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Fair Pricing of Unemployment Insurance Premiums*

Actuarially fair unemployment insurance premiums are derived in a theoretical model of a regulated private market for unemployment insurance. Fair premiums are derived using the capital asset pricing model under the assumption that insurance firms borrow and lend in the capital market to finance benefit payments. Empirical estimates of betas and fair premiums for the U.S. unemployment insurance system are presented.

I. Introduction

The unemployment insurance (UI) system in the United States differs from a standard competitive insurance market in at least two ways. First, because workers and firms can influence the probability of an adverse event (unemployment), there is a moral hazard problem. Consequently, an optimal insurance program would require coinsurance of unemployment risk.[1] A second difference, which has received less attention than the first (in the recent UI literature), is the fact that much of unemployment risk is undiversifiable aggregate risk.[2] If shareholders of firms are averse to aggregate risk, an optimal UI program will require coinsurance of aggregate risk.

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1. Shavell and Weiss (1979) and Baily (1978) are concerned with this issue.

2. This point was recognized in the debate over the Wisconsin UI program in the 1920s. Since much of the unemployment that occurs in an industrial economy is due to business cycle factors beyond the control of the firm, it has been argued that charging firms for cyclical unemployment is unfair. It has been also noted that the high correlation in unemployment across firms strains the solvency of a UI fund whether publicly or privately financed. See the references in Nelson (1969) and Becker (1972) for early discussions of these issues. Recently similar points have been made by Rosen (1977) and Topel and Welch (1980), who estimated that over 50% of unemployment risk is undiversifiable.

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This paper presents a theoretical framework for deriving actuarially fair UI premiums in a competitive insurance market when unemployment risk is correlated across firms due to aggregate risk. On the basis of this framework, I calculate actuarially fair UI premiums for the U.S. economy. These calculations do not purport to be estimates of what UI premiums would be if the provision of unemployment insurance were "privatized." However, they indicate the order of magnitude of the real cost of providing UI under any system of finance and thereby contribute an essential ingredient to the analysis of any proposal to reform this institution.

Actuarially fair pricing of UI premiums depends on the cost of borrowing and lending in the capital market. In a model with no aggregate risk, the cost of capital would be the interest rate. In an uncertain world with risk-averse investors, the cost of financing UI benefits must exceed the interest rate sufficiently to compensate insurers for systematic risk in the timing of receipts and payments. To contrast the theoretical UI system used in my calculations with the current system in the United States, in the next section I describe a method of financing UI benefits which is more or less typical of current practice.

Section III presents a competitive model of unemployment insurance. This model was first introduced in the property-liability insurance literature, and competitive premiums (assumed to be actuarially fair) were derived with the aid of the capital asset pricing model (CAPM). This model of the insurance market is well adapted to analyzing my hypothetical UI system. Section IV presents my calculations of actuarially fair premiums under a competitive UI system. The final section summarizes the paper's results and indicates areas for future research.

II. UI Benefit Financing in the United States

In the United States UI benefits are financed by taxes levied against covered firms. Implicitly, each covered firm is assumed to have a positive probability of contributing to the pool of unemployed wokers. The most common technique of financing UI benefits is the reserve ratio method. Under this method, each firm is assigned an account in the state UI fund, the balance of which increases with the firm's UI tax payments and decreases with benefits paid to the firm's unemployed former workers. In general, a firm's tax bill is determined primarily by the number of its (covered) employees, but in many states a firm's tax liability is experience rated as well. Experience rating in the UI tax system means that a firm's current tax rate is a function of its account balance and history of generating insured unemployment.

When a firm increases its layoff rate, its accumulated fund balance is drawn against to pay benefits to its former workers. If the fund balance is inadequate for this purpose, the firm receives an implicit loan from the state UI fund to finance payment of the benefits. The converse occurs when a firm decreases its layoff rate. The effect of experience rating is to raise the tax rates of firms whose balances are insufficient, with the aim of bring them up to satisfactory levels.

