_2 = Money supply (Broader money)
- TTBR = Three months treasury bills rate

2.1. Stationary tests

In macroeconomics, financial economics, and monetary economics, most of the variables are non-stationary (Hill *et al.* 2001). If a time series is non-stationary, then mean or the variance or both depend on time. If variance depends on time, then it approaches to infinity as time approaches to infinity (Asteriou, and Hall 2006).

Following three tests were applied to test the stationarity of the above quoted series.

2.1.1. Augmented Dickey Fuller test

The Augmented Dickey Fuller test was commonly used because extra lagged terms of the dependent variable can be included in order to eliminate autocorrelation. On the basis of Akaike Information Criteria (AIC) or Schwartz Bayesian Criteria (SBC) decision was made that how many extra lagged dependent variables were included to capture autocorrelation. In order to test for unit root through Augmented Dickey Fuller test (ADF), the following equation was used to determine the unit root.

$$\Delta y_t = \alpha_0 + \alpha_1 y_{t-1} + \sum_{i=1}^p \beta_i \Delta y_{t-i} + u_t \quad (1)$$

2.1.2. Phillips – Perron test

In Phillips and Perron test (1988), a nonparametric method was used to control the higher-order serial correlation between the error terms avoiding the addition lagged difference terms. Phillips-Perron test is free from parametric errors and it allows the disturbances to be weakly dependent and heterogeneously distributed. Therefore, Phillips – Perron (PP) test (Phillips and Perron 1988) was also applied to check the stationarity. The test regression for the Phillips- Perron test was as under:

$$\Delta y_{t-1} = \alpha_0 + \gamma y_{t-1} + e_t \quad (2)$$

2.1.3. KPSS test (Kwiatkowski, Phillips, Schmidt. and Shin, 1992)

In order to investigate the integration properties of a series, KPSS test the null hypothesis was stationary against the alternative hypothesis that data generating process (DGP) was non-stationary. If it was assumed that there is no linear trend term, the point of departure was a data generating process of the form

$$y_{t-1} = X_t + Z_t \quad (3)$$

Where; X_t is a random walk, $X_t = X_{t-1} + U_t$, $U_t \sim \text{iid}(0, \sigma_u^2)$ and Z_t is a stationary process. $H_0: \sigma_u^2 = 0$ against $H_1: \sigma_u^2 > 1$. If H_0 holds, Y_t composed of constant and Z_t stationary process (Lütkepohl, and Krätzig 2004).

2.2. Cointegration test and Vector Error Correction Model

To explore long-run relationship between the macroeconomic variables and KSE100 Index, Johansen and Juselius (1990) cointegration techniques were used. This technique resolved the most of the problems attached with Engle and Granger technique. This technique gives maximum Eigen Value and Trace Value test statistics for determining number of cointegrating vectors. Johansen method was clarified as below:

$$x_t = A_o + \sum_{j=1}^k A_j x_{t-j} + \varepsilon_t \quad (4)$$

This equation was redesigned to get a vector error correction model (VECM) as under:

$$\Delta x_t = A_o + \sum_{j=1}^{k-1} \Gamma_j \Delta x_{t-j} + \Pi x_{t-k} + \varepsilon_t \quad (5)$$

Where;

$$\Gamma_j = - \sum_{i=j+1}^k A_i \quad \text{and} \quad \Pi = -I + \sum_{i=j+1}^k A_i$$

The Trace and the Maximum Eigen Value test was used to find the number of cointegrating vectors.

2.3. Variance Decomposition

To explore short run causality between macroeconomic variables and KSE100 Index, the vector autoregressive (VAR) by Sims (1980) was calculated. To explain the relationships between macroeconomic variables and KSE100 Index, variance decomposition technique was used. In this study, Bayesian VAR model specified in first differences obtained in equation (6) and (7).

$$\Delta X_t = \alpha_1 + \sum_{i=1}^k \alpha_{11}(i) \Delta X_{t-i} + \sum_{j=1}^k \alpha_{12}(j) \Delta Y_{t-j} + \varepsilon_{xt} \quad (6)$$

$$\Delta Y_t = \alpha_2 + \sum_{i=1}^k \alpha_{21}(i) X_{t-i} + \sum_{j=1}^k \alpha_{22}(j) Y_{t-j} + \varepsilon_{yt} \quad (7)$$

2.4. Model

To explore long run relationship between macro economic variables and KSE100 index, following econometric models was specified in the study.

$$KSE100 = \beta_1 CPI + \beta_2 IP + \beta_3 REER + \beta_4 M_2 + \beta_5 TTBR + \varepsilon_t$$

Following model was estimated to explore short-run dynamics between the variables and their long-run equilibrium relations.

$$\begin{aligned} \Delta KSE100_t = & \alpha_1 + \gamma_1 U_{|t-1} + \sum_{i=1}^P \theta_{1i} \Delta CPI_{t-1} + \sum_{i=1}^P \beta_{1i} \Delta IP_{t-1} + \sum_{i=1}^P \mu_{1i} \Delta REER_{t-1} \\ & + \sum_{i=1}^P \eta_{1i} \Delta M2_{t-1} + \sum_{i=1}^P \lambda_{1i} \Delta TTBR_{t-1} + \varepsilon_t \end{aligned} \quad (8)$$

3. Empirical results

3.1. Stationarity test

In the time series analysis, it was mandatory to test the time series whether it was stationary or non-stationary. The study applied three different tests for checking the stationarity of the data. All three tests were unanimous in the results and indicated that all the series were found stationary at first difference as shown in Table 1.

Table 1. Unit Root Analysis

Variables	Augmented Dickey – Fuller Test Statistic		Phillips – Perron Test Statistics		Kwiatkowski – Phillips – Schmidt – Shin Test statistic	
	Null Hypothesis: Variables are Non-stationary		Null Hypothesis: Variables are Non-stationary		Null Hypothesis: Variables are stationary	
	Level	First Difference	Level	First Difference	Level	First Difference
KSE100	-0.187	-14.509*	-0.175	-14.509*	1.268	0.178*
CPI	-0.148	-4.273*	-0.695	-11.291*	1.702	0.368*
IPI	2.106	-13.446*	-2.285	-21.744*	1.755	0.266*
REER	-1.904	-11.346*	-1.383	-11.233*	1.498	0.065*
M2	0.295	-3.107*	-0.734	-15.749*	1.749	0.190*
TTBR	- 2.172	-5.249*	-1.609	-10.276*	0.707	0.112*
MacKinnon (1996) critical values						
5% Level	- 2.875		- 2.875		0.463	
10% Level	-2.574		-2.574		0.347	
* & ** shows that the coefficient are significant at significance level 5% and 10% respectively.						

3.2. Cointegration analysis

The results of stationarity tests were exposed in the Table 1. The results depicted that the variables involved in the study were integrated of order one i.e. I(1), therefore the Johansen and Juselius (1990) technique was applied to examine the long-run associations between macroeconomic variables and KSE100 Index. In multivariate cointegration analysis using JJ technique, the first step was the appropriate lag selection for the variables. One lag length was selected equal in this study on the basis of Schwarz Bayesian Criteria (SBC) and following the study of Harris and Sollis (2003). The variables involved in the cointegration analysis were; KSE100, CPI, P, REER, M₂, and TTBR. To explore the number of cointegrating vectors Maximal Eigenvalue and Trace statistics were used. In multivariate cointegration analysis, five different models were available. These models were based upon different specifications of intercept and trend term. Using Pantula principle, the model with ‘Unrestricted intercept and no trend’ was selected. The results of Maximum Eigenvalue and Trace statistics were shown in Table 2 and Table 3 respectively.

Table 2. Unrestricted Cointegration Rank Test (Maximum Eigen value)

Hypothesized	Max-Eigen			0.05
No. of CE(s)	Eigen value	Statistic	Critical Value	Prob.**
None *	0.412	103.591	40.078	0.000
At most 1 *	0.132	27.550	33.877	0.235
At most 2	0.109	22.441	27.584	0.199
At most 3	0.070	14.104	21.132	0.357
At most 4	0.055	10.946	14.265	0.157
At most 5	0.009	1.818	3.841	0.178
Max-eigenvalue test indicates 1 cointegrating eqn(s) at 5% significance level				

Table 3. Unrestricted Cointegration Rank Test (Trace)

Hypothesized		Trace	0.05	
No. of CE(s)	Eigen value	Statistic	Critical Value	Prob.**
None *	0.412	180.450	95.754	0.000
At most 1 *	0.132	76.859	69.819	0.012
At most 2 *	0.109	49.309	47.856	0.036
At most 3	0.070	26.868	29.797	0.105
At most 4	0.055	12.764	15.495	0.124
At most 5	0.009	1.818	3.841	0.178

Trace test indicates 3 cointegrating eqn(s) at 5% significance level

* denotes rejection of the hypothesis at 5% significance level

The Trace statistic recognized three cointegrating vectors, while the Maximal Eigen statistic identified only one cointegrating vector. Because the Trace statistic was more robust than the Maximal Eigen statistics (Cheung, and Lai 1993), therefore, the study used three cointegrating vectors in order to establish the long-run relationships among the variables.

3.4. Long run relationships

After normalization the first cointegrating vector on KSE100, normalized cointegrating coefficients were estimated as reported in Table 4.

Table 4. Normalized coefficients

KSE 100	CPI	IP	REER	M2	TTBR
1	-35.567	-25.051	-10.959	26.369	2.330
S.E.	-6.140	-2.284	-5.463	-3.613	-0.511
t-value	5.793	10.966	2.006	-7.298	-4.555

The first normalized equation was estimated as below:

$$\text{KSE100} = 35.567\text{CPI} + 25.051\text{IP} + 10.959\text{REER} - 26.369\text{M}_2 - 2.33\text{TTBR}.. \quad (9)$$

The first normalized equation, depicted that in the long run, consumer price index had an positive impact on KSE100 Index which implied that equities were hedged against inflation. The positive relation between consumer price index and stock prices was consistent with the study of Abdullah and Hayworth (1993) and Ratanapakorn and Sharma (2007). The market rate of interest included expected inflation Fisher (1930). As the rate of inflation rises, the nominal rate of interest also goes up. Consequently, real rate of interest remained the same in the long run. Thus, it was concluded that there was a positive one-to-one relationship between rate of inflation and stock prices. Thus, equities provided hedge against inflation rate. Industrial production showed positive impact on KSE100 Index as reported in many studies (see *inter alia* Fama, 1981; Abdullah and Hayworth, 1993; Eva and Stenius, 1997; Ibrahim and Yusoff, 2001; Nishat and Shaheen, 2004; Cook, 2007; Ratanapakorn and Sharma, 2007; Liu and Sinclair, 2008; Shabaz *et al.*, 2008; Humpe and Macmillan, 2009). Stock prices were also positively affected by real effective exchange rate. It interpreted that with the depreciation in domestic currency due to increase in exchange rate, exports become cheaper which resulted in increase in exports and stock prices of exporting firms. The same results were reported by Aggarwal (1981), and Ratanapakorn and Sharma (2007), but Soenen and Hennigan (1988) reported negative correlation between the exchange rate and stock prices. The impact of money supply on KSE100 Index was found significantly negative. The same results were shown in the study of Humpe and

Macmillan (2009) for Japan. The negative relation between stock prices and money supply was perhaps due to Keynesian liquidity trap experienced by Pakistani economy in the last nine years. The study established that there was a significant negative long run relationship between three month treasury bills and the stock prices. This finding was consistent with the previous studies (see Nishat, and Shaheen 2004, Humpe, and Macmillan 2009) but it was in contrast with the results of Ratanapakorn and Sharma (2007).

3.4 Vector Error Correction Model

In order to find the short run relationships among the variables, vector error correction mechanism was applied. The results of VECM were shown in Table 5. The coefficients of ecm1 (-1), ecm2 (-1) and ecm3 (-1) disclosed the adjustment speed and disequilibrium of the previous period. The adjustments in LKSE100 Index were only due to the second error correction term (ecm2). Equation 10 showed that the coefficient of ecm2 (-1) was significant which implied that KSE100 adjusted by 23.2 percent in one month to the long run equilibrium. The results showed that it took more than four months (1/0.232= 4.31) to eliminate the disequilibrium.

$$DKSE100 = 0.008 - 0.018 DKSE100(-1) + 0.208CPI(-1) + 0.18DLIP(-1) + 0.115DLREER(-1) + 0.042DM2(-1) - 0.124DTTBR(-1) - 0.034 Vecm1(-1) - 0.232 Vecm2(-1) - 0.018 Vecm3(-1) \tag{10}$$

Table 5. Results of Vector Error Correction Model

Variables	D(KSE100)	D(CPI)	D(IP)	D(REER)	D(M2)	D(TTBR)
Vecm1(-1)	-0.034 (-1.26)	0.006* (3.74)	0.039 (1.37)	0.016* (3.46)	0.020* (4.06)	0.037*** (1.72)
Vecm2(-1)	-0.232*** (-1.78)	0.029* (3.44)	-0.476* (-3.47)	0.050** (2.23)	0.065** (2.75)	0.187*** (1.79)
Vecm3(-1)	-0.001 (0.02)	-0.001 (-0.37)	-0.404* (-6.84)	0.011 (1.11)	-0.010 (-0.94)	0.002 (0.03)
D(KSE100(-1))	-0.018 (-0.24)	-0.001 (-0.31)	0.093 (1.18)	-0.026** (-2.1)	-0.015 (-1.09)	-0.042 (-0.7)
D(CPI(-1))	0.208 (0.16)	0.123 (1.57)	-0.502 (-0.38)	-0.240 (-1.15)	-0.233 (-1.04)	1.418 (1.43)
D(IP(-1))	0.180** (2.63)	-0.001 (-0.15)	0.148** (2.06)	0.008 (0.71)	0.030** (2.37)	-0.002 (-0.04)
D(REER(-1))	0.115 (0.28)	-0.056** (-2.15)	0.252 (0.58)	0.272* (3.9)	0.094 (1.25)	-0.272 (-0.82)
D(M2(-1))	0.042 (0.11)	0.012 (0.47)	0.670*** (1.65)	0.039 (0.58)	-0.171** (-2.38)	-0.032 (-0.14)
D(TTBR(-1))	-0.124 (-1.43)	0.008 (1.49)	-0.034 (-0.37)	-0.011 (-0.73)	-0.009 (-0.57)	0.313* (4.52)
C	0.008 (0.66)	0.006* (7.08)	-0.003 (-0.24)	0.001 (0.38)	0.016* (7.18)	-0.008 (-0.84)
R-squared	0.10	0.18	0.23	0.20	0.13	0.17
F-statistic	2.31	4.66	6.19	5.45	2.89	4.57

() shows 't' values, * shows the coefficient significant at significance level 1%, ** shows the coefficient significant significance level at 5%, *** shows the coefficient significant significance level at 10%

3.5. Variance Decompositions

In order to calculate the degree of exogeneity among the variables, variance decomposition additionally provided evidence of the relationships between the variables under examination. It demonstrated the proportion of the forecast error of one variable due to the other variables. Therefore, it determines the relative importance of each variable in creating variations in the other variables (Ratanapakorn and Sharma, 2007). Table 6 showed that the KSE100 index was relatively more endogenous in relation to other variables because almost 39 percent of its variance was explained by its own shock after 24 months. Among the macroeconomic variable CPI explained 46 percent impact on stock prices. Movements in other

macroeconomic variables i.e. IP, REER M2, and TTBR explained forecast variance of KSE100 0.54 percent, 5.14 percent, 7.33 percent, and 2.18 percent respectively. The value of variance forecast error explained by all macroeconomic variables increased with the passage of time except IP.

Table 6. Variance decompositions

VDC of	Months	S.E.	GINDEX	CPI	IP	REER	M2	TTBR
GINDEX	1	0.10	100.00	0.00	0.00	0.00	0.00	0.00
	6	0.20	89.39	7.36	1.09	1.15	0.36	0.65
	24	0.39	38.81	46.00	0.54	5.14	7.33	2.18
CPI	1	0.01	1.77	98.23	0.00	0.00	0.00	0.00
	6	0.02	0.40	96.06	0.02	2.38	0.04	1.10
	24	0.04	12.29	81.31	0.27	1.94	1.43	2.75
IP	1	0.09	0.67	2.90	96.43	0.00	0.00	0.00
	6	0.13	1.42	13.44	78.86	1.03	3.56	1.70
	24	0.17	2.85	15.45	70.61	2.89	4.90	3.29
REER	1	0.02	0.87	2.80	0.04	96.30	0.00	0.00
	6	0.03	6.57	1.58	1.27	89.67	0.69	0.22
	24	0.04	17.83	2.75	1.78	61.48	2.10	14.06
M2	1	0.02	0.00	5.63	4.31	0.52	89.54	0.00
	6	0.03	4.41	6.65	5.58	2.11	80.25	1.00
	24	0.06	18.94	12.35	1.79	9.81	50.04	7.07
TTBR	1	0.08	3.62	0.00	0.12	0.25	0.00	96.01
	6	0.26	2.52	8.13	0.09	0.06	0.29	88.92
	24	0.50	7.61	22.88	0.07	1.42	1.32	66.70

Cholesky Ordering: GINDEX, CPI, IP, REER, M2, TTBR

4. Conclusion

This study explored the impact of macroeconomic variables on KSE100 index. All the series used in this analysis were found stationary at first difference but non-stationary at levels. Three long run relationships were found between macroeconomic variables and KSE100 index. In the long run, inflation, Industrial production index, and real effective exchange rate affected stock returns positively. While, Money supply and three month treasury bill rate showed negative impact on stock returns in the long run.

The VECM analysis depicted that it took more than four months for the adjustment of disequilibrium of the previous period. The results of Variance Decomposition revealed that KSE100 index explained nearly 39 percent of its own forecast error variance while CPI, IP, REER, M2, and TTBR explained 46 percent, 0.54 percent, 5.41 percent, 7.33 percent, and 2.18 percent variance in KSE100 index respectively. Among the macroeconomic variables, inflation was showing the maximum variation.

The study proposed that by controlling inflation the volatility of the stock markets can be reduced. Therefore monetary managers should adopt appropriate monetary measures. Positive impact on KSE100 Index revealed that by raising the Industrial production the capital markets of Pakistan can be developed significantly. Thus, it was recommended that authorities should formulate such policies, which uphold stock prices through the promotion of industrial production. The long run positive impact of exchange rate on KSE100 index suggested that for the development of stock market in Pakistan, exchange rate should be managed carefully keeping in view the elasticities of exports and imports, which will lead to stability in stock market. The monetary authorities should take care in executing monetary policies particularly to affect movements in the stock market, because soft monetary policy elevate stock prices in the short-run leading to

adverse results in the long-run. The study also recommended that three months treasury bills rate should be kept appropriately low so that it cannot affect stock returns adversely.

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DO BIDDERS GAIN FROM TAKEOVERS?

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Abstract

Although there are numerous studies examining takeover effects, there are very few that focus on emerging stock markets. There is even less evidence about whether such activities result in value-increasing or value-decreasing effects for bidding firms when applied different methods. This research features a study of takeover effects on one such emerging market: the Stock Exchange of Thailand (SET). The bidding firms' performances during a period (-12,+12) months before and after the takeover were investigated using more advanced methodologies and metrics. Their long-term bid period returns were measured by cumulative, buy-and-hold and monthly average abnormal returns estimated from the matched reference portfolio firms, which is the latest research method. The bootstrapped skewness adjusted t-statistic tests were used for significance tests of the means. The results add to the literature on emerging markets and provide a further comparison with developed stock markets. They are consistent when compared within this study, and most past studies using the limited range of research methods, suggesting that a Thai takeover results in significantly positive and negative abnormal returns for the bidding firm's shareholders.

Keywords: takeover, M&A, abnormal return, wealth effect, bidding firm, Thailand

JEL Classification: C10, C40, G34, O16

1. Introduction

Forms of the event study methodology has been the predominant method used to measure stock price responses to merger or takeover announcements, and the prior studies report inconclusive results; such as Akbulut, and Matsusaka 2010, Alexandridis, Petmezas, and Travlos 2010, and Jensen 2006, among others. Although there have been an increased number of recent studies that concentrate more on long-term performance examination, and that use more complicated research methods, nearly all are interested in investigating bidding firms' return performance in post-bid period, and the majority concentrate on developed stock markets.

Thus, this research examines takeover effects on the bidding firms traded on the Stock Exchange of Thailand (SET). The analysis emphasized abnormal performance estimations for the long-term (bid period) using monthly stock price data, the matched reference portfolio method and bootstrapped skewness-adjusted *t*-statistic. This study enriches the financial literature on emerging markets in terms of greatly enhancing variety results and provides a further comparison with developed stock markets.

2. Review of Prior Studies

Previous studies show negative results for bidding firms, for example, Mork, Shleifer and Vishny (1990) observe that stock returns to diversifying acquisitions are statistically insignificant from zero in the 1970s, but become negative in the 1980s. Healy, Palepu, and Ruback (1992), Mitchell and Stafford (2000), Morellec and Zhdanov (2005), Mulherin and Boone (2000) and Walker (2000) all report small negative returns to acquiring firms. Outside the U.S market, Dumontier and Pettitt (2002), a French study, show low or negative returns to bidding firms. In the UK, Limmack (1991) uses three benchmarks to compute abnormal returns and his results show insignificantly negative abnormal returns of -0.20% for successful bids. Sudarsanam, Holl, and Salami (1996) analyze 429 UK bidding firms, and find significant and negative cumulative abnormal returns of -4.04% over the period (-20,+40) days which are similar to those of Raj and Forsyth (2003) and Sudarsanam and Mahate (2003). Campa and Hernando (2004) report that bidding firms in the European Union in their sample have 55% returns that are negative, though insignificant. Finally, Alexandridis *et al.*, (2010) investigate the performance of acquiring firms using a worldwide sample covering 39 countries, and suggest significantly average abnormal returns of -0.91%.

By contrast, some studies suggest positive results; see, for example, Kohers and kohers (2000) and Martynova and Renneboog (2006). Similarly, in Australia, Brown and da Silva Rosa (1998) report that acquisitions increase bidding firm shareholders' equity value. In Japan, Pettway and Yamada (1986) suggest that acquiring firms experience positive but insignificant abnormal returns; Kang, Shivdasani, and Yamada (2000) and Kang and Yamada (1996) report that bidding firms gain significantly positive two-day abnormal returns of 1.20% and 1.41%, respectively. Some other studies find zero or small positive abnormal returns such as Eckbo and Thorburn (2000), Hyland and Diltz (2002), Loderer and Martin (1990) and Maquieria,

Meggison, and Nail (1998). A study by Goergen and Renneboog (2004) analyzes the wealth effects of large (intra) European takeovers and finds that share prices of the bidding firms positively respond with a statistically significant announcement effect of 0.70%. Parrino and Harris (1999) find that the bidding firm's shareholders experience a significant and positive 2.10% operating cash flow return after mergers. Furthermore, some research work suggests negative as well as positive abnormal returns for bidding firms. The list includes Bouwman, Fuller, and Nain (2003), Bradley and Sundaram (2004), Faccio, McConnell, and Stolín (2006) and Moeller, Schlingemann, and Stulz (2004).

With consistency, surveys reveal inconclusive results; see, for example, Datta, Pinches, and Narayanan (1992) report some contrary results to Jensen and Ruback (1983) and Jarrell, Brickley, and Netter (1988). They find that bidding firm's shareholders do not gain whether the bids are successful or not; while Jensen and Ruback (1983) find that bidding firm's shareholders gain in successful mergers and lose in unsuccessful transactions. Jarrell, Brickley, and Netter (1988) report declining returns for bidding firm's shareholders in the 1970s and 1980s compared to the 1960s; while Datta *et al.* (1992) find the decline over time is insignificant. Others surveys, for example, Bruner (2002), Campa and Hernando (2004) and Burkart and Panunzi (2006) reveal similar results and conclude that the findings are distributed rather evenly amongst studies, showing both value-decreasing and value-increasing effects. Thus, the outcomes for the bidding firm's shareholders are mixed.

Even though the first two waves were suggested as predominantly US takeover waves, and the fifth wave was a truly international phenomenon (Martynova and Renneboog, 2008a), most studies of mergers and acquisitions have focused on developed market as the US stock market, some others have paid attention on the UK or European stock markets. Only a small number of merger studies have concentrated on developing or emerging stock markets; see, for example, Estrada, Kritzman, and Page (2006) and Fernandes (2005). Lins and Servaes (2002) examine the value of corporate diversification in seven emerging markets, including the Thai stock market, and find that diversified firms experience a discount of approximately 7% compared with single-segment firms. Very few studies or none has specifically paid attention to those activities on the Stock Exchange of Thailand (SET).

A majority motivation for this study is to examine whether or not different samples, markets and methodologies result in different outcomes. This is the first comprehensive study of mergers and acquisitions on the SET, focusing bidding firms. This study extends the literature and permits an international comparison of merger and acquisition effects on the Thai stock market.

3. Data

This study uses stock price data rather than accounting data for the takeover performance measurement. There are four significant sources of data set out as follows:

1. The list of total companies listed on the SET at any point of time during the period 1991-2003, the list of delisted companies and the list of companies traded under the rehabilitation sector or 'REHABCO' were obtained from the SET.

2. All tender-offer statistics between August 1992 and October 2002 were obtained from the Securities and Exchange Commission, Thailand (SEC).

3. The Thomson Primarc Datastream database was used to provide stock prices, market values (MV) or market capitalizations, and book values (BV) or net tangible assets (NTA) for the sample firms.

4. Brooker Group Public Co., Limited, based in Bangkok, Thailand, was used as a minor source of data for cross-checking the book values obtained from the Datastream.

4. Research Methodology

Past studies show evidence that market reaction to news is not always completed over short-time periods. For example, Loughran and Vijh (1997) argue that the effect of restructuring decisions related to the appointment of new managers, combining operations of both companies and pursuing new investment opportunities should take a few years. Rosen (2006) suggests that examining a three-year horizon is necessary to include enough time to allow the results of the mergers to become known. Several studies document abnormal returns spread over the long-term post-event period of time, for example, studies by Baker and Limmack (2001), Fama (1998), Hou, Olsson, and Robinson (2000), Kothari (2001), Kothari and Warner (1997) and Schwert (2002).

Errors in risk adjustment can make a difference in measured abnormal performance over long-term periods, and the estimated abnormal returns are highly sensitive to expected return model choice. Two main methods for assessing and calibrating post-event risk-adjusted abnormal performance are used in most long-term event studies: the buy-and-hold benchmark approach and Jensen's alpha approach. The findings of

studies that use the latter approach are mixed thus; the former approach is suggested to be a method with more appealing features. A further recent refinement is the bootstrapped skewness-adjusted *t*-statistic, which is developed by Lyon, Barber, and Tsai (1999). I adopted this to address any potential cross-correlation and skewness biases.

Studies concentrate on merger and acquisition activities on developed stock markets, for example, Brown and Warner (1980 and 1985), Campbell and Wasley (1993), Dumontier and Petitt (2002), Dyckman, Philbrick, Stephan, and Ricks (1984), and Goergen and Renneboog (2002), among others. Most of them examine abnormal returns measured on a particular day or cumulated over several months. Even though, there are an increased number of recent studies that have concentrated more on long-term performance examination, they have emphasized more on the measurements of performances of post-announcement month rather than around the announcement month. By comparison, with a limitation number of studies examining takeover effects either on developing markets or the Thai market, nearly all of them have given priority to short-term performance investigation, used daily stock price data, applied the market model and limited ranges of statistical tests.

An interest of this research is in examining long-term bid-period abnormal return behaviour of bidding firms responded to takeover announcements on the SET. These performances were measured by applying more advanced research methodologies, for example, the matched reference portfolio of firms and the bootstrapped skewness-adjusted *t*-statistics.

This study is largely based on a sample of successful tender offers. The analysis emphasizes abnormal performance measurement by using monthly stock price data. The firm's stock price reaction to the takeover announcement was estimated as the rate of abnormal return to the shareholders of the bidding firm. The abnormal return was defined as the difference between the realized return observed from the market and the benchmark return over the period around the takeover announcements. Also, it was defined 'at the announcement of takeovers' or 'around the takeover announcements' as the event-window of the examination.

The event period was the bid period or (-12,0,+12) months, month '0' was defined as the event month, and the event month was defined as the submission month of the tender offer by the bidder to the SEC, or the month that the proposal was filed at the SEC. The analysis is based on the tender offer statistics obtained from the SEC between 1992 and 2002. The sample firms were classified according to whether they were involved as a bidder. In addition, where there were any tender offer that involved repeated bidders, either of the same target and the same bidder or a different target and the same bidder, the latest tender offer was first selected, then, the second, and then the third latest one, were selected respectively in this sequence. However, these selected tender offers were considered with respect to no less than one year's length between each tender offer.

In the time selected, the takeovers on the SET involved 151 tender offers (74 bidders). From this database, a sample was set up according to the following criteria:

1. A tender offer was classified as being successful if the bidder increased its holding of the target shares or purchased at least some⁵ of the outstanding target shares that were tendered for. Thai security legislation defines a proportion above 25% of the target shares' holdings as a 'strategic shareholder' and the bidder is required to tender an offer for the total remaining outstanding shares of the target.

2. Any tender offer was excluded from the sample when it occurred with the purpose of a de-listing⁶. Some cases were also deleted when the tender offer was cancelled later.

3. The survivorship period of time required in this study is the period over (-48,+16) months, due to the limitation of available stock price data.

These selection criteria reduced the initial sample from 151 tender offers to 28 tender offers (42 bidders).

⁵ The control of a firm can increase continuously from none for those who own no shares to complete for those who own 100% of the target's shares or voting rights operations (see more in Bradley, Desai, & Kim, 1988, p. 5; also see Dodd & Ruback, 1977, p.352). In this study, the bidders hold the target shares approximately 28.19% before they tender an offer and/or offers, then the purchased target shares of about 28.99% finally result in their target share holding of 57.18%, on average.

⁶ There are about 22.52% of the total tender offers are engaged with delisted purposes and approximately 60.78 % of the total delisted companies are caused by mandatory delisting.

4.1 Measurement of abnormal returns

4.1.1 A matched reference portfolio method

In developing a test to detect long-term abnormal stock returns, it is significant to control for firm size and book-to-market ratios. The size of the Thai stock market is small, with a total number of listed companies varying between 320 and 454 firms during 1992-2003. Sorting by another factor, such as beta, would further reduce the number of firms available for any control group and lead to small numbers in the control groups. This number could be less than twenty firms, and serve to undermine the benefits of using a matched reference portfolio method. Thus, this research used a two-factor benchmark.

I used the matched reference portfolio of firms that matched the event firm on the basis of size and book-to-market ratio as the benchmark for the calculation of abnormal returns. There are studies that apply this method, for example, *see* Baker and Limmack (2001), Bouwman, Fuller, and Nain (2003), Brown and da Silva Rosa (1998), Gregory and McCorriston (2002) and Rosen (2003). These studies examine takeover effects on developed stock markets, and most of them used the matched reference portfolio as a benchmark for bidding firm long-term post-bid period abnormal return measurement. In my study, the matched reference portfolio method was used for the bidding firm's performance measurement, and was applied for long-term bid period investigation, rather than long-term post-bid period as most studies.

The benchmark group was the firms listed on the SET and then deleted the firms that are related to takeover activities and under the 'Rehabilitation' sector. I excluded the firms that reported negative book value of common equities and those with non-available book values. The returns were calculated and it was assumed that the sample firms' returns would have changed in the same way as those of the benchmark group. The effects of the takeovers were examined by comparing the performance of the event firms with that of a reference portfolio of non-event firms.

The reference portfolio was formed by using a control group of firms matched on the basis of size and book-to-market ratio rankings. The number of firms in a control group varies between 302 and 420 firms and the number of firms in a portfolio varies between 56 and 95 firms. The matched reference portfolios were built up by following a set of determining criteria. This resulted in about 42.86% or 54 reference portfolios were dropped from a total of 126 reference portfolios, and there remains a total of 72 reference portfolios or approximately 57.14% for 32 bidders. The number of firms in each portfolio varies between 18 and 32 firms.

Both the CAR and BHAR methods were applied to calculate abnormal returns relative to the benchmark. The BHAR method is an alternative procedure that is important for long-term abnormal return assessing, even if the CAR method is straightforward. Long-term buy-and-hold abnormal returns are significantly right-skewed, but they are warranted if it is interesting to know the answer to the question that whether or not the event firms earn abnormal returns over a particular time period of analysis (*see* Kothari & Warner, 1997; Lyon, Barber, & Tsai, 1999). Ang and Zhang (2002) also suggest that it is close to the approach that is taken by traditional short-term event studies and is easy to follow.

(1) Cumulative Abnormal Return (CAR)

The long-term cumulative abnormal return (CAR) was calculated as

$$CAR = \sum_{t=1}^T [R_{it} - E(R_{it})] \quad (1)$$

where R_{it} is the monthly return of a sample firm (firm i) and $E(R_{it})$ is the return on a matched reference portfolio.

$$CAR = \sum_{t=s}^{s+T} [R_{it} - 1/n_t^s \sum_{j=1}^{n_t^s} R_{jt}] \quad (2)$$

where R_{jt} is the monthly return for the $j = 1, \dots, n_t^s$ firms that are in the same size/book-to-market reference portfolio as firm i , which are also publicly traded in both period s and t .

(2) Buy-and-Hold Abnormal Return (BHAR)

The long-term buy-and-hold abnormal return (BHAR) of firm i , denoted as AR_i , was computed as

$$AR_i = R_i - BR_i \tag{3}$$

where R_i is the long-term buy-and-hold return of firm i and BR_i is the long-term return for a particular benchmark of firm i .

The long-term buy-and-hold return of firm i over T months post-events was obtained by compounding monthly returns, that is

$$R_i = \prod_{t=0}^{T-1} (1 + r_{it}) - 1 \tag{4}$$

where r_{it} is the return on firm i in month t , $t = 0$ is the event month or the beginning period and $T-1$ is the period of investment (in months).

The long-term benchmark return of firm i (BR_i) was calculated as

$$BR_i(R_{bh}) = I / n \sum_{i=1}^n \prod_{t=0}^{T-1} (1 + r_{it}) - 1 \tag{5}$$

where R_{bh} is the long-run benchmark buy-and-hold return and n is the number of firms in a reference portfolio.

$$BR_i(R_{rb}) = \prod_{t=0}^{T-1} (1 + I / n \sum_{i=1}^n r_{it}) - 1 \tag{6}$$

where R_{rb} is the long-term benchmark rebalanced return.

Another alternative, the average compounded or holding-period abnormal return (AHPAR) (see Cowan & Sergeant, 2001) was calculated as

$$AHPAR = I / n \sum_{i=1}^n (HPR_i - HPR_{benchmark_i}) \tag{7}$$

where HPR_i is the long-term buy-and-hold return of stock i (firm i) and $HPR_{benchmark_i}$ is the long-term return for a particular benchmark of stock i (firm i).

(3) Monthly Average Abnormal Return

The monthly long-term abnormal returns were estimated by means of the matched reference portfolio method. The simple average was then used for abnormal return calculation. This results in 604 monthly average abnormal returns to the total bidding firms in the sample.

4.2 Significance tests of abnormal returns

4.2.1 Bootstrapped skewness-adjusted t-statistics

I adopted this t -statistic method by applying for the significance tests of both cumulative average abnormal returns (CAARs) and average buy-and-hold abnormal returns (ABHARs). The bootstrapping involves drawing b re-samples of size m with replacement from the original sample. $b = 1,000$ times of re-samplings are implemented in the procedures. m is 1 and 5, even though it seems arbitrary, 5 is approximately a quarter of the number of firms in typical reference portfolios in this study. The skewness-adjusted t -statistic was calculated as the formula below. To test the null hypothesis of zero mean at the

significance level of α , the critical values for the skewness-adjusted t -statistic are based on the tabulated distribution of t -statistics.

$$t_{sa} = \sqrt{n} (S + 1/3 \hat{\gamma} S^2 + 1/6n \hat{\gamma}^3) \tag{8}$$

$$S = \overline{AR}_T / \sigma (AR_T) \tag{9}$$

$$\hat{\gamma} = \frac{\sum_{i=1}^n (AR_{iT} - \overline{AR}_T)^3 / n \sigma (AR_T)^3}{\sqrt{n} S} \tag{10}$$

where t_{sa} is the skewness-adjusted t -statistic, $\sqrt{n} S$ is the conventional t -statistic of $t = \overline{AR}_T / \sigma (AR_T) / \sqrt{n}$ and $\hat{\gamma}$ is an estimate of the coefficient of skewness.