In the aggregate, a state's UI fund makes loans to employers of unemployed workers during cyclical contractions, depleting its reserves, and reverses the process during cyclical expansions. In the current system, financial transactions occur at a zero interest rate. Firms do not earn interest on deposits in their UI account, nor are they charged interest for any implicit loans made during a recession.

One purpose of this paper is to present a theoretical model that specifies an appropriate risk-adjusted interest rate for the borrowing and lending of funds in a firm's UI account. This is done in the next section through an analysis of the functioning of a hypothetical market in which expected profit-maximizing insurers provide UI benefits to unemployed workers. This model determines what actuarially fair premiums would be if private insurers were to sell UI to a random sample of all persons now covered under current UI legislation under the assumption that the cost of public and private insurance was the same (i.e., there are no differences in the input prices or methods of production associated with the ownership characteristics of insurance carriers).

It is to be emphasized that this model cannot predict what competitive UI premiums would be if complete privatization of the UI system were to occur. Risk premiums for UI losses are functions of current UI legislation. If UI were privately provided, a number of important changes in the current system would occur, and the timing and magnitude of fluctuations in unemployment and UI benefits might be greatly altered. For example, private insurers would (i) charge different premiums for individuals and firms with different risk characteristics, (ii) probably use experience rating more extensively, and (iii) be more likely to require coinsurance provisions than the current public systems. Because of these differences, under private insurance individuals might choose different amounts of coverage than under the current system (some might refuse to pay the market premiums and remain uninsured), which would cause the stochastic structure of both unemployment and UI benefits to change.

However, the estimates presented in Section IV are relevant in determining what actuarially fair premiums would be if employers of all currently covered workers were required to purchase UI from private (profit-maximizing) insurance companies, but eligibility and benefit rules were maintained as now determined by law. The premiums estimated in Section IV would be actuarially fair and would enable private insurers to earn a (risk-compensated) normal rate of return on their capital, thereby inducing their voluntary participation. To the best of my knowledge, these estimates are the first of their kind.

III. A Model of a Competitive Insurance Market[3]

The (typical) insurance company in this model collects premiums each period and holds a dollar level of reserves K, supplied by investors in the company. The insurance company holds reserves because losses are not independently distributed across workers. In adverse states of the world, the company collects less in premiums than it pays in losses and draws out of reserves to pay claims.

Assume that the insured pays a premium P, which is nonstochastic, at the beginning of each period.[4] The insurance company bears losses of $\tilde{L}$, corresponding to the dollar amount of UI claims; these losses are paid at the end of each period. ($\tilde{L}$ is a random variable.)

Reserves and premium income are invested in securities each period. In a competitive capital market with aggregate uncertainty and risk-averse investors, the shareholders of the insurance company will receive a return on their investment sufficient to compensate for the risk in their income stream. Using the CAPM framework,[5] one can derive the UI premium that would prevail in a competitive market.

The derivation is as follows: given the assumptions of CAPM, the expected return on a risky asset is given by

$$\bar{R}_i = R + \lambda\beta_i, \tag{1}$$

where $\bar{R}_i$ is the expected return on the ith asset, R is the risk-free return, β_i is the systematic risk of the ith asset in the market portfolio, and λ is the market price of risk. (All returns have the dimension of one plus an interest rate, $R = 1 + r$.) The excess expected return of the market portfolio over the risk-free rate is λ; $\lambda = (\bar{R}_m - R)$, and β_i is given by $\beta_i = \mathrm{cov}(\tilde{R}_i, \tilde{R}_m)/\sigma^2_{R_m}$.

Shareholders of the insurance firm receive a return on their investment of

$$\tilde{R}_i = [\tilde{R}_j (K + P) - \tilde{L}]/K, \tag{2}$$

where $\tilde{R}_j$ is the return on the insurance company's investment portfolio.[6] The expected return for a shareholder of the insurance firm is

$$\bar{R}_i = \bar{R}_j (1 + P/K) - \bar{L}/K, \tag{3}$$

3. This is essentially the model of Hill (1979) or Kraus and Ross (1982). See their papers for a more complete discussion of this model.

4. Competitive firms are assumed to use complete experience rating in setting premiums. Feldstein (1976), Brechling (1977*a*, and 1977*b*), and Topel and Welch (1980) discuss the incentive effects of imperfect experience rating.

5. See Fama (1976) for a general discussion of the CAPM model.

6. As Hill (1979) noted, the choice of the insurance company's investment portfolio is irrelevant to the determination of P (see eq. [6]). The insurance company may invest reserves in any portfolio, even one that is inefficient (in the mean-variance sense). A state UI fund may invest reserves only in Treasury bills and bonds, but this choice of $\tilde{R}_j$ is consistent with the model.

where $\bar{L}$ is the expected dollar loss in UI claims for the insurance company. Substituting (3) into the CAPM equilibrium condition (1) yields

$$R + \lambda\beta_i = \bar{R}_j (1 + P/K) - \bar{L}/K. \tag{4}$$

Using (2) one can solve for β_i, the beta of the insurance firm:

$$\beta_i = (1 + P/K)\,\beta_j - \beta_L/K. \tag{5}$$

Substituting (5) into (4), and noting that $\lambda\beta_j = (\bar{R}_j - R)$, equation (4) can be written as

$$R(P/K) + \lambda\beta_L/K = \bar{L}/K, \tag{4'}$$

where $\beta_L = \text{cov}\,(\tilde{L}, \tilde{R}_m)/\sigma^2_{R_m}$. Solving for the premium per dollar of expected loss, we obtain

$$(P/L) = \frac{1}{R}(1 - \lambda\beta'_L), \tag{6}$$

where $\beta'_L = \text{cov}\,(\tilde{L}/\bar{L}, R_m)$.

Equation (6) is identical to the pricing equation for insurance premiums derived by Hill (1979) and Kraus and Ross (1982). If losses exhibited no systematic risk ($\beta'_L = 0$), competitive insurance firms would charge a price per dollar of expected loss equal to $1/R$. That is, the insurance company would receive $L/(1 + r)$ dollars in premiums at the beginning of the period and would pay L dollars in claims at the end, earning a normal rate of return on its assets.

If losses exhibit systematic risk ($\beta'_L \neq 0$), the premium per dollar of loss will deviate from $1/R$. A positive β'_L would reduce the competitive premium in (6). Shareholders of the insurance firm would be willing to accept a lower premium income because supplying insurance reduces the risk of their total portfolio. Conversely, if β'_L were negative, losses would be negatively correlated with the market return and shareholders of the insurance firm would require a premium per dollar of expected loss greater than $1/R$.

IV. Empirical Results

Background

As a preliminary to estimating the systematic risk of UI losses, it is useful to examine the time-series behavior of market returns, output, and unemployment. Figure 1 presents annual averages of monthly data for aggregate output, insured unemployment, and real stock returns in the United States over the period 1956–82. (Appendix table A1 shows the data used in figs. 1 and 2.) Output is measured as the log deviation from trend in the Industrial Production Index, unemployment is mea-