5. Results

The matched reference portfolio method was used for the estimation of long-term abnormal returns for the bidding firm's shareholders. The CAR, BHAR and monthly average abnormal return methods were applied for the return measurements. The results are presented and explained in the following section in terms of the performances of the average long-term abnormal returns for the bidding firm's shareholders. The main issues are the size and signs of these abnormal returns and whether or not they are significantly different from zero. The details of the results are shown in Tables 1-4.

Table 1. The Average Buy-and-Hold Abnormal Returns, ABHARs (1) and ABHARs (3), Estimated from the Matched Reference Portfolio Method for Bidding Firms (Bid Period) Investigations

A matched reference portfolio method was applied for the measurements of the bid period (-12,+12) abnormal returns for the bidding firm's shareholders. The results estimated from a total 72 reference portfolios for 32 bidding firms for the bid period (-12,+12) investigation were analyzed. This Table provides the bid period average buy-and hold abnormal returns (ABHARs) for the bidding firm's shareholders, ABHARs(5) which BR_i was calculated from

$BR_i(R_{bh}) = 1/n \sum_{i=1}^n \prod_{t=0}^{T-1} (1+r_{it}) - 1 \dots (5)$ and $ABHARs(7)$ which were calculated from $AHPAR = 1/n \sum_{i=1}^n (HPR_i - HPR_{benchmark_i}) \dots (7)$. The return performances were measured from all tender offers occurring from 1992-2002. Any bidding firm that was listed at any point of time of the takeovers was selected. The bidding firms' price data were available over the period (-48,+16) correspondence with the takeover announcement months. The monthly data during the period (-12,+12) were used to estimate the returns to the bidding firms and reference portfolios matched on size and book-to-market ratios. After the criteria consideration, the number of the bidding firms included in the sample reduced from 42 to 32 firms; and the number of the reference portfolios reduced from 126 sets to 72 sets or accounts for approximately 57.14%. The bid period buy-and-hold returns or compounded monthly returns to obtain a holding period buy-and-hold returns of the bidding firms and each subset of the reference portfolios were calculated as in the following

formula: $R_{iT} = \prod_{t=0}^{T-1} [1+R_{it}] - 1$. The bootstrap approach was applied by using 1000 time re-sampling from each subset of the reference portfolios then, randomly selecting five of them which is about 25% of the typical reference portfolios. The returns on the mentioned five reference portfolios were added together and averaged to get the return on one bootstrapped reference portfolio from 1000 simulations. The previously described procedures resulted in the bid period

buy-and-hold returns to the bidding firms as $R_i = \prod_{t=0}^{T-1} (1+r_{it}) - 1$; and the reference portfolio as $BR_i(R_{bh}) = 1/n \sum_{i=1}^n \prod_{t=0}^{T-1} (1+r_{it}) - 1 \dots (5)$. The bid period buy-and-hold abnormal returns (AR_i) to the bidding firms were estimated from the difference between the bid period buy-and-hold returns to the bidding firm and the bootstrapped reference portfolios using the following formula, $AR_i = R_i - BR_i$. Likewise, the bootstrap approach was applied by using 1000 times re-sampling from each subset of the reference portfolios then, the buy-and-hold abnormal returns to the bidding firms were

calculated according to the following formula: $AHPAR = 1/n \sum_{i=1}^n (HPR_i - HPR_{benchmark_i}) \dots (7)$. Then, the means of the bid period BHARs to the bidding firms were calculated. Also, the skewness-adjusted t -statistics were calculated as in the

following formula: $t_{sa} = \sqrt{n} (S+1/3 \hat{\gamma} S^2+1/6n \hat{\gamma}^2)$, $S = \overline{AR}_T / \sigma (AR_T)$ and $\hat{\gamma} = \frac{\sum_{i=1}^n (AR_{iT} - \overline{AR}_T)^3}{n \sigma (AR_T)^3}$. The bid period buy-and-hold returns or compounded monthly returns to obtain a holding period buy-and-hold return of the bidding firms and each subset of the reference portfolios were calculated as earlier shown in the formulas. Also, the skewness-adjusted *t*-statistics were calculated as in the previously shown formula. Finally, to test the null hypothesis of zero means at a significance level of α , the critical values for the skewness-adjusted *t*-statistics are based on the tabulated distribution of *t*-statistics. Significant means at 1% and 5% levels that are shown by ** and * respectively. To compare the results, the bid period ABHARs(5) and ABHARs(7) for the bidding firm's shareholders are shown in the Table.

Sample	ABHARs (5) adjusted <i>t</i> -statistic	Skewness- <i>t</i> -statistic	ABHARs (7) adjusted <i>t</i> -statistic	Skewness- <i>t</i> -statistic
Bidding Firms (32 firms)				
Average	-0.046	-18.97**	0.125	6.94**
% of negative	68.75	68.75	31.25	31.25
% of positive	31.25	31.25	68.75	68.75

Table 2. The Average Buy-and-Hold Abnormal Returns, ABHARs (2), Estimated from the Matched Reference Portfolio Method for Bidding Firms (Bid Period) Investigations

A matched reference portfolio method was applied for the measurements of the bid period (-12,+12) abnormal returns for the bidding firm's shareholders. The results estimated from a total of 72 reference portfolios for 32 bidding firms for the bid period (-12,+12) were analyzed. This Table provides the bid period average buy-and hold abnormal returns

(ABHARs) for the bidding firm's shareholders, ABHARs(6), which BR_i was calculated from $BR_i(R_{rb}) = \prod_{t=0}^{T-1} (1 + 1/n \sum_{i=1}^n r_{it}) - 1 \dots (6)$. The return performances were measured from all tender offers occurring from 1992-2002. Any bidding firm that was listed at any point of time of the takeovers taking place was selected. The bidding firms price data were available over the period (-48,+16) corresponding with the takeover announcement months. The monthly data during the period (-12,+12) were used to estimate the returns to the bidding firms and the reference portfolios matched on size and book-to-market ratios. After the criteria consideration, the number of the bidding firms included in the sample reduced from 42 to 32 firms; and the number of the reference portfolios reduced from 126 sets to 72 sets or accounting for approximately 57.14%. The bid period buy-and-hold returns of the bidding firms and the set of reference portfolios

were calculated as in the following formulas: $R_i = \prod_{t=0}^{T-1} (1+r_{it}) - 1$; $BR_i(R_{rb}) = \prod_{t=0}^{T-1} (1 + 1/n \sum_{i=1}^n r_{it}) - 1 \dots (6)$, respectively. Then, the average bid period BHARs to the bidding firms or means were calculated by the simple average method (method 1) and bootstrap approach (method 2). Also, the skewness-adjusted *t*-statistics were calculated as in the

following formula: $t_{sa} = \sqrt{n} (S+1/3 \hat{\gamma} S^2+1/6n \hat{\gamma}^2)$, $S = \overline{AR}_T / \sigma (AR_T)$ and $\hat{\gamma} = \frac{\sum_{i=1}^n (AR_{iT} - \overline{AR}_T)^3}{n \sigma (AR_T)^3}$. Finally, to test the null hypothesis of zero means at a significance level of α , the critical values for the skewness-adjusted *t*-statistics are based on the tabulated distribution of *t*-statistics. Significant means at 1% and 5% levels and are shown by ** and * respectively.

Sample	Measurement ¹	
	ABHARs (6) Method 1	ABHARs (6) Method 2
Bidding Firms (32 firms)		
Average	0.142	0.129
Skewness-adjusted-t statistic	2.48*	7.84**
% of positive difference between BHARs ²	56.94	

Note: ¹ Method 1 is the simple average method and Method 2 is the bootstrap approach
² The difference between BHARs of the bidding firm – BHARs of a set of portfolios which are actually averaged by the number of the sub-sets

Table 3. The Monthly Average Abnormal Returns Estimated from the Matched Reference Portfolio Method for Bidding Firms (Bid Period) Investigations

A matched reference portfolio method was applied for the measurement of the bid period abnormal returns for the bidding firm’s shareholders. The results estimated from a total of 72 reference portfolios for 32 bidding firms for the bid period (-12,+12) were analyzed. This Table provides the bid period abnormal returns for the bidding firm’s shareholders, the monthly average bid period abnormal returns. The return performances were measured from all tender offers occurring from 1992-2002. Any bidding firm that was listed at any point of time of the takeovers taking place was selected. The bidding firms’ price data were available over the period (-48,+16) corresponding with the event month. The monthly data during the period (-12,+12) were used to estimate the returns to the bidding firms and reference portfolios matched on size and book-to-market ratios. After the criteria consideration, the number of the bidding firms included in the sample reduced from 42 to 32 firms; and the number of the reference of portfolios reduced from 126 sets to 72 sets or approximately 57.14%. The monthly bid period abnormal returns for the bidding firm’s shareholders were estimated from the difference between the monthly returns to the bidding firms and a reference portfolio or each subset of the reference portfolios. The bootstrap approach was applied by means of using 1000 times re-sampling from the monthly returns of each subset of the reference portfolios. Then, the monthly average bid period abnormal returns to the bidding firms were calculated which resulted in 604 monthly average abnormal returns (observations) to the total bidding firms in the sample. Also, skewness-adjusted *t*-statistics were calculated as in the

following formulas: $t_{sa} = \sqrt{n} (S+1/3 \hat{\gamma} S^2+1/6n \hat{\gamma}^3)$, $S = \overline{AR}_T / \sigma(AR_T)$ and $\hat{\gamma} = \frac{\sum_{i=1}^n (AR_{iT} - \overline{AR}_T)^3 / n\sigma(AR_T)^3}{\sum_{i=1}^n (AR_{iT} - \overline{AR}_T)^2 / n\sigma(AR_T)^2}$. The means of the monthly bid period abnormal returns and skewness-adjusted *t*-statistics to each of the bidding firms were calculated which are shown in the Table. Finally, to test the null hypothesis of zero means at a significance level of α , the critical values for the skewness-adjusted *t*-statistics are based on the tabulated distribution of *t*-statistics. Significant means at 1% and 5% levels are shown by ** and * respectively.

Sample	Monthly average abnormal returns	Skewness- adjusted <i>t</i> -statistic
Bidding Firms (32 firms)		
Average	0.008	-0.90
% of positive	68.75	65.63

Table 4. The Cumulative Average Abnormal Returns (CAARs) Estimated from the Matched Reference Portfolio Method for Bidding Firms (Bid Period) Investigations

A matched reference portfolio method was applied for the measurements of the bid period (-12,+12) abnormal returns for the bidding firm’s shareholders. The results estimated from a total of 72 reference portfolios for 32 bidding firms for the bid period (-12,+12) were analyzed. This Table provides the bid period cumulative average abnormal returns (CAARs) for the bidding firm’s shareholders. The return performances were measured from all tender offers occurring from 1992-2002. Any bidding firm that was listed at any point of time of the takeovers taking place was selected. The bidding firms’ price data were available over the period (-48,+16) in correspondence with the event months. The monthly data during the (-12,+12) were used to estimate the returns to the bidding firms and reference portfolios matched on size and book-to-market ratios. After the criteria consideration, the number of the bidding firms included in the sample reduced from 42 to 32 firms; and the number of the reference portfolios reduced from 126 sets to 72 sets or accounting for approximately 57.14%. The cumulative method was applied to estimate the bid period cumulative returns from the bidding firms (R_{it}) and the reference portfolios ($E(R_{it})$). The bid period cumulative average abnormal returns (CAARs) to the bidding firms were calculated from the difference between the bid period cumulative returns to

the bidding firms and the reference portfolios as in the following formulas: $CAR = \frac{\sum_{i=1}^T [R_{it} - E(R_{it})]}{T}$. Then, the CAARs to the bidding firms or means were calculated by the simple average method (method 1) and bootstrap approach (method

2). Also, the skewness-adjusted *t*-statistics were calculated as in the following formulas: $t_{sa} = \sqrt{n} (S+1/3 \hat{\gamma} S^2+1/6n \hat{\gamma}^3)$,

$S = \overline{AR}_T / \sigma(AR_T)$ and $\hat{\gamma} = \frac{\sum_{i=1}^n (AR_{iT} - \overline{AR}_T)^3 / n\sigma(AR_T)^3}{\sum_{i=1}^n (AR_{iT} - \overline{AR}_T)^2 / n\sigma(AR_T)^2}$. Finally, to test the null hypothesis of zero means at a significance level of α , the critical values for the skewness-adjusted *t*-statistics are based on the tabulated distribution of *t*-statistics. Significant means at 1% and 5% levels are shown by ** and * respectively.

Sample	Measurement ¹	
	CAARs Method 1	CAARs Method 2
Bidding Firms (32 firms)		
Average	0.102	0.118
Skewness-adjusted-t statistic	2.14*	8.79**
% of positive difference between CARs ²	54.17	

Note: ¹ Method 1 is the simple average method and Method 2 is the bootstrap approach

² The difference between CARs of the bidding firm - CARs of a set of portfolios which are actually averaged by the number of the sub-sets

Tables 1 and 2 show that for the bid period or the period (-12,+12), the average buy-and-hold abnormal returns (ABHARs) estimated from the BHARs(6), or ABHARs (6), and the BHARs (7), or ABHARs (7), for the bidding firm's shareholders are positive at 14.20% (method 1) and 12.90% (method 2); and 12.50% respectively. Accordingly, Table 3 shows that the monthly average abnormal returns are positive at 0.80%. These results are confirmed by the percentages of positive abnormal returns of 56.94% for the ABHARs(6), 68.75% for the ABHARs(7), and 68.75% for the monthly average abnormal returns. They are further confirmed by the significance tests which are significant with *t*-statistics of 2.48 and 7.84 for the ABHARs(6) (method 1) and (method 2) respectively, and 6.94 for the ABHARs(7), but insignificant with *t*-statistics of -0.90 for the monthly average abnormal returns. Therefore, the results are consistent with each other in terms of both the direction and magnitude between the ABHARs(6) and ABHARs(7), but of different magnitude when compared with the monthly average abnormal returns.

At the same time, Table 4 shows that the cumulative average abnormal returns (CAARs) for the bidding firm's shareholders are positive at 10.20% (method 1) and 11.80% (method 2), both are significant with *t*-statistics of 2.14 and 8.79 respectively. Also, it is supported by the percentage of the positive CAARs of about 54.17%. The results are consistent with the ABHARs(6), ABHARs(7), and the monthly average abnormal returns. However, Table 1 shows that the average buy-and-hold abnormal returns estimated from the BHARs(5), or ABHARs (5), are significantly negative at -4.60% ($t = -18.97$). It is also confirmed by the percentage of the negative ABHARs (5) of approximately 68.75%. Nevertheless, each earlier result is supported by the percentages of the positive and negative skewness-adjusted *t*-statistics for the abnormal returns. The percentage of the positive skewness-adjusted *t*-statistics for the ABHARs(7) is 68.75%, and the percentage of the negative skewness-adjusted *t*-statistics for the ABHARs(5) is 68.75% meanwhile, the percentage of the positive skewness-adjusted *t*-statistics for the monthly average abnormal returns is up to 65.63%.

In conclusion, the results are mostly robust or consistent, when compared across the same and different methods as well as between the same and different formulas. The ABHARs(6) for the bidding firm's shareholders are strongly consistent, in terms of both the return direction and magnitude, with the ABHARs(7), and the CAARs; and consistent in the sense of return direction but not magnitude with the monthly average abnormal returns. However, the results are not consistent with the ABHARs (5) which are significantly negative. Nevertheless, even though the takeover results in positive and negative bid period abnormal returns, as estimated from the matched reference portfolio method, for the bidding firm's shareholders, all of the findings from this study show that they are significant and supportive to each other, on average, when using different return measures for the investigations. Thus, it is concluded that the takeover announcement results in positive as well as negative abnormal returns for the bidding firm's shareholders.

6. Conclusions

The study gives light to many results which are robust. The findings are consistent with each other, particularly in terms of the return direction at least, when comparisons are made between the CAR and BHAR methods, and also with the monthly average abnormal return method. The results are internally consistent when compared within this study itself and also with most of the findings of previous studies of the developed stock markets and the limited existing studies of the emerging stock markets, with respect to the different samples, methods and time periods of the investigations. The CAARs, ABHARs, and monthly average abnormal returns over the period (-12,+12) are significantly positive at 10-12%, 13-14%, significant and negative at -4.60%, and 1.80% (monthly), respectively.

In comparison, this study applied more advanced research methods by using the CAR, BHAR and monthly average abnormal return methods for the measurement of the returns estimated by the matched reference portfolio method, and the bootstrapped skewness-adjusted *t*-statistic tests to undertake the mean abnormal return significance tests. This research contributes to the understanding of the impact of takeover effects on the bidding firms traded on the SET. The main findings of this study suggest that a Thai takeover effect results in positive and negative significant abnormal returns to bidding firm's shareholders. However, alternatively, most of the findings from this study show that there are positive rather than negative abnormal returns and the prior is greater than the latter in terms of magnitude, explaining that takeovers create value. The results add to the literature on emerging markets in terms of enhancing the existing literature, given the limited number of prior studies involved and limited ways of applying research methodologies, and international comparisons of the takeover effects on the Thai stock market.

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THE ROBUSTNESS OF OKUN’S LAW: A TIME SERIES VALIDATION IN THE CONTEXT OF PAKISTAN (1975-2009)

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Abstract

Growth is a matter of extreme importance for the countries of developed and developing world. Sustained growth with employment generating policies eventually trims down the critical problem of unemployment. This paper emphasizes the link between GDP per capita and unemployment rate, as described by Okun’s law. In a developing country like Pakistan, Okun’s law approach is employed on a data set of 35 years starting from 1975-2009. Okun’s law helps in examining the relationship between economic growth and unemployment. Non-parametric estimates of the potential output are calculated. The results are in the range of 6.73 to 13.22 percent. In this paper three different methods have been used to test the validity of the Okun’s law in the context of Pakistan i.e., Original Okun’s Model, Inverse Okun’s Model and Normalized Cointegration Okun’s model. The empirical analysis shows that a rise of one percentage point of unemployment is associated with a decline of 0.15, 0.41 and 0.63 percentage point of real GDP growth in the all three models respectively. The result suggests that when the state of the economy improves, the unemployment rate falls, though, this relationship is less than one to one.

Keywords: economic growth, unemployment, Okun’s Law, Inverse Okun’s Law, cointegration, Pakistan.

JEL Classification: E34, E24, C2

1. Introduction

In the sixties and seventies the relationship between GDP growth and unemployment was clear and undisputed. ‘Okun’s Law’ was regarded as one of the most reliable macroeconomic relations at that time. In the eighties and nineties, most politicians and along with them the mainstream of economists was playing down the relationship between growth and unemployment. Unemployment was explained by structural factors, mainly by inflexible labour markets: too high wages, too high unemployment benefits and too narrow wage differentials. It has been argued that even with growth rates of 2 percent unemployment was rising and that the relation has become very unstable. Moreover, it has been argued that higher growth rates would cause inflation and therefore would not be sustainable. However, the experience of the US in the nineties does not support this view (see, Walterskirchen 1999). Okun (1962) used three different econometric specifications to prove that there was a robust bi-directional statistical relationship between unemployment and economic growth for the economy of the United States (1947.2–1960.4) which are presented in Table 1.

Table 1. Okun (1962) Models

Model	Estimation	Okun Coefficient	
		β_2	$1/\beta_2$
First differences	$\Delta U_t = 0.3 - 0.3Y_t$	0.3	3.3
(1) $\Delta U_t = \beta_1 + \beta_2 Y_t + \varepsilon_t$			
Output Gap	$U_t = 3.72 - 0.36Y_t^b$	0.36	2.8
(2) $U_t = \beta_1 + \beta_2 Y_t^b + \varepsilon_t$			

Model	Estimation	Okun Coefficient	
		β_2	$1/\beta_2$
Fitter trend and elasticity (3) $\ln(E)_t = \beta_1 + \beta_2 \ln(Y)_t + \beta_3 t + \varepsilon_t$	$\ln(E)_t = 212 + 0.4 \ln(Y)_t - 0.32t$	0.4-0.35	2.5-2.8

Notes: U^t = Unemployment rate; Y_t = Output growth; Y_t^b = Output gap = $\frac{Y_t^p - Y_t}{Y_t^p} : Y_t^p$ = Potential output; Y_t = Actual output; E = Employment Rate = (100- U^t), t = time.

Okun’s empirical conclusion coming out from the first two estimations is that in the long run, the unemployment reduction has a more than proportional effect on the dynamics of GDP($1/\beta^2$). Economic growth is recognized as a way of improving the conditions of the residents of the country. However, despite the various efforts, Pakistan failed to achieve a sustainable growth to reduce unemployment which ultimately converts into poverty. During the first five decades as mentioned in the Table 2.

Table 2. Economic Growth during First Five Decades

Decades/Year	Economic Growth (%)
1960s	6.8
1970s	4.8
1980s	6.5
1990s	4.6
2000s	4.8

Source: Khan (2002), Chaudhri (2003), Bhatti (2001) and Economic Survey of Pakistan (2009-10).

Khan (2002) identified that a high unsTable growth and its structure (pattern) are the primary factors explaining changes in poverty in Pakistan. The pattern of growth in Pakistan failed to provide sufficient employment and income opportunities (Mahmood 2005). Despite severe challenges, the economy has shown resilience in the outgoing year. Growth in Gross Domestic Product (GDP) for 2009-10, on an inflation-adjusted basis, has been recorded at a provisional 4.1%. This compares with GDP growth of 1.2% in the previous year (Economic Survey of Pakistan 2009-10). In order to combat poverty, the government of Pakistan has taken various practical steps to increased employment opportunities in the country. However, the following Table 3 indicates the unemployment its self remained a challenge from the first five decades as the rate of unemployment increased from 1.35% (1960s) to 6.8% (2000s).

Table 3. Labor Force Participation and Unemployment Rates

Decades/ Year	Labor Force (million)	Employment Labor Force (million)	Labor Force Participation Rate (%)	Unemployment Rate (%)
1960s	17.05	16.82	32.00	1.35
1970s	21.51	20.97	30.18	2.43
1980s	28.46	24.59	32.15	3.51
1990s	35.10	33.10	28.35	5.23
2000s	45.54	42.41	32.41	6.81

Source: Chaudhry (2003) and Economic Survey of Pakistan, 2009-10.

Economic growth is essential for job creation and poverty alleviation. Pakistan’s economy has gone through a various stages of decline and high economic growth over the first five decades (1960 - 2000) which provides an interesting case study of the relationship between growth and labour market characteristics. The data of the first five decades compiled from various resources provide a confused picture of economic growth, and unemployment as shown in the following Table 4.

Table 4. Trends in Growth and Unemployment in Pakistan

Decades/ Year	Growth	Unemployment
1960s	Rapid Increase	Low
1970s	Decreased	Increased
1980s	Rapid Increase	Increased
1990s	Substantial Decline	Increased
2000s	Slow Increased	Increased

Source: Zaidi (2007) and Self Developed.

The above discussion does not clarify that how much growth is necessary to reduce unemployment to a certain amount / level. Therefore, the macroeconomic links between economic growth and the labour market are analyzed in the specific context of Pakistan. The main purpose of the study is to estimate the three Okun models (1962) for the Pakistan economy using annual data (1975-2009), in order to prove that unemployment constraints the long run growth, and compare our results with those obtained with annual series by Lee (2002), Loria, and Ramos (2007), Hussain *et al.* (2010) and Lal *et al.* (2010). Therefore, we corroborate that in Pakistan the Okun law is validated for data of different periodicity and length. Our results indicate that there is a relationship between the unemployment rate and output growth –in its three variants- and that Okun’s coefficient is found in the interval of 0.15-0.63.

1.1. Objectives:

The objective of this paper is:

- To empirical estimate the relationship between economic fluctuation and the change in unemployment (Okun’s Law) in the last thirty five years of Pakistan i.e., 1975-2009.
- To analyze how much growth changes with the change of unemployment in the long run and short run?

1.2. Hypothesis:

The study hypothesis the following:

- There is still a strong and positive relation between GDP growth and employment. But employment, of course, will rise only if economic growth rates are outstripping productivity gains.
- There is a long-run relationship exists between unemployment and GDP per capita, but certainly not a 1:1 relation. This connection may be obscured by political and social factors.

The paper is organized as follows: after introduction which is provided in Section 1 above, we present the brief overview of unemployment rate and GDP growth rate in Pakistan in Section 2. Data source and methodological framework is carried out in Section 3. Results are presented in Section 4. Final section concludes the study.

2. Brief Overview of Unemployment and GDP Growth Rate in Pakistan

2.1. Unemployment Rate

In 1970s, average unemployment rate was 3.43 percents. It increased by only 0.1 percent in the year 1980s (3.44%). Afterward, average unemployment rate increased sharply in the year 1990s and 2000s, where average unemployment rate was reported almost 5.56 and 6.97 percent respectively (*see* Figure 1).

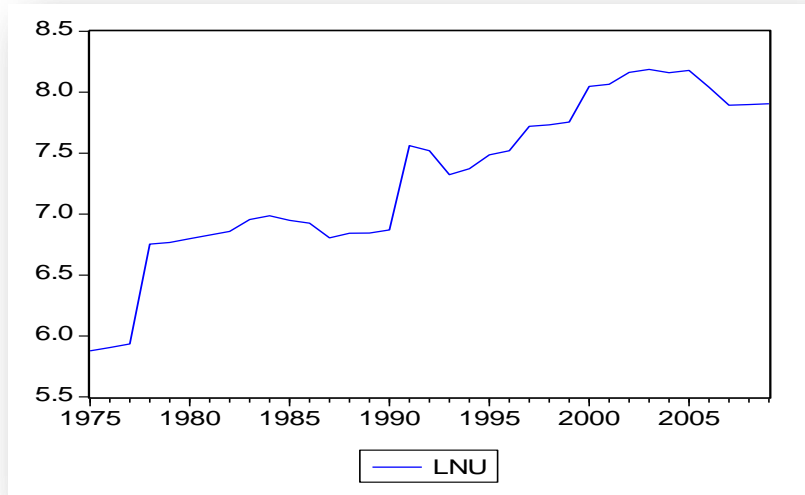


Figure 1. Unemployment rate in Pakistan

Source: World Development indicators (2010) and Economic Survey of Pakistan (2010).

2.2. Changes in economic growth (Y) and Unemployment Rate (U) in Pakistan

The relationship between unemployment and GDP growth rate in Pakistan is an interesting example. There have been greater fluctuations in economic growth and unemployment rate during the years 1975-2009. Hence, there has been found a positive relationship between economic growth and unemployment rate.

$$\Delta Y_t = \beta_0 + \beta_1 \Delta Y_{t-1} + \beta_2 U_t + \varepsilon \tag{1}$$

$\beta_0 = -0.070 (0.067)***$; $\Delta Y_{t-1} = 0.764 (0.0000)*$; $U = 0.010 (0.0426)**$
 Adjusted R-square = 0.45; D.W = 1.807; F-statistics = 2.985 (0.047) **

Note: *, ** and *** represents 0.01%, 0.05% and 0.09% significance level.

2.3. Actual Growth Rate (AY), Potential Growth Rate (PY) and Output Gap (YGAP) estimates in Pakistan

Output Gap is the difference between the actual growth rate minus potential output (PY). The potential output could be estimated from the regression of the percentage change in the real GDP on the unemployment rate (U). The estimated regression equation is:

$$\Delta Y = \beta_0 + \beta_1 U + \varepsilon \tag{2}$$

$$\Delta Y = 0.119 - 0.0090 * U$$

Adjusted R-square = 0.37; D.W = 2.012; F-statistics = 6.450 (0.0042)*

Note: * represents 0.01% significance level.

According to the regression line, the potential output growth is approximately 13.2 percent. Output gap is estimated from 1975-2009 and observed as 7.29 percent, while average growth rate was 5.92 percent which is less than the potential output. It means that growth expectations have been fall between these years, so low growth tends is observed. Actual growth and output gap for the period of 1975-2009 are mentioned in Table 5 and Figure 2 respectively.

Table 5. Potential Output Estimates

Sample Period	PY	AY	YGAP	R ²
1975-1985	7.66	7.77	0.12	0.48
1985-1995	6.73	3.68	-3.04	0.42
1995-2005	7.28	4.76	-2.51	0.33
1999-2009	7.63	6.87	-0.75	0.41
1975-2009	13.22	5.92	-7.29	0.45

Source: Authors calculation. PY = Potential output, AY = Average output, YGAP = Output Gap

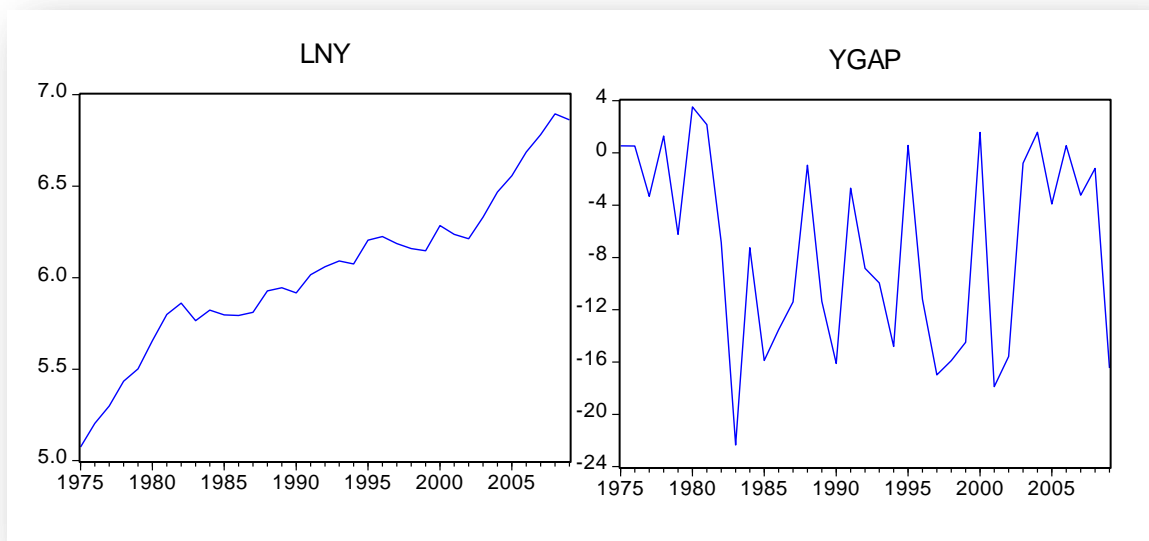


Figure 2. Actual Growth rate and Output Gap in Pakistan

Source: World Development indicators (2010) and Self estimated (YGAP).

3. Literature Review

There has been extensive literature on the issue of growth and unemployment. In the late forties, Verdoorn (1949) stating a close linear relationship between the growth of industrial output and labour productivity in the long run. Verdoorn found an elasticity of productivity with respect to industrial production of 0.45. Verdoorn and later also Kaldor (1966) interpreted the productivity elasticities (‘Verdoorn coefficients’) as indicators of increasing returns to scale due to a higher division of labour. The results of Kaldor's cross-country study were similar to that of Verdoorn: An increase in output growth of 1 percent leads to an increase in productivity and employment growth of half a percentage point each. It should be noted: The higher the productivity effects of growth, the more difficult it will be to keep unemployment from rising.

Okun's discovery has great importance because of its explicative capacity of economic development:

‘The failure to use one year's potential fully can influence future potential GNP: to the extent that low utilization rates and accompanying low profits and personal incomes hold down investment in plant, equipment, research, housing, and education, the growth of potential GNP will retarded’ (Okun 1962, 2).

Okun (1962), at the high-tide of Keynesianism, referred to a stable relation between GDP growth and the change in the unemployment rate. According to ‘Okun's Law’ an increase of the economic growth rate by 3 percent (above the normal rate) was expected to reduce the unemployment rate by 1 percentage point. Or, to put it the other way round: The gain of real GDP associated with a reduction in unemployment of one

percentage point was estimated to be 3 percent. Okun's Law covers the short-run productivity gains from higher capacity utilization, longer working hours (overtime) and less labour hoarding associated with output growth. This overlaps with Verdoorn's Law, which states a linear relationship between the growth of GDP and labour productivity in the long run, with increasing returns to scale as an important determinant (see, Hagemann and Seiter, 1999). Aranki *et al.* (2010) finds on the basis of Swedish data regarding the relationship between GDP and unemployment which varied in different periods. The estimate shows that the relationship varies over time and that a higher level of economic growth is needed today to change the level of unemployment compared to the average historical relationship.

Seyfried (2005) examine the relationship between economic growth, as measured by both real GDP and the output gap, and employment in the ten largest states from 1990 to 2003. Results indicate that economic growth has positive and significant impact on employment, its effects continue for several quarters in most of the states considered. Hussain *et al.* (2010) examine causal relationship between growth and unemployment, using time series data for Pakistan from 1972 to 2006. The results indicate that there is short and long run causal relation between growth and unemployment including capital, labor and human capital as explanatory variables.

Jones and Manuelli (1990), King and Rebelo (1990) and Rebelo (1991) elucidated that the firms frequently add to their stocks of capital in a perfectly competitive background with constant returns to scale. A second approach casts outer economies in a leading role in the growth process. When firms gather new capital, they unwillingly contribute to the productivity of capital seized by others. Such spill-overs may take place in the course of investment in physical capital or human capital. Factors of growth in transition economies appeared in 1990s.

Tatoglu (2011) finds the movement of unemployment rate and economic growth rate for individuals and pooled cases in European countries over the period 1977-2008. The result show that the validity of Okun's Law and the significance of the relationship between economic growth rate and unemployment rate vary between countries. According to estimates by Gordon (2008) potential output has grown at an average annual rate of 3.4%, however, that growth in potential GDP will be that rapid over the next 20 years. He argues that the acceleration in productivity growth of the late 1990s was temporary. He examines economy-wide productivity rather than just that for the private business sector and finds that productivity growth slowed between 2004 and 2008 because the gains from information technology investments were beginning to diminish. His assumption of slower productivity growth along with expected declines in the growth rate of the labour force led him to project a 2.4% rate of growth in potential output over the next 20 years. If that view is correct, then over the long run, real economic growth in excess of 2.4% would be likely to yield a declining rate of unemployment.

Adachi (2007) constructs a model of economic growth that includes the unemployment rate as an endogenous variable. The dynamic equation of this model is reduced to the relation between changes in the unemployment rate and changes in output growth, which gives theoretical foundations of Okun's law. This theoretical relation is tested by using the data of the USA and Japan. The result reveals that the substantial difference of Okun's coefficient between the two countries may be attributed at least partly to the difference in the elasticity of the real wage rate to the unemployment rate, i.e., the real wage flexibility.

Lal *et al.* (2010) estimate the Okun's coefficient, and check the validity of Okun's law in some countries of a Asian region namely Pakistan, Bangladesh, India, Srilanka and China, for this purpose they have used time series annual data during the period 1980 to 2006 and used Engle Granger (1987) co integration technique to find long run relationship between variable and error correction mechanism for short run dynamic. The result reveals that Okun's law interpretation may not be applicable in some Asian developing countries.

Both unemployment and economic growth have been a rising concern in the developing economies, hence there is a pressing need to evaluate and analyze the growth-unemployment nexus and to find out the inter relationship. In the subsequent sections an effort has been made to empirically find out the long-run relationship between growth and unemployment in the context of Pakistan.

4. Data Source and Methodological Framework

The data of economic growth, employment and unemployment will be taken from the World Development Indicator (2010) and Economic Survey of Pakistan (2009-10) for the period of 1970-2009. Unemployment normally co-varies with the business cycle. Economists usually refer to this relationship as the Okun relationship or Okun's law. Okun (1962) presented two empirical relationships, the difference version and the gap version, between the business cycle and unemployment. The difference version of Okun's law captures the relationship between GDP growth and the change in unemployment, while the gap

version shows the relationship in the form of deviations from a more long-term trend. Okun's law states the level of GDP growth required for the level of unemployment to remain unchanged. The law itself states that if actual GDP growth is below this level then unemployment will increase, and vice versa. However, as the business cycle affects unemployment with a certain time lag it is not only the contemporaneous relationship that is of interest. The change in unemployment is also affected by GDP growth in earlier periods and possibly by the change in unemployment in earlier periods.

The purpose of the study is to estimate three Okun models inversely, thus solving a serious econometric bias problem detected by Barreto & Howland (1993) in Okun's seminal article. This problem consists in estimating the current regression and afterwards solving arithmetically for the exogenous, just by doing algebra. Therefore, it does not matter regressing U on Y or the other way around. By doing this Okun claims that it is possible to find economic sense in both directions. This procedure has been followed by many authors. Accordingly, when passing directly in estimations (1) and (2) from β_2 to $1/\beta_2$ he was able to explain –at the same statistical level– either economic growth or unemployment. Nevertheless, in the original Okun's models (1 and 2) there are two variables and the reading must be made as usual (from the right hand side to the left hand side), and the fact of reading inversely is not only related to the causality sense coming out from the economic theory, but also –and not less important– has to do with the properties of a joint distribution function, which refers a conditional specification of random variables of the kind.

$$E(Y|X) = \alpha + \beta X, E(X|Y) = \gamma + \theta Y$$

Barreto and Howland (1993, 4) outline that the correct specification depends on the specific question of interest. This task determines the regression direction:

Thus Okun's procedure [make the bi-directional reading as of β_2 , our aggregate] makes sense only if the underlying structure in the model is assumed to be stable, i.e., if the parameters of the model do not change between the sample period and the date on which the GNP gap is to be predicted. If any of the structural parameters have changed in the intervening time, then the sample relationship will produce biased estimates of the GNP gap.

Thus, in order to avoid the possible problem of referred bias and since our main purpose is to prove specifically that unemployment restricts economic growth, we choose the direct estimation for the three Okun estimations. That is, we proceeded by the inverse specification to that of Okun in the following way: $Y = f(U)$, thus the reading is direct in terms of our hypothesis. One advantage of this procedure is that the estimated parameter 'potential output' captures the long run movements of the series involved as well as the effects that β_2 can't explain' (Loría, and Ramos 2007, 29).

4.1. Econometric Framework

Cointegration is a statistical property of time series variables. If two or more series are individually integrated (in the time series sense) but some linear combination of them has a lower order of integration, then the series are said to be cointegrated.

4.1.2. Johansen Cointegration (Multivariate cointegration) Method

In order to confirm the degree, the series split univariate integration properties; we execute unit root stationarity tests. The DF (Dickey & Fuller, 1979 and 1981) is suitable for testing procedures, because it is based on the null hypothesis that a unit root exists in the autoregressive representation of the time series.

Step 1: Setting the appropriate lag length of the model. The most common procedure in choosing the optimal lag length is to estimate a VAR model including all our variables in non-differenced data. This VAR model should be estimated for a large number of lags, then reducing down by reestimating the model for one lag less until we reach zero lags. In each of these models we inspect the values of AIC and the SBC criteria. The model that minimizes the AIC and the SBC is selected as the one with the optimal lag length.

Step 2: Choosing the appropriate model regarding the deterministic components in the multivariate system. In general five distinct models can be considered. Although the first and the fifth model are not that realistic and they are also implausible in terms of economic theory, therefore, the problem reduces to a choice of one of the three remaining models (model 2, 3 and 4).

Model 1: No intercept or trend in CE or VAR.

Model 2: Intercept (no trend) in CE, no intercept or trend in VAR.

Model 3: Intercept in CE and VAR, no trends in CE and VAR.

Model 4: Intercept in CE and VAR, linear trend in CE, no trend in VAR.

Model 5: Intercept and quadratic trend in the CE intercept and linear trend in VAR.

Step 3: Determining the ranks of Π or the number of cointegrating vectors. For the intention of investigating the long-run relationship among the variables, they must be co-integrated. In the multivariate case, if the I(1) variables are linked by more than one co-integrating vector, the Engle-Granger procedure is not applicable. The test for co-integration used here is the likelihood ratio put forward by Johansen and Juselius (1990), indicating that the maximum likelihood method is more appropriate in a multivariate system. Therefore, this method is used in this study to identify the number of co-integrated vectors in the model. The Johansen and Juselius method has been developed in part by the literature available in the field and reduced rank regression, and the co-integrating vector 'r' is defined by Johansen as the maximum Eigen-value and trace test. There is 'r' or more co-integrating vectors.

Johansen's method involves the estimation of the above equation by the maximum likelihood technique, and the testing of the hypothesis $H_0: (\pi = \Psi \xi)$ of 'r' co-integrating relationships, where 'r' is the rank or the matrix $\pi(O \angle r \angle P)$, Ψ is the matrix of weights with which the variable enters co-integrating relationships and ξ is the matrix of co-integrating vectors. The null hypothesis of non-cointegration among

variables is rejected when the estimated likelihood test statistic $\phi_i = -n \sum_{t=r+1}^p \ln(1 - \hat{\lambda}_i)$ exceeds its critical value. Given estimates of the Eigen-value ($\hat{\lambda}_i$) the Eigen-vector (ξ_i) and the weights (Ψ_i), we can find out whether or not the variables in the vector are co-integrated in one or more long-run relationships among the dependent variables.

Step 4: Impulse Responses. A shock to the *i*-th variable not only directly affects the *i*-th variable but is also transmitted to all of the other endogenous variables through the dynamic (lag) structure of the VAR. An impulse response function traces the effect of a one-time shock to one of the innovations on current and future values of the endogenous variables (EViews 5 User's Guide, Retrieved January, 14, 2011).

Step 5: Variance Decomposition. While impulse response functions trace the effects of a shock to one endogenous variable on to the other variables in the VAR, variance decomposition separates the variation in an endogenous variable into the component shocks to the VAR. Thus, the variance decomposition provides information about the relative importance of each random innovation in affecting the variables in the VAR (EViews 5 User's Guide, Retrieved January, 14, 2011).

5. Results and Discussion

The study first estimate the Okun's law in the context of Pakistan. The empirical results in Table 6 appear to be very good in terms of the usual diagnostic statistics. The value of R^2 adjusted for equation (1) indicates that 51.8% variation in dependent variable has been explained by variations in independent variables. F value is higher than its critical value suggesting a good overall significance of the estimated model. Therefore, fitness of the model is acceptable empirically. The Durbin Watson Test is almost near to 2, therefore, there may have no serious problem of autocorrelation in the model. The constant in this equation shows the mean change in the unemployment rate when the growth rate of the economy is equal to zero, so from the obtained results we conclude that when the economy does not growth the unemployment rate rises by 0.76 percent. The negative coefficient of GDP per capita indicates that when the state of the economy improves, the unemployment rate falls. The relationship is less than one to one. A one percent increase in GDP per capita is connected with a 0.15 percent decrease in the unemployment rate. The result further reveals that coming out from the first two estimations, in the long run, the unemployment reduction has a more than proportional effect on the dynamics of GDP ($1/\beta_2$). The value of the coefficients is congruent with the structure of the Pakistan economy which is labor intensive and low productivity

Table 6. Estimation of Okun's Model in Pakistan (1975-2009)

Model	Estimation	Okun Coefficient	
		β_2	$1/\beta_2$
First differences	$\Delta U_t = 0.76 - 0.15Y_t$	0.15	6.61
(1) $\Delta U_t = \beta_1 + \beta_2 Y_t + \varepsilon_t$	$R^2 = 0.518, D.W = 1.97, F = 7.245^*$		

Model	Estimation	Okun Coefficient	
		β_2	$1/\beta_2$
Output Gap (2) $U_t = \beta_1 + \beta_2 Y^b_t + \varepsilon_t$	$U_t = 7.729 + 0.021Y^b_t$ $R^2 = 0.428, D.W = 1.67, F = 5.825^*$	0.02	4.72
Fitter trend and elasticity (3) $\ln(E)_t = \beta_1 + \beta_2 \ln(Y)_t + \beta_3 t + \varepsilon_t$	$\ln(E)_t = 12.165 + 1.093 \ln(Y)_t - 0.092t$ $R^2 = 0.409, D.W = 1.42, F = 2.872^{**}$	1.09-0.09	0.91-11.11

Notes: U^t = Unemployment rate; Y_t = Output growth; Y^b_t = Output gap = $\frac{Y_t^p - Y_t}{Y_t^p} : Y_t^p$ = Potential output; E =

Employment Rate = (100 - U^t), t = time. * and ** represents 0.01 and 0.05 percent significance level.

The study further estimate inverse Okun’s law in Table 7 to solve a serious econometric bias problem which was detected by Barreto & Howland (1993) in Okun’s seminal article.

Table 7. Estimation of Barreto and Howland (1993) – Inverse Okun’s Model in Pakistan (1975-2009)

Model	Estimation	Okun Coefficient	
		β_2	$1/\beta_2$
First differences (1) $Y_t = \beta_0 (PY)_t + \beta_1 \Delta U_t + \varepsilon_t$	$Y_t = 0.621(PY)_t - 0.414\Delta U$ $R^2 = 0.482, D.W = 1.675, F = 4.292^*$	0.414	2.415
Output Gap (2) $(YGAP)_t = \beta_0 (PY)_t + \beta_1 U_t + \varepsilon_t$	$(YGAP)_t = 0.745(PY)_t + 0.396U_t$ $R^2 = 0.430, D.W = 1.521, F = 3.982^*$	0.396	2.525
Fitter trend and elasticity (3) $\ln(Y)_t = \beta_0 (PY)_t + \beta_1 \ln(E)_t + \varepsilon_t$	$\ln(Y)_t = 0.067(PY)_t + 2.425E_t$ $R^2 = 0.410, D.W = 1.425, F = 3.912^*$	2.425	0.412
Average Inverse Okun’s Coefficient = 1.784			

Notes: U^t – Unemployment rate; Y_t – Output growth; YGAP – Output gap = $\frac{Y_t^p - Y_t}{Y_t^p} : PY_t$ = Potential

output; E – Employment Rate = (100 - U^t), t – time.

Empirical evidence reported in Table 10 shows the inverse specification of Okun’s law, this law accomplished in Pakistan. The value of the coefficients for equation (1) and (2) are congruent with the structure of the Pakistan economy i.e., labour intensive and low productivity. Model (3) depicts two results with high economic meaning. On the one hand, potential output has a positive impact on growth per capita, while on the other side, economic growth tends to increase employment rate in the economy. However, this is less than ones less elastic. The parameter of the employment rate (E) can calculate the output elasticity to employment i.e., $1/2.425 = 0.412$, that even with the methodological anticipated warnings, we can take it safely since it is congruent with the results obtained by Loría & Ramos and other applied works such as Loría (2006) and Hernández (1998) for taking time series data for Mexican economy. The problem of spurious regression could only exist in model (3) and to discard it we followed the Johansen Cointegration procedure. The descriptive statistics of Y, PY, YGAP and U are given in Table 8.

Table 8. Descriptive statistics

	Y	PY	YGAP	U
Mean	456.5429	8.939429	-7.337530	1787.514
Median	428.0000	7.660000	-6.856364	1591.000
Maximum	987.0000	13.22000	3.514694	3594.000
Minimum	160.0000	6.730000	-22.33681	357.0000
Std. Dev.	205.6517	2.771015	7.443374	1032.423
Skewness	1.060797	0.890819	-0.196481	0.417164
Kurtosis	3.685338	1.877179	1.670899	1.834749
Jarque-Bera	2.299155	3.127651	2.801356	2.995287
Probability	0.196660	0.209406	0.246430	0.223657
Sum	15979.00	312.8800	-256.8136	62563.00
Sum Sq. Dev.	1437949.	261.0698	1883.730	36240487
Observations	35	35	35	35

Note: Y represents GDP per capita in US \$, PY represents potential output, YGAP represents output gap and U represents unemployment rate.

The above statistics shows that there has a positive skewed distribution of Y , PY and U, while there is negatively skewed distribution of YGAP. Jarque-Bera test of residual shows the normality of the distribution. Further, the present study finds the correlation matrix between the variables to analyze the size, direction and magnitudes of the said variables in Table 9.

Table 9. Correlation Matrix

Variables	D(Y)	PY	D(U)
D(Y)	1		
PY	0.856	1	
D(U)	-0.193	0.0704	1

Note: Y represents GDP per capita in US \$, PY represents potential output, YGAP represents output gap and U represents unemployment rate.

The result reveals that there is a positive and high correlation between Y and PY which shows the co-movement between the variables. However, there is a negative and smaller correlation between Y and U which shows that increasing economic growth tends to decrease unemployment. The study further analyze the variables with Hodrick – Prescott Filter to find the actual, trend and cyclical movement of the variable Y , YGAP and U respectively.

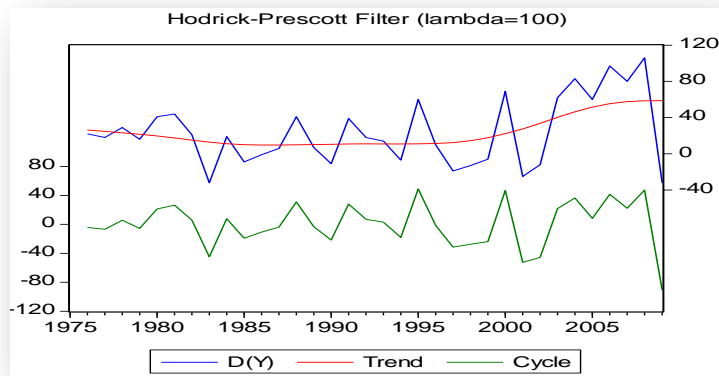


Figure 3. Hodrick-Prescott Filter for GDP per capita (Y)

The trend shows that there is the cyclical variation in the variable Y, Therefore, one could expect the non-stationary of the series. Next, we analyze the trend of PY and U in Figure 4 and 5 respectively.

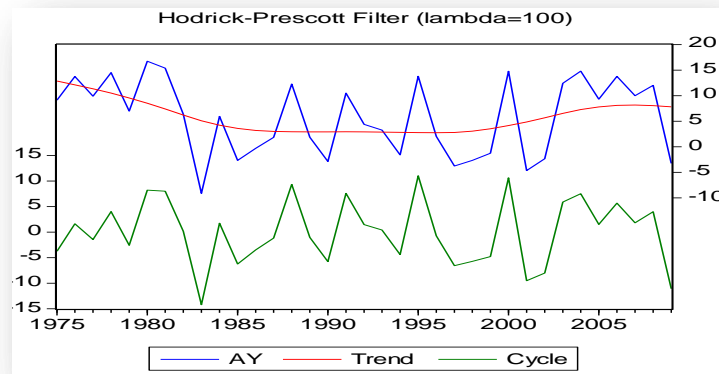


Figure 4. Hodrick-Prescott Filter for Potential Output (PY)

In Figure 5, we can find the trend of unemployment rate.

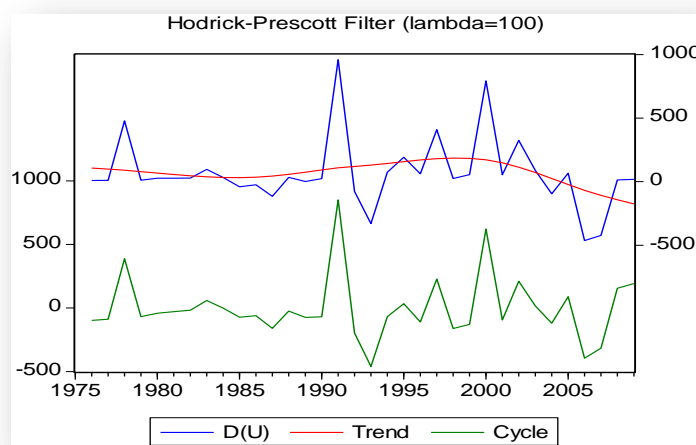


Figure 5. Hodrick-Prescott Filter for Unemployment Rate (U)

Figure 7, 8 and 9 depicts that the data has a cyclical rotation; therefore, the present study finds the unit root test at level and their first difference.

5.1. Cointegration Test

Economic time-series data are often found to be non-stationary, containing a unit root. Ordinary Least Squares (OLS) estimates are efficient if variables included in the model are stationary of the same order. Therefore, first we check the stationarity of all variables i.e. GDP per capita (Y), Potential Output (PY) and Unemployment rate (U) used in the study. For this purpose the study employed Augmented Dickey-Fuller (ADF) test. Table 10 gives the results of ADF tests.

Table 10. Augmented Dickey-Fuller (ADF) Test on the levels and on the First Difference of the Variables (1975-2009)

Variables	Level		First Difference		Decision
	Constant	Constant & Trend	Constant	Constant & Trend	
Y	1.526 (0)	-0.098 (0)	-4.053* (0)	-4.252*(0)	Non Stationary at level but stationary at first difference i.e., I (1)
PY	-0.562 (0)	-1.717 (0)	-5.716*(0)	-5.764*(0)	Non Stationary at level but stationary at first difference i.e., I (1)
U	-1.143 (0)	-1.640 (0)	-5.261*(0)	-5.240*(0)	Non Stationary at level but stationary at first difference i.e., I (1)

Note: The null hypothesis is that the series is non-stationary, or contains a unit root. The rejection of the null hypothesis is based on MacKinnon (1996) critical values i.e., at constant: -3.646, -2.954 and -2.615 are significant at 1%, 5% and 10% level respectively. While at constant and trend: -4.262, -3.552 and -3.209 are significant at 1%, 5% and 10% level respectively. First Difference: at constant: -3.646, -2.954 and -2.615 are significant at 1%, 5% and 10% level respectively and at constant and trend: -4.262, -3.552 and -3.209 are significant at 1%, 5% and 10% level respectively. The lag length are selected based on SIC criteria, this ranges from lag zero to lag four.

Based on the ADF tests, all given variables i.e., Y, PY and U are non-stationary at level, but stationary at their first difference i.e., I (1) variables. To find the long-run relationship between GDP per capita (Y), potential output (PY) and unemployment rate (U), the study employed Johansen cointegration technique. After finding the variables series of I (1), the next step is finding the appropriate lag length is very important because we want to have Gaussian error terms. The most common procedure in choosing the optimal lag length is to estimate a VAR model including all given variables in levels (non-differenced data). The study tested for the existence of long-run relationships. As the study use annual data, the maximum number of lags was set equal to 3 on the basis of AIC criteria, which is showing in Table 11.

Table 11. VAR Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-439.3043	NA*	1.28e+09	29.48695	29.62707*	29.53178*
1	-429.7821	16.50510	1.25e+09*	29.45214*	30.01262	29.63144
2	-427.2078	3.947285	1.95e+09	29.88052	30.86136	30.19430
3	-423.1587	5.398877	2.87e+09	30.21058	31.61178	30.65883
4	-415.4200	8.770478	3.46e+09	30.29467	32.11622	30.87740

* indicates lag order selected by the criterion

LR: sequence modified LR test statistic (each test at 5% level)

FPE: Final prediction error

AIC: Akaike Information criterion

SC: Schwarz information criterion

HQ: Hannan-Quinn information criterion

To examine the relationship between Y, PY and U, the Multivariate Co-integration Methodology as proposed by Johansen & Juselius (1990) is used. The Johansen maximum likelihood approach has some advantages over the traditional Engle-Granger procedure: (i) it allows testing in a multivariate framework (ii) it considers the error structure of the data processors (iii) it allows for interactions in the determination of the relevant economic variables, independent of the choice of the endogenous variables and (iv) it allows explicit hypothesis tests of parameter estimates and rank restrictions, using the likelihood ratio tests that employ Chi-square statistics. The Johansen’s Co-integration Test indicates at least one co-integrating vector. Thus, long-run relationships are supported by the data-generating process. When the Johansen and Juselius (1990) multivariate co-integration tests are used, it is found that a statistically significant relationship exists between the Y and U. The following co-integrating vectors have been determined using the above test.

The results are presented in Table 12. This starts with the null hypothesis of no co-integration ($r=0$) among the variables. It is found that the trace statistic of 32.36 exceeds the 95 per cent critical value (29.765) of the λ trace statistic. It is possible to reject the null hypothesis ($r=0$) of no co-integration vector in favor of the general alternative $r \geq 1$. As evident in Table 13, the null hypotheses of $r \leq 1, r \leq 2$ cannot be rejected at 5 per cent level of confidence. Consequently, we conclude that there are only one co-integration relationships involving the variables Y, PY and U.

Table 12. Johansen’s Test for Multiple Cointegration Tests among Y, PY and U

H0:	H1:	Test Statistics	0.05 Critical Values	Prob. **
λ_{trace}	Λ_{trace}			
$r = 0^*$	$r > 0$	32.36	29.76	0.024
$r \leq 1$	$r > 1$	10.05	15.49	0.276
$r \leq 2$	$r > 2$	3.42	3.84	0.166
Note: Trace test indicates 1 co-integrating equations at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level.				
** MacKinnon-Haug-Michelis (1999) p-values				
Λ_{max} Values		λ_{max} Values		
$r = 0^*$	$r > 0$	22.31	21.13	0.033
$r \leq 1$	$r > 1$	6.63	14.26	0.533
$r \leq 2$	$r > 2$	3.42	3.84	0.164
Note: Max-Eigen Value test indicates 1 co-integrating equations at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
** MacKinnon-Haug-Michelis (1999) p-values				
Co-integrating Vector		Y	PY	U
(Standard error in parentheses)		-1 (0.646)	1.658 (0.329)	-0.635 (0.072)

In contrast, λ_{max} statistic rejects the null hypothesis of no co-integration vector ($r=0$) against the alternative ($r=1$) as the calculated value $\lambda_{\text{max}}(0, 1) = 22.31$ exceeds the 95 per cent critical value (21.13). Thus, on the basis of λ_{max} statistic, there are one co-integration vectors. The presence of the co-integration vectors shows that there exists a long-run relationship among the variables. The co-integrating equation is displayed in the last column, showing that the long-run elasticities of Y, PY and U which shows that the similar results of correlation and Okun’s coefficient which we find previously, the results are 1.658 per cent and 0.63 percent respectively.

6.2. Impulse Response Function

Detecting Granger causality is restricted to within sample tests which are useful in describing the plausible Granger exogeneity or endogeneity of the dependent variable in the sample period but are unable to deduce the degree of exogeneity of the variables beyond the sample period. To examine this issue, we consider the generalized impulse response functions. Table 13 shows the impulse response of the Y to shocks in PY and U.

Table 13. Impulse Response Function

Response of DLOG(Y):			
Period	DLOG(Y)	PY	DLOG(U)
1	0.076325	0.000000	0.000000
2	0.014535	0.006327	-0.011176
3	0.002571	-0.007275	0.004343
4	-0.001123	0.002104	0.005022
5	-0.002868	-0.002371	-4.52E-05
6	0.000540	0.000644	-0.000722
7	-5.68E-05	-0.000202	-0.000499
8	0.000172	0.000145	0.000187
9	-0.000118	-3.80E-05	0.000101
10	-9.91E-06	-3.91E-06	5.44E-06
Response of PY:			
Period	DLOG(Y)	PY	DLOG(U)
1	8.001099	0.221625	0.000000
2	1.516933	0.602840	-1.192074
3	0.320381	-0.711828	0.455884
4	-0.123772	0.203030	0.519416
5	-0.291220	-0.240991	0.001592
6	0.052362	0.064135	-0.075741
7	-0.004882	-0.020609	-0.051985
8	0.017597	0.014954	0.019048
9	-0.012152	-0.003961	0.010609
10	-0.001094	-0.000370	0.000638
Response of DLOG(U):			
Period	DLOG(Y)	PY	DLOG(U)
1	0.062992	0.047443	0.203034
2	-0.049548	-0.014636	0.011707
3	0.015787	-0.007018	-0.032187
4	0.013215	0.006235	-0.013735
5	0.000896	-0.001438	0.005319
6	-0.002143	0.000549	0.005314
7	-0.001760	-0.001022	-0.000224
8	0.000528	0.000218	-0.001191
9	0.000295	4.04E-05	-0.000372
10	5.94E-05	- 5.69E-05	- 0.000246

A shock in the Y has a negative effect on U, while positive effect on PY over a 10-year period. Similarly, a shock to PY has a positive impact on Y, however, a negative positive relationship with U still prevail over a subsequent years. A shock to U has a positive impact on PY while there is a negative impact on Y over a 10 year period. The results portray this relationship in Figure 6.

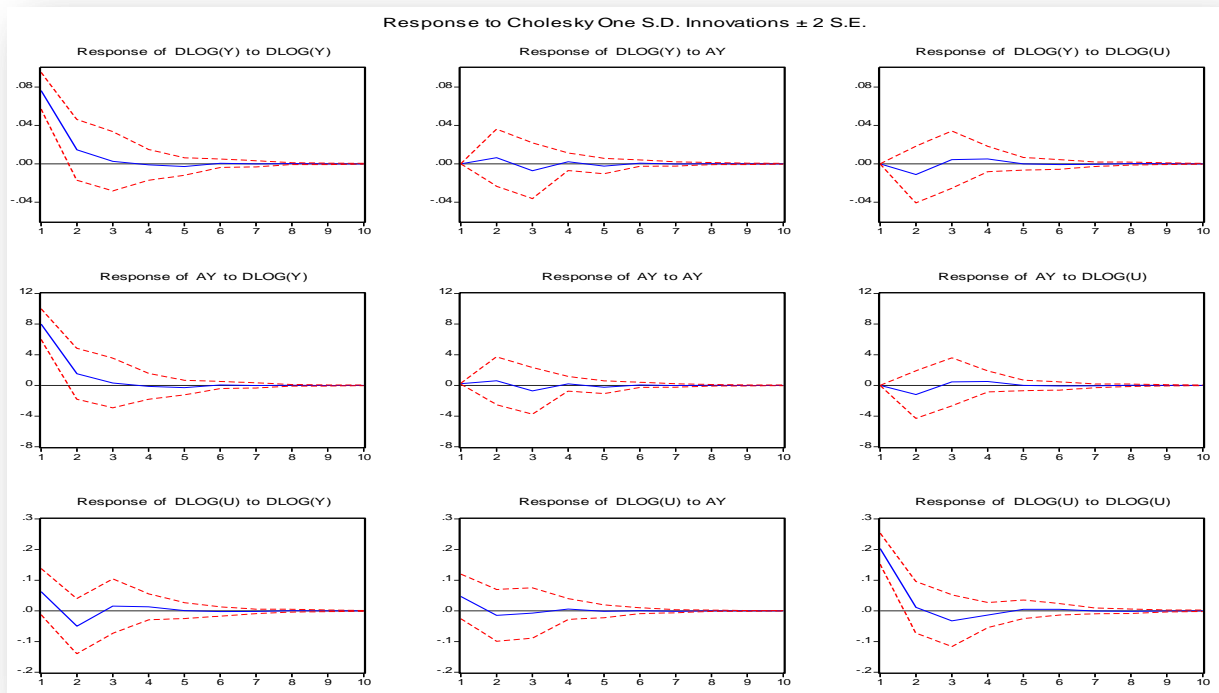


Figure 6. Impulse Response Function

6.3. Variance Decomposition

As impulse response functions trace the effects of a shock to one endogenous variable on to the other variables in the VAR, variance decomposition separates the variation in an endogenous variable into the component shocks to the VAR. Thus, the variance decomposition provides information about the relative importance of each random innovation in affecting the variables in the VAR (EViews 5 User’s Guide). Sims (1980) notes that if a variable is truly exogenous with respect to the other variables in the system, own innovations will explain all of the variables forecast error variance. The results depict in Table 14.

Table 14. Variance Decomposition of Dlog(Y), PY and Dlog (U)

Variance Decomposition of DLOG(Y):				
Period	S.E.	DLOG(Y)	PY	DLOG(U)
1	0.776325	100.0000	0.000000	0.000000
2	0.778751	97.34057	0.645544	2.013891
3	0.779247	96.23064	1.480297	2.289059
4	0.79442	95.77937	1.543211	2.677417
5	0.779529	95.69968	1.628739	2.671585
6	0.779537	95.68571	1.634980	2.679313
7	0.779539	95.68132	1.635551	2.683130
8	0.779539	95.68049	1.635860	2.683648
9	0.779540	95.68033	1.635876	2.683798

10	0.779540	95.68033	1.635876	2.683798
Variance Decomposition of PY:				
Period	S.E.	DLOG(Y)	PY	DLOG(U)
1	0.004168	19.92333	0.076666	0.000000
2	0.255438	17.30959	0.605312	2.085097
3	0.304783	16.30546	1.332812	2.361729
4	0.324407	15.87404	1.386022	2.739941
5	0.332985	15.79889	1.466807	2.734307
6	0.333741	15.78547	1.472464	2.742071
7	0.333930	15.78115	1.473008	2.745838
8	0.333984	15.78036	1.473311	2.746325
9	0.334000	15.78020	1.473328	2.746476
10	0.334000	15.78020	1.473328	2.746477
Variance Decomposition of DLOG(U):				
Period	S.E.	DLOG(Y)	PY	DLOG(U)
1	0.217811	8.363898	4.744505	86.89160
2	0.224160	12.78255	4.905818	82.31163
3	0.227117	12.93502	4.874393	82.19059
4	0.228001	13.17090	4.911458	81.91764
5	0.228069	13.16455	4.912489	81.92296
6	0.228142	13.16499	4.909941	81.92507
7	0.228151	13.16988	4.911553	81.91856
8	0.228155	13.16998	4.911480	81.91854
9	0.228156	13.17009	4.911461	81.91845
10	0.228156	13.17008	4.911461	81.91846

The variance decomposition analysis indicates that Y is the exogenous variable. A high proportion of its shock is explained by the own innovations compared to the contributions of own shocks to innovations for PY and U. At the end of 10 years, the forecast error variance for Y explained by their own innovations is 77.9 percent, while the forecast error variance for PY and U explained by their own innovations are 33.4 and 22.8 percent respectively. The results portray in Figure 7.

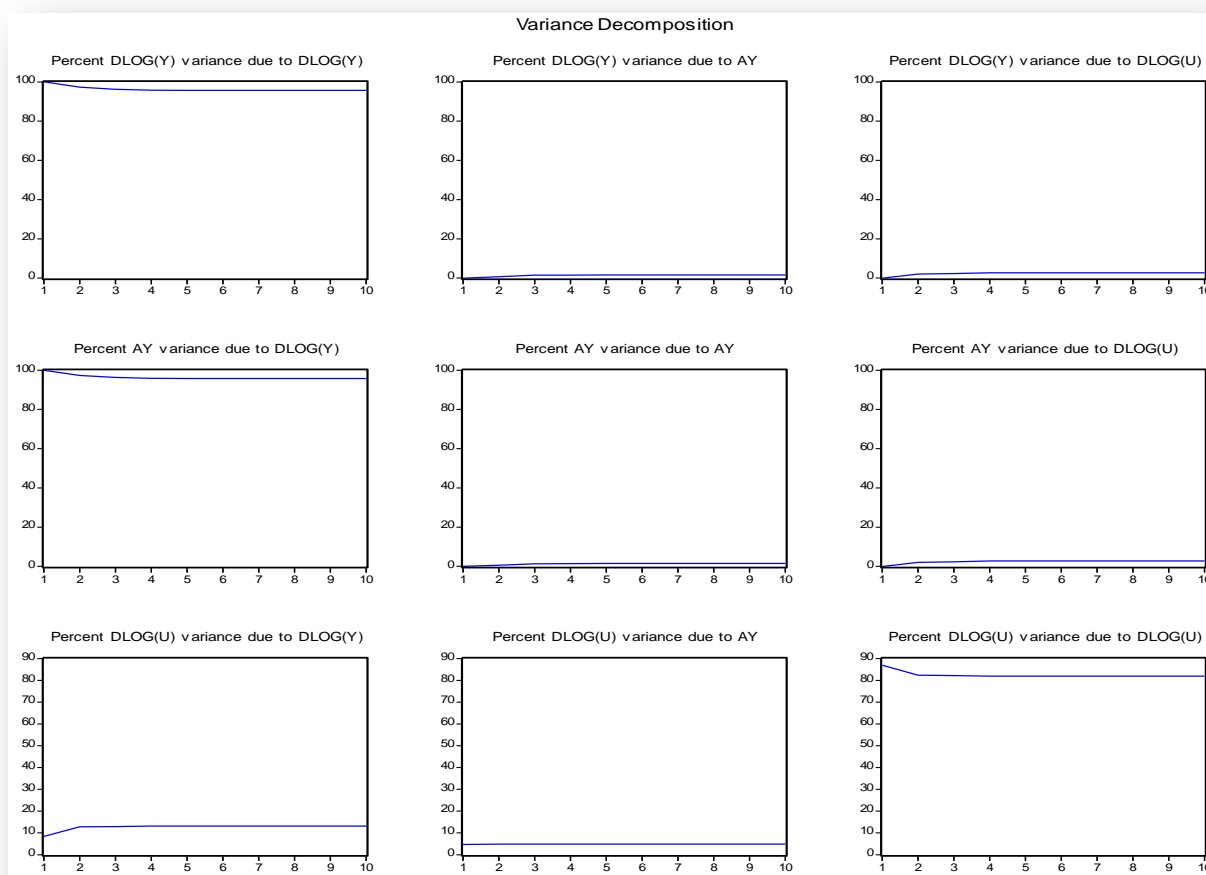


Figure 7. Variance Decomposition Analysis

At the end, empirical findings of the present study show that there is a long-run relationship between Y and U , when the Johansen Co-integration Technique is applied. These findings provide a strong empirical support for the existence of the Okun's law, in the context of a developing country like Pakistan. Studies conducted by Hussain *et al* (2010) and Lal *et al* (2010) have advocated the long-run relationship between the growth and unemployment in the context of Pakistan. While, studies conducted by Loria and Ramos (2007) using the same methodological framework, find the similar results of Okun's law for their Mexican economy. In a collective study on OECD by Lee (2000), these individual country shocks cannot be accounted for. Therefore, in this study, country shocks are absorbed and data are refined accordingly.

7. Summary and Conclusion

Economic growth is one of the key macroeconomic variables which are closely monitored by both policy makers and the public. Alongside with inflation, the exchange rate and the unemployment rate it helps to create an overview picture of a country's economy and its level of development. Being an economist, it is a social responsibility to explore the reality mentioned by Okun's law i.e., increased economic growth results into decreased unemployment rate in the country. This study provides strong empirical existence of Okun's law in Pakistan, both in the long- and short-runs. On the basis of this study, one can forecast the future trend for the next ten years will be in favor of Okun's law. Policy makers can get guidance from this paper for making future policy decisions for Pakistan. This research can be replicated for other developing countries especially SAARC countries, such as Bangladesh, Bhutan, India, Maldives, Nepal, and Sri Lanka. By assessing the existence of the Okun's law in SAARC economies can have more insight.

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AMBIGUITY, ANALYST FORECAST INCENTIVES AND ABNORMAL STOCK RETURNS

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Abstract

This paper aims to assess the role of ambiguity in financial analyst forecast and associated abnormal stock returns. I present a model incorporating ambiguity aversion into a two-period Lucas tree model, which generates a lower price and higher required rate of returns compared with the model without ambiguity concern. A measure of ambiguity has been constructed providing empirical evidence showing that under ambiguity, analysts are more likely to bias their forecasts and the optimistic forecasts for good/bad news tend to deteriorate. Further, investors systematically underreact/overreact to good/bad news forecasts when ambiguity is present.

Keywords: ambiguity, analyst forecast, Abnormal Stock Returns

JEL Classification: G10, G14

1. Introduction

The literature on financial analyst forecast defines ‘forecast inefficiency’ as a forecast that fail to accurately incorporate new information on a timely basis. If markets treat analysts’ forecasts as both rational and statistically optimal, then inefficient forecasts could have significant implications for price efficiency in securities markets.

Many researchers have attributed the inefficiencies and/or bias to the analysts’ ability to incorporate new information into their earnings forecasts to a cognitive processing bias, by which the analysts inadequately incorporate negative feedback signals (Francis, and Philbrick 1997). Empirical studies have also suggested that certain motivational and financial incentives inherent in brokerage firms can lead to optimistic estimates of earnings (Schipper 1991, Francis, and Philbrick 1997, McNichols 1989, Dechow *et al.* 1995, Hayn 1995, Hunton *et al.* 2003). Some suggest that analysts underreact to information whereas others indicate that analysts overreact to information (e.g., Abarbanell, and Bernard 1992, Teoh, and Wong 1997). Such systematic under- or overreaction may be perceived as inconsistent with rational forecasts and efficient markets; therefore, understanding such biases becomes significant to get the big picture of analyst behavior and stock market imperfection.

Most of the studies mentioned above are based on managerial forecasts and not on analyst forecasts. Compared with the managerial forecasts, sell-side analysts are forced to issue more optimistic forecasts/recommendations for several reasons. First, sell-side analysts are not paid directly by the investors. Their compensations are based on the profits they help to generate for the brokerage firms that employ them. Their compensations are totally unrelated to their stock picking or their earnings estimates. The real money, which is their bonus, is determined by the amount of trading they bring in for the sales force, and more importantly, the measure of business they generate for the firm’s investment bankers. Therefore, their incentives are not always consistent with telling the truth. Second, a positive outlook increases the chances of more funds being financed from the investment banks for the analysts’ employers. Third, being optimistic has historically helped analysts obtain inside information from the firms they cover.

All these pressures give an optimistic bias to the analysts’ views, while the magnitude of the bias is held in check by reputational concerns (Hutton *et al.* 2007). Analysts respect their reputation to the extent that it can be deployed to generate trading and attract investment banking business. Therefore, analysts are constrained from adding an arbitrarily high optimistic bias to their private estimates because systematic optimistic bias is expensive. It increases litigation risks and damages the analysts’ reputations and credibility (Stocken 2000, Williams 1996). Stockholder lawsuits based on earnings disclosures are typically categorized under SEC Rule 10b-5, which makes it unlawful for any person ‘to make any untrue statement of a material fact or to omit to state a material fact necessary in order to make the statement made, in light of the circumstances under which they were made, not misleading.’ Though analysts possess incentives to bias their earnings forecasts, concerned with the cost of biasing, they are constrained because investors can use

the subsequent earnings report to assess whether they have misrepresented their information.⁷ If the market detects misrepresentation, then the analysts' reputations could be at stake and they could be liable for legal censure.

However, the threat of litigation is less likely when it is difficult to deter optimistic forecast. Without incentive concerns, an analyst should predict earnings more accurately when there are few ambiguity concerns because investors can better assess the credibility of a forecast.⁸ However, when a firm's earnings fluctuate drastically according to its circumstances, it becomes more difficult for an analyst to accurately forecast earnings, and therefore, more difficult for investors to evaluate the truthfulness of the analysts' forecasts. The motivational incentives faced by analysts may exacerbate risky choice behavior during forecast revision, thereby magnifying the overestimates of earnings.

One of the fundamental problems of financial analyst forecasts is the analysis of decisions under ambiguity, where the probabilities of potential outcomes are neither specified in advance nor readily assessed, based on the available evidence. Knight (1921) distinguishes between measureable uncertainty (risk), which can be represented by precise probabilities, and unmeasurable uncertainty, which cannot. Ellsberg (1961) demonstrated that the distinction between risk and ambiguity is behaviorally meaningful. Generally speaking, risk refers to a situation where there is a probability measure to guide choice, while ambiguity refers to a situation where the decision makers are uncertain about this probability measure due to informational constraints. One striking feature of ambiguity is that it responds more directly to possibilities than to probabilities. Ambiguity affects the investors' decision choice through ambiguity aversion, which is an anticipatory emotion experienced by investors, prior to the resolution of uncertainty, related to the negative feeling of living with uncertainty. However, risk aversion is a static concept pertaining to the curvature of the utility function within a time period. Ellsberg (1961) argued that people's willingness to act despite the uncertainty depends not only on the perceived probability of the event in question, but also on its ambiguity. As decision makers usually do not know the precise probabilities of the potential outcomes when decisions were made, thus an individual under ambiguity may appear more risk averse.

Theoretical, as well as empirical research for ambiguity in the financial market has great significance because the unique feature of ambiguity can mitigate or exacerbate market inefficiency and biases. However, incredibly little research has been done so far to assess the role of ambiguity on financial analyst forecast incentive and the abnormal stock returns associated with it. This study sets up a direct test of financial analyst forecast behavior and stock market reactions under ambiguity. To get an insight of the implications of ambiguity on decision choice, a model incorporating ambiguity aversion has been developed into a two-period Lucas tree model, in this paper. The resulting model shows that ambiguity significantly impacts asset pricing. Particularly, a model having ambiguity aversion generates a lower price and higher required rate of returns compared with the classical model without ambiguity concern, thus implying that investors under ambiguity appear more risk averse. It confirms the fact that by ignoring ambiguity, conventional measures of risk aversion underestimate the effect of uncertainty on asset prices. This result can be used to explain why investors appear to overreact/underreact to small probability events. The associated return premium also helps to explain risk-free rate puzzle and equity premium puzzle.

To provide empirical evidence of the role of ambiguity, a measure of ambiguity has been constructed reflecting the difficulties in detecting analysts' misrepresentation. Then I examine how the 'ambiguity' influences analysts' incentives to propose misleading forecasts and how the investors respond to analysts' forecasts made under 'ambiguity.'

The primary finding is that the incentives of the analysts to misrepresent their information vary with the market's ability to detect their misrepresentation. Specifically, the analysts' incentive to misrepresent their information is found to be a function of ambiguity that market participants have experienced in detecting analyst misrepresentation. Analysts are more likely to bias their forecasts when it is more difficult for investors to detect their misrepresentation. Under ambiguity, analysts' optimistic forecasts for good/bad news tend to deteriorate. These results provide evidence to show that financial analysts forecast errors are to be underestimated if ambiguity is ignored.

Further, I find stock returns are positively related with ambiguity. It implies that investors are compensated for the ambiguity they bear, which confirms the role of ambiguity in the determination of asset returns. Further, empirical results reveal that under ambiguity neither good nor bad news is credible. The

⁷ Lev and Penman (1990) argue that analyst forecasts are credible because investors can ex post verify a manager's forecast by comparing it with the audited earnings report.

⁸ In an experimental study, Hirst *et al.* (1999) find that management forecast specificity and prior forecast accuracy affect the confidence of investors' judgment about a firm's earnings.

investors systematically underreact to good news forecasts and overreact to bad news forecasts when ambiguity is present.

The paper is organized as follows: The model with ambiguity aversion is discussed in Section 2, Hypothesis development is in section 3, data are reported in Section 4, methodology and empirical analysis are described in Section 5, and Section 6 concludes the paper.

2. Model

To understand the implications of ambiguity on decision choice, a simple model is presented by introducing ambiguity aversion into a utility maximization model. Ambiguity aversion is a subjective emotion experienced by individuals reflecting market ambiguity. Although market ambiguity is objective by nature, it affects the investors' portfolio choice and stock price through ambiguity aversion. Consider a two-period Lucas tree model of consumption and saving (Stokey and Lucas, 1989), where a representative agent is born with an endowment of a consumption good equal to ω_1 . The agent is also endowed with n (where $n \in N$) productive assets (normalized to unity), which yield s_n units of the consumption good in period 2. A competitive equilibrium market will decide on a price to support the asset allocation, where first-period consumption is equal to the endowment, $c_1 = \omega_1$; second-period consumption is equal to the random output of the assets $c_2 = \sum s_n$.

Let θ denote the vector of portfolio shares held by the agent, where θ_n is the shareholding of asset n . Assume $\phi(\bullet)$ is the differentiable function that measures the investor's anticipation of ambiguity associated with the holdings on risky assets. A representative agent chooses the level of first period consumption and the asset portfolio to maximize the expected utility function,

$$\begin{aligned} & \max \mu_1(c_1, \phi(\theta)) + \beta E[\mu_2(c_2)] \\ & \text{subject to the budget constraint,} \\ & c_1 + \sum_n p_n \theta_n = \omega_1 + \sum_n p_n \end{aligned}$$

where p_n is the price of asset n . The first-order condition for asset n is as below.

$$\frac{\partial \mu_1}{\partial c_1} p_n = \frac{\partial \mu_1}{\partial \phi} \frac{d\phi}{d\theta_n} + \beta E(s_n) \frac{\partial \mu_2}{\partial c_2}$$

Rearranging the above equation, the price of the asset can be ascertained:

$$p_n = \frac{(\partial / \partial \phi) \mu_1(\omega_1, \phi(\theta)) (\partial / \partial \theta_n) \phi(\theta) + \beta E(s_n) (\partial / \partial c_2) \mu_2(\sum_n s_n)}{(\partial / \partial c_1) \mu_1(\omega_1, \phi(\theta))}$$

Since $\partial \mu_1 / \partial \phi$ is negative, it is evident that ambiguity generates a lower price and a higher required rate of return. If investors react not only to risk but to ambiguity, then asset prices will tend to overreact/underreact to small probability events. For example, a government announcement of increased oil demand will attract investors' attention regarding the possibility of oil price increase, causing investors to make a more sensitive investment choice on a likely oil price change.

As ambiguity aversion is an anticipatory emotion experienced by investors, it will probably differ from investor to investor. However, one can reasonably assume that ambiguity decreases in the mean of future consumption and increases in the riskiness of future consumption. Assuming that ambiguity is linear in the mean and variance of second period consumption,

$$\phi(\theta) = -\alpha E(c_2) + \beta \text{var}(c_2),$$

where α and β are positive parameters. As $c_2 = \sum s_n \theta_n$, it follows that

$$\frac{d\phi(\theta)}{d\theta_n} = -\alpha E(s_n) + 2\beta \text{cov}(c_2, s_n)$$

This equation indicates the effects on ambiguity for a unit increase in asset holding, and explains both the risk-free rate puzzle and the equity premium puzzle. For a riskless asset, in which s_n is constant,

$$d\phi/d\theta_n = -\alpha s_n < 0$$

$$\beta E(s_n) \left(\frac{\partial \mu_2}{\partial c_2} / \frac{\partial \mu_1}{\partial c_1} \right)$$

It follows that the price of the riskless asset, $\beta E(s_n) \left(\frac{\partial \mu_2}{\partial c_2} / \frac{\partial \mu_1}{\partial c_1} \right)$, is greater than the price which would accommodate the standard model. From this perspective, the agent is actually purchasing ‘peace of mind’ along with the asset, which justifies the low risk-free rate.

As stocks are risky, their purchase will tend to increase both the mean and the variance of a second-period consumption. The sign of $d\phi/d\theta_n$ will depend on the manner these two effects balance out. If β is sufficiently large relative to α , the effect through the variance will dominate, and $d\phi/d\theta_n$ will be positive. In this situation, ambiguity will reduce the price of stocks and increase their returns relative to the standard model. Here, stock ownership entails psychic costs. The agent has to accept the ambiguity that accompanies the holding of a risky portfolio.

By providing secure returns, safe assets may reduce the ambiguity even before the final consumption takes place. They, therefore, provide an extra benefit in addition to even out the final consumption across states, helping to reduce the risk-free rate. Stocks and other risky assets, however, by increasing the variance of the portfolio, increase ambiguity in the period before final consumption occurs. Therefore, owning stocks involves an extra cost apart from increasing the variance of final consumption, which increases their required return. Therefore, ambiguity complements risk aversion in our discussion of the risk-free rate puzzle and the equity premium puzzle.

3. Hypothesis Development

Ambiguity occurs in situations where available information is scanty or obviously unreliable or highly conflicting or where the expressed expectations of different individuals differ widely. For example, when financial environment is ambiguous and earnings are difficult to predict, analysts are expected to disagree about the forthcoming earnings. The standard deviation of analyst forecasts, denoted as STD_AF have been used to measure the lack of analyst consensus. Therefore, STD_AF is positively associated with ambiguity. Further, it becomes more difficult to forecast a firm’s earnings when its ‘true’ earnings are more volatile, which are measured as the standard deviation of daily stock returns, denoted as STD_RET . To examine the effect of ambiguity, a measure of forecasting ambiguity is constructed as a function of the analyst’s consensus forecast of the previous period and the standard deviation of daily stock returns 120 days prior to the forecast date. To be considered as having a forecasting ambiguity, the following conditions must hold true:

$$STD_AF_{t-1} > STD_AF_{t-2} \text{ and,}$$

$$STD_RET_{-120,-1} > STD_RET_{-240,-121}$$

With this measure of forecasting ambiguity, the analysts’ forecasts with ambiguity were separated from those without ambiguity. I then tested if forecast ambiguity affected the magnitude of accuracy of the current period forecast, and the effect of the ambiguity on the post-forecast drift, in returns. Therefore, the four possible hypotheses drawn from this study are:

H1: Analysts’ incentive to misrepresent their information is a function of the ambiguity that market participants observed in detecting analyst misrepresentation. Analysts are more likely to make biased forecasts when it is more difficult for investors to detect their misrepresentation.

H2: Under ambiguity, analysts’ optimistic forecasts for good/bad news tend to deteriorate.

H3: Stock returns are expected to be positively related to ambiguity, implying that investors require a higher rate of return to compensate the ambiguity they are bearing.

H4: Stock-returns responses to analysts’ forecasts are consistent with the predicTable bias in the forecasts. Thus, under ambiguity, stock returns will overreact to bad news forecasts and underreact to good news forecasts.

4. Data

Stock return data are drawn from the Center for Research in Securities Prices (CRSP) combined file, which includes NYSE, AMEX, and Nasdaq stocks. Financial analysts’ earnings estimates are obtained from the Institutional Brokers Estimate System (IBES). Firms’ characteristic variables, such as size, market to book ratio, accruals, and special items, are taken from Compustat.

The sample for the study consists of the time period from 1996 to 2006. As the legal environment affects analysts' forecasting behavior, the sample has been restricted after enactment of the PSLR act on December 22, 1995⁹. As the short-window stock returns reactions were utilized to assess the investors' response to analysts' earnings forecasts, 2,231 observations with more than one forecast made on the same day were deleted. This was done because separately identifying investor reaction to each forecast was quite impossible, and it also ensured that the sample observations are independent. Deleting forecasts made within a three-day window reduces the likelihood that news of other earnings explains the observed stock returns reactions. Observations with missing stock return, analyst estimates or actual earnings, and missing data on control variables were deleted.

Next, the IBES dataset was merged with stock return data from CRSP and firm characteristics from Compustat. Stocks with share price lower than \$5 are ignored to ensure that the results are not driven by small, illiquid stocks or by bid-ask bounce (Jegadeesh and Titman, 1993). Observations with insufficient (less than 5 years) continuous operations were deleted to estimate earnings persistence. Firms having less than four individual analysts (Elliott *et al.*, 1995) were excluded. Finally, all variables found in the upper 99% and lower 1% were identified as outliers, and eliminated (Ali, Klein, and Rosenfeld, 1992; Frankel and Lee, 1996). Finally, a sample containing 35,280 forecasts remained, composed of 2,586 firms.

Financial analyst forecast error is defined as the difference between analyst forecast and actual earnings scaled by stock prices, calculated as follows:

$$FE_t = \frac{F_t^{t-1} - E_t}{P_t}$$

where FE_t denotes the forecast error for year t , E_t is actual earnings for year t , F_t^{t-1} is the earning forecast for year t made in year $t-1$, and P_t is the stock price in time t . Assuming day 0 is the announcement date, three-day accumulative abnormal returns centered on the announcement date are calculated as follows:

$$CAR_i = \sum_{t=-1}^1 (r_{it} - r_{mt})$$

where r_{it} is the return for firm i at time t , r_{mt} is the return on the CRSP Value-Weighted Market Index at time t . Table 1 reports the year-by-year distribution of analyst forecast errors and accumulative stock returns. Untabulated results using raw returns are similar with the market-adjusted returns.

Consistent with prior research, mean forecast errors are significantly positive in all the years represented, and the median forecast errors are significantly positive in all, except three years (2000, 2003 and 2005), implying that on an average financial analysts' forecasts are optimistic. The accumulative stock returns register the highest mean and standard deviations in 1999, and the lowest mean value in 2001. The magnitudes of the forecast errors and stock returns do not consistently move either up or down. This sample thus meets all data requirements for analysis.

Skinner (1994) provided evidence for bad news forecasts being generally considered more credible than good news forecasts. For example, the unconditional stock returns response to bad news forecast was greater than the response to good news forecasts. To assess whether earnings forecasts represent good or bad news, the forecast EPS and the previous period actual EPS are considered. If the forecast EPS is greater than the previous period actual EPS, the forecast is classified as conveying good news, where $EPS_{forecast}^t - EPS_{actual}^{t-1} > 0$; else, the forecast conveys bad news.

Table 1. Year-by-year Distribution of Analyst Forecast Errors and Accumulative Stock Returns

Panel A: Year-by-year Distribution of Analysts' Forecast Error				
Year	Number of	Mean Forecast	Median Forecast	Standard Deviations
1996	3652	0.0051	0.0009	4.358
1997	4531	0.0025	0.0016	3.642

⁹ The PSLR act, which protects analysts from litigation arising from unattained forward-looking statements, lowered the expected litigation costs associated with unattained forecasts (Johnson *et al.*, 2001).

Panel A: Year-by-year Distribution of Analysts' Forecast Error				
Year	Number of	Mean Forecast	Median Forecast	Standard Deviations
1998	3766	0.0035	0.0007	2.339
1999	5004	0.0049	0.0010	4.569
2000	4812	0.0027	-0.003	3.831
2001	5393	0.0042	0.0006	3.142
2002	6243	0.0020	0.0000	5.911
2003	6807	0.0028	-0.004	1.806
2004	6453	0.0012	0.0040	3.219
2005	5978	0.0024	-0.006	4.094
2006	6254	0.0021	0.0000	2.201

Panel B: Year-by-year Distribution of CARs				
Year	Number of Observations	Mean Returns	Median Returns	Standard Deviations
1996	1039	0.0683	0.0766	3.7928
1997	1252	0.0642	0.0789	3.8639
1998	1331	0.0535	0.0611	4.1267
1999	1467	0.0829	0.0862	5.7886
2000	1458	0.0658	0.0701	5.4512
2001	1529	0.0301	0.0329	3.0829
2002	1446	0.0346	0.0311	3.5761
2003	1538	0.0532	0.0532	3.2336
2004	1551	0.0636	0.0582	2.7912
2005	1543	0.0642	0.0579	2.6458
2006	1522	0.0656	0.0686	2.5701

Notes: Panel A is the year-by-year distribution of analyst forecast errors, which is defined as the difference between analyst forecast and actual earnings scaled by stock prices. Panel B reports stock returns, CARs, which is defined as three-day accumulative returns centered on the announcement date.

Table 2 presents summary statistics of financial analysts' forecasts, stock returns, and various firm characteristics. Panel A of Table 2 lists the forecast news, market responses to these forecasts, as well as the forecast errors. The mean forecast errors are positive for both good news and bad news. The median forecast errors are positive for good news and slightly negative for bad news. The mean and median accumulative stock returns are positive for good news and negative for bad news. According to *t*-test, the mean and median values of forecast errors and CARs significantly differ between good news and bad news.

Table 2. Summary Statistics of Accumulative Stock Returns and Various Firm Characteristics

Panel A: Forecast Error and Market Returns Associated with Good or Bad News.					
		Analysts Forecast Error		Market Returns CARs	
	N	Mean Forecast Error	Median Forecast Error	Mean Returns	Median Returns
Bad News	10,304	0.0059	-0.001	-0.0341	-0.0175
Good News	26,901	0.0068	0.003	0.0247	0.0210
T-test differences between Good and Bad News Forecast		2.89**	6.51**	3.51**	5.28**
		0.081	<0.001	0.002	0.000
Panel B: Sample Partition by Forecast Ambiguity CARs					
		Forecast Error		Market Returns CARs	
	N	Mean Forecast Error	Median Forecast Error	Mean Returns	Median Returns
Bad News					
No Ambiguity	6,022	0.003	0.000	-0.026	-0.019
Ambiguity	4,282	0.008	0.003	-0.057	-0.028
T-test diff. between ambiguity/no ambiguity		3.59**	2.68**	3.16**	2.49*
		0.002	0.001	0.017	0.009
Good News					
No ambiguity	14,800	0.005	0.001	0.0361	0.25
Ambiguity	12,101	0.021	0.005	0.0125	0.08
T-test diff. between ambiguity/no ambiguity		2.61**	3.29**	2.87**	3.49**
		<0.001	0.005	0.018	0.051

*, ** significant at 5% and 1% levels, respectively, using a two-tailed test.

Notes: Panel A reports the forecast news, the market responses to these forecast news and the forecast errors. The mean forecast errors are positive for both good news and bad news. The median forecast errors are positive for good news and slightly negative for bad news. Panel B of Table 2 partitions the full sample by ambiguity. According to t-test, forecast errors and stock returns are significantly different between the forecasts with ambiguity and those with no ambiguity. This panel has three noteworthy features: first, though mean forecast errors are positive for both good and bad news, the magnitudes are larger for the forecasts with ambiguity. Second, the mean and median stock-return reactions to good news are much lower for the forecasts with ambiguity than that with no ambiguity. Third, the mean and median stock returns decrease in bad news forecast is deteriorated in the case of ambiguity compared to the forecasts with no ambiguity.

Panel B of Table 2 separates the whole sample by ambiguity. This panel has three noteworthy features: first, though mean forecast errors are positive for both good and bad news, the magnitudes are greater for the forecasts with ambiguity. For example, for bad news, the mean forecast error is 0.003 without ambiguity, whereas it is 0.008 with ambiguity. Similarly for good news, the mean forecast error is 0.005 with no ambiguity, whereas it is 0.021 with ambiguity. This implies the tendency of analysts to make more biased optimistic forecasts under ambiguity.

Second, the mean and median stock-return reactions to good news are much lower for the forecasts with ambiguity than for those with no ambiguity. This implies that investors are less responsive to good news forecast under ambiguity. Third, the mean and median stock returns decrease in bad news forecasts is deteriorated in cases of ambiguity, compared with cases without ambiguity, suggesting that investors overreact to bad news forecasts under ambiguity. According to t-test, forecast errors and stock returns are significantly different between the forecasts with ambiguity and those without ambiguity.

5. Empirical Analysis

(i) Ambiguity and Analysts Forecast Incentives

In this section, the three hypotheses developed in section II are examined. First, the relation between forecast ambiguity and forecast errors is tested, followed by examining the association between predicted ambiguity and stock-return responses.

H1: Analysts' incentive to misrepresent their information is a function of the ambiguity that market participants experienced in detecting analyst misrepresentation. Analysts are more likely to bias their forecasts in situations where it is more difficult for investors to detect their misrepresentation.

H2: Under ambiguity, analysts' optimistic forecasts for good/bad news tend to deteriorate.

To examine the effect of ambiguity on forecast errors, the following pooled cross-sectional regression model is estimated:

$$FE = \alpha_0 + \alpha_1 Ambiguity + \alpha_2 Good \times News + \alpha_3 Bad \times News + \alpha_4 Ambiguity \times Good \times News + \alpha_5 Ambiguity \times Bad \times News + ControlVariables + \varepsilon. \quad (1)$$

The variables in the model are defined and discussed below:

Forecast Error (FE): FE is defined as the difference between analysts' forecast and actual earnings scaled by stock prices. It is calculated as $FE_t = (F_t^{t-1} - E_t) / P_t$, where F_t^{t-1} denotes the forecast error in year t , E_t represents the actual earnings for year t , F_t^{t-1} is the earning forecast of year t made in year $t-1$, and P_t is the stock price at time t .

News: is the forecast earnings per share (EPS) minus the previous period's actual EPS.

Good: is an indicator variable. Good equals to 1 if the forecast EPS is greater than the previous period actual EPS, where $EPS_{forecast}^t - EPS_{actual}^{t-1} > 0$, and zero otherwise.

Bad: is an indicator variable. Bad equals to 1 if the forecast EPS is less than the previous period actual EPS, where $EPS_{forecast}^t - EPS_{actual}^{t-1} \leq 0$, and zero otherwise.

Ambiguity: is an indicator variable. To be classified under forecasting ambiguity, two conditions viz., $STD_AF_{t-1} > STD_AF_{t-2}$ and, $STD_RET_{-120,-1} > STD_RET_{-240,-121}$ must hold true. The variable ambiguity is assigned a value of 1 if the above conditions hold true, and is zero otherwise.

Control variables: Several variables identified in earlier studies as affecting forecasting behavior are introduced to control for cross-sectional differences. These variables include forecast horizon, growth opportunities, accruals, predicted losses, the effects of Reg FD, Size, and special items. First, the forecast horizon is introduced as several studies find that forecast errors decline as forecasts are issued closer to the fiscal year-end (Johnson *et al.*, 2001). The closer to the end of the fiscal year the forecast is made, the more information the analyst would be able to use in generating the forecast. Thus, forecasts that are made closer to the end of the fiscal year are likely to have higher accuracy. Horizon indicates the number of calendar days between the forecast release date and the firm's fiscal year-end. Second, prior studies observed forecast behavior was associated with firm size (Baginski and Hassell, 1993; Bamber and Cheon, 1995). The natural log of the firm's market capitalization one day prior to the forecast, termed size, is used to proxy for firm size. Third, Bamber and Cheon (1995) document that growth opportunities affect a firm's forecasting behavior. Here, a firm's market value to book value of equity ratio, M/B, is used as a measure of a firm's growth opportunities. M/B is calculated as the ratio of the firm's market capitalization one day prior to the forecast divided by the previous year's book value of equity. Fourth, earnings management can affect forecast errors because managers can manipulate reported earnings (McNichols, 1989; Dechow *et al.*, 1995; Kasznik, 1999). Kasznik (1999) presented evidence consistent with managers issuing earnings forecast and then manipulating the earnings to match the forecast. Therefore, the firm's ability to manipulate earnings as reflected by its discretionary accruals is included as a control. Further, predicted losses (Hayn, 1995), the effects of Reg FD (Heflin *et al.*, 2003), and special items (Bradshaw and Sloan, 2003) as control variables are included. Last, the fixed effects for industry and year are included. I defined firms within the same industry as the firms reported on Compustat sharing the same SIC code.

In equation (1), α_1 measures the impact of the ambiguity on forecast errors. α_4 measures the impact of the ambiguity on the responses of forecast errors to good news whereas α_5 measures the impact of the ambiguity on the responses of forecast errors to bad news. The primary interests are in these three coefficients because they indicate how ambiguity affects financial analyst forecast behavior.

The coefficients on $Ambiguity \times Good \times News$ and $Ambiguity \times Bad \times News$ are predicted positive; i.e., $\alpha_4 > 0$ and $\alpha_5 > 0$, indicating that analysts are more likely to bias their forecasts when it is more difficult for investors to detect their misrepresentation. However, if financial analysts do not consider the forecast environment when forecasting, or if ambiguity has no effect on analyst forecasts, the coefficients of α_4 and α_5 will be zero.

Table 3. The Effect of Ambiguity on Analyst Forecast Performance

$FE =$	$\alpha_0 +$	$\alpha_1 Amb +$	$\alpha_2 GNews +$	$\alpha_3 BNews +$	$\alpha_4 Amb$ $GNews +$	$\alpha_5 Amb$ $BNews +$	Controls + ϵ
Estimate	-0.08	0.023	1.813	1.250	4.668	3.526	
t-statistic	9.21	2.95**	2.96**	3.09**	3.20**	4.90**	
F Value of Model=35.02			$R^2 = 36.48\%$			Adj. $R^2 = 32.56\%$	

Control Variables:	Predicted Sign	Coefficient	t-statistic
Horizon	+	0.091	3.29**
M/B	-	-0.225	1.98*
Size	+	0.788	3.27**
Accruals	+	0.645	3.49**
Reg FD	-	-0.024	0.72
Predicted Loss	+	0.035	3.39**
Special Items	+	0.633	3.52**

*, ** significant at 5% and 1% levels, respectively, using a two-tailed test.
 Untabulated results including fixed effect for industry and years are robust.

Notes: The pooled cross-section regression examines effects of Ambiguity on forecast performance. The results of the regression indicate that the overall model is highly significant with an adjusted R-square of 0.3256. T-tests on the independent variables and the interaction term indicate that the coefficients are highly significant, supporting rejection of the null hypothesis of no effect. Table 3 reports the regression results. This indicates that the overall model is highly significant with an adjusted R-square of 0.3256. The t-tests on the independent variables and the interaction term indicate that the coefficients are highly significant, supporting rejection of the null hypothesis of no effect.

The coefficients for good news and bad news are both positive. This result is consistent with the findings of Daniel *et al.*, (1998) and Abarbanell and Bernard (1992), which indicate that financial analysts are optimistic in general. The coefficient on ambiguity is positive, implying that forecast errors are positively related to ambiguity. Therefore, systematically financial analysts tend to make more optimistic (biased) forecasts when ambiguity exists, which supports hypothesis 1. The coefficients of α_4 is positive and significant. Also, the magnitude of α_4 is larger than that of α_2 . This implies that for good news, analysts tend to make more optimistic forecasts with ambiguity, than without ambiguity. Similarly, the coefficient of α_5 is positive and significantly larger than the coefficient of α_3 , suggesting that under ambiguity, analysts tend to make more biased forecasts for bad news than the forecast without ambiguity. This finding supports hypothesis 2. Overall, the magnitude of the bias significantly increases when ambiguity is accounted for. When ambiguity is included, financial analysts tend to make more biased forecasts than in situations when ambiguity is absent. These results provide evidence showing that financial analysts forecast errors are to be underestimated if ambiguity is ignored.

For the control variables, horizon, size, accruals, predicted loss and special items are significant at 1%; M/B is significant at 5%. All significant coefficients have the expected sign. Particularly, horizon, size,

accruals, predicted loss and special items are positively related to the analysts' forecast error, whereas M/B and forecast error are negatively associated. Further, empirical results show that Reg. FD has no significant impact on analyst forecast errors.

(ii) *Ambiguity and Abnormal Stock Returns*

To investigate the stock-return responses to ambiguity, the following two hypotheses are tested.

H3: Stock returns are expected to be positively related to ambiguity, meaning that investors require a higher rate of return to compensate for the ambiguity they are bearing.

H4: Stock-returns responses to analysts' forecasts are consistent with the predicTable bias in the forecasts. Thus, under ambiguity, stock returns will overreact to bad news forecast and underreact to good news forecast.

The following cross-sectional regression model is used:

$$CAR_{0,+1} = \alpha_0 + \alpha_1 Ambiguity + \alpha_2 Good \times News + \alpha_3 Bad \times News + \alpha_4 Ambiguity \times Good \times News + \alpha_5 Ambiguity \times Bad \times News + ControlVariables + \varepsilon. \quad (2)$$

The model's variables are defined as follows:

Event Returns: the market response to earnings forecast, denoted CARs, is the three-day accumulative

abnormal returns centered on the announcement date. $CAR_i = \sum_{t=-1}^1 (r_{it} - r_{mt})$, where r_{it} is the return for firm i on day t , r_{mt} is the return on the CRSP Value-Weighted Market Index on day t .

Several control variables identified in earlier studies are introduced to control for cross-sectional differences in response coefficients. Particularly, I control for forecast horizon (Johnson *et al.*, 2001), growth opportunities (Bamber and Cheon, 1995), predicted losses (Hayn, 1995), the effects of Reg FD (Heflin *et al.*, 2003), Size (Baginski and Hassell, 1993; Bamber and Cheon, 1995), accruals (McNichols, 1989; Dechow *et al.*, 1995, Kasznik, 1999), and special items (Bradshaw and Sloan, 2003). Lastly, industry and year dummies are used to control fixed effects.

Based on hypothesis 3, the coefficient of α_1 is predicted as positive and significant. According to hypothesis 4, the coefficient on $Ambiguity \times Good \times News$ is predicted to be positive whereas the coefficient on $Ambiguity \times Bad \times News$ is negative; i.e., $\alpha_4 > 0$ and $\alpha_5 < 0$. However, if the market ignores ambiguity when responding to forecast news or if ambiguity has no effect on stock returns, then the coefficients of α_4 and α_5 will be zero.

Table 4. The Effect of Ambiguity on Stock Returns

$CAR_{0,+1} =$	$\alpha_0 +$	$\alpha_1 Amb +$	$\alpha_2 GNews +$	$\alpha_3 BNews +$	$\alpha_4 Amb +$	$\alpha_5 Amb +$	$Controls + \varepsilon$
					$GNews$	$BNews$	
Estimate	0.006	1.847	1.025	-1.625	0.431	-2.849	
t-statistic	2.38	4.82**	3.22**	3.01**	2.98**	3.51**	
F Value of Model=	31.25		$R^2 = 36.52\%$		Adj. $R^2 = 34.08\%$		

Control Variables:	Predicted Sign	Coefficient	t-statistic
Horizon	-	-0.056	2.85**
M/B	+	0.128	3.17**
Size	-	-0.214	1.98*
Accruals	+	1.015	3.41**
Reg FD	+	0.012	1.14
Predicted Loss	-	-0.093	4.28**

Special Items	-	-2.755	4.52**
*, ** significant at 5% and 1% levels, respectively, using a two-tailed test. Untabulated results including fixed effect for industry and years are robust.			

Notes: The pooled cross-section regression examines stock market response to Ambiguity. The results of the regression indicate that the overall model is significant with an adjusted R-square of 0.3408. T-tests on the independent variables and the interaction term indicate that the coefficients are highly significant, supporting rejection of the null hypothesis of no effect.

Table 4 presents the regression results indicating that the overall model is significant with an adjusted R-square of 0.3408. The *t*-tests on the independent variables and the interaction term indicate that the coefficients are highly significant, supporting rejection of the null hypothesis of no effect.

As expected, the coefficient on ambiguity, on average, is positive and significant. This provides empirical evidence showing that investors are compensated for the ambiguity they bear. This finding confirms the role of ambiguity in determining asset returns.

Consistent with prior studies (i.e., Ajinkya, and Gift 1984, Waymire 1984), stock returns are positively associated with good news and negatively associated with bad news, i.e., the coefficient of α_2 is positive and significant, whereas the coefficient of α_3 is negative and significant. Further, the coefficient of α_4 is positive and significant whereas the magnitude is less than that of α_2 , showing that the increase in stock returns to good news forecast is smaller in the situation of ambiguity. In other words, the stock returns underreact to good news forecasts under ambiguity. However, the magnitude of α_5 is larger than that of α_3 . This shows that the decrease in stock returns in response to bad news forecast is deteriorated under ambiguity. This finding suggests that stock returns overreact to bad news forecast under ambiguity, and implies that investors can identify analysts' incentive to make more biased forecasts in a situation of ambiguity. Consequently, investors underreact to good news forecasts and overreact to bad news forecasts when ambiguity is present.

For the control variables, horizon, M/B, accruals, predicted loss and special items are significant at 1%; size is significant at 5%, which indicates predicting power. But RegFD is insignificant at zero. All significant coefficients have the expected sign. Horizon, size, predicted loss and special items particularly are negatively related with stock returns, whereas M/B and accruals are positively related to stock returns.

6. Discussions and Conclusions

This paper aims to investigate financial analyst forecast behavior and market reactions under ambiguity. A model incorporating ambiguity aversion into a two-period Lucas tree model has been developed, showing significant impacts of ambiguity on asset pricing. Particularly, the model with ambiguity aversion generates a lower price and higher required rate of returns compared with the classical model without ambiguity concern. This confirms the fact that by ignoring ambiguity, conventional measures of risk aversion underestimate the effect of uncertainty on asset prices. This result can be used to explain why investors appear to overreact/underreact to small probability events.

To provide empirical evidence of the role of ambiguity, I construct a measure of ambiguity that reflects the difficulties in detecting analysts' misrepresentation. Then I examine how the 'ambiguity' influences analysts' incentives to offer misleading forecasts and how the investors respond to analysts' forecasts made under 'ambiguity.'

The primary finding is that the incentives of analysts to misrepresent their information vary with the market's ability to detect their misrepresentation. Specifically, the analysts' incentive to misrepresent their information is a function of ambiguity that market participants observed in detecting analyst misrepresentation. Analysts are more likely to bias their forecasts when it is more difficult for investors to detect their misrepresentation.

Further, stock returns are positively related with ambiguity, confirming the role of ambiguity aversion in the determination of asset returns. Also, under ambiguity, stock returns overreact to bad news forecast and underreact to good news forecast. Investors can predict and filter out some of the bias in analysts' forecasts, according to market environment. The empirical results show that under ambiguity neither good nor bad news is credible.

Earlier research documented that good news is less credible than bad news. Williams (1996) uses an empirical measure of prior forecast usefulness to capture the 'believability' of forecasts. She argued that bad

news is more credible than good news. She presents that analysts consider prior forecast useful when responding to good news, although not to bad news forecasts. Hutton *et al.* (2003) also argue that bad news forecasts are inherently more believable than good news forecasts. This study provides evidence to show that under ambiguous situations neither good nor bad news forecast is credible. When ambiguity is present, investors can predict some of the bias in analysts' forecasts according to market environment, and they are found to systematically underreact to good news forecast and overreact to bad news forecast.

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