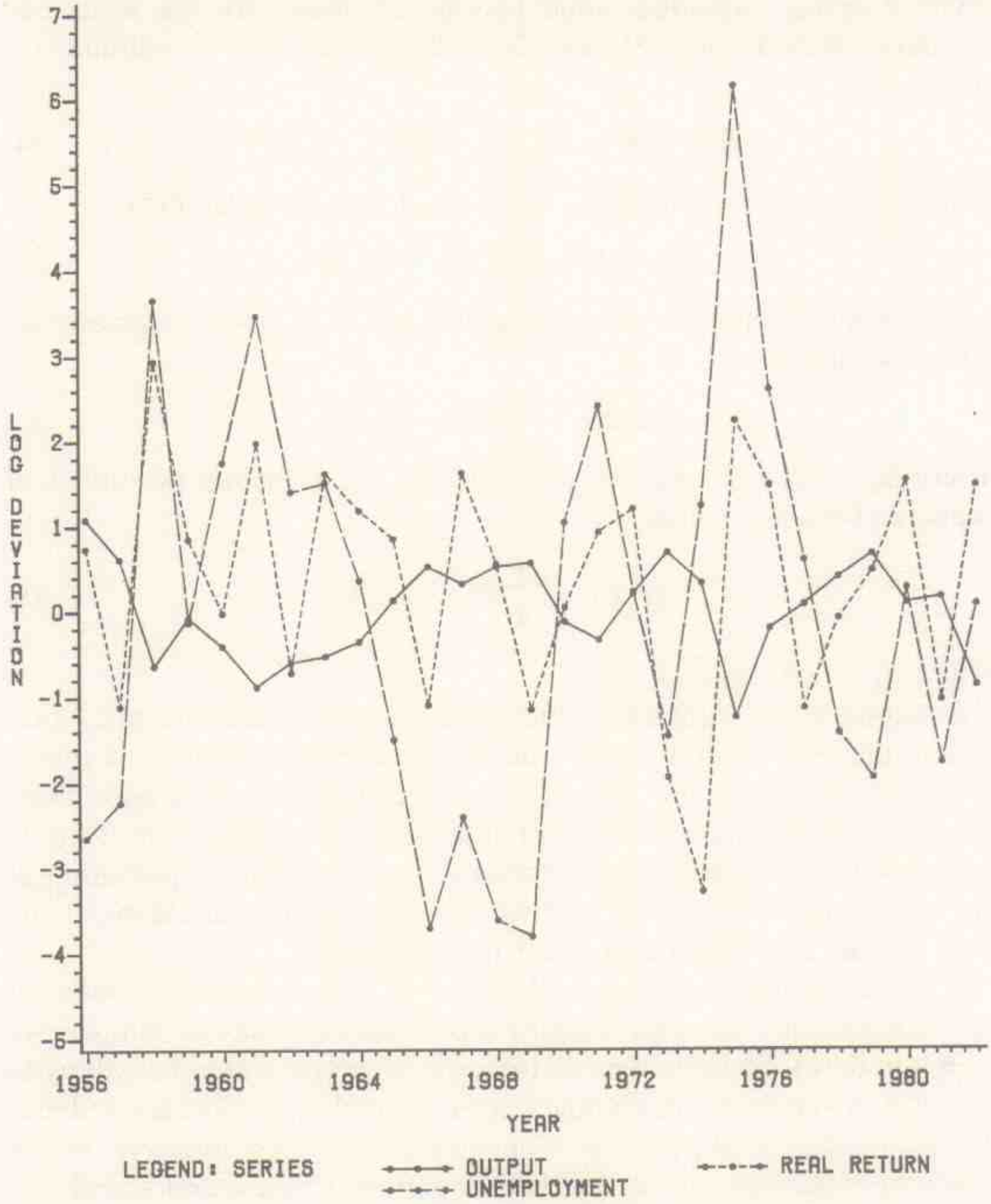

FIG. 1.—Log deviation of output, unemployment, and real stock returns (annual average of monthly data, 1956–82).

sured as the log deviation from trend in the number of insured unemployed, and stock returns are measured by the real monthly percentage return on the Standard and Poor's composite stock index (adjusted for dividends). Figure 1 clearly shows that periods of high unemployment and below average growth in output have been preceded by below average stock market returns. This observation corroborates the empirical results of Fama (1981), who reported that stock returns lead real business cycle activity.

Figure 2 presents annual averages of monthly data for nominal stock returns and nominal UI losses. Stock returns are measured as the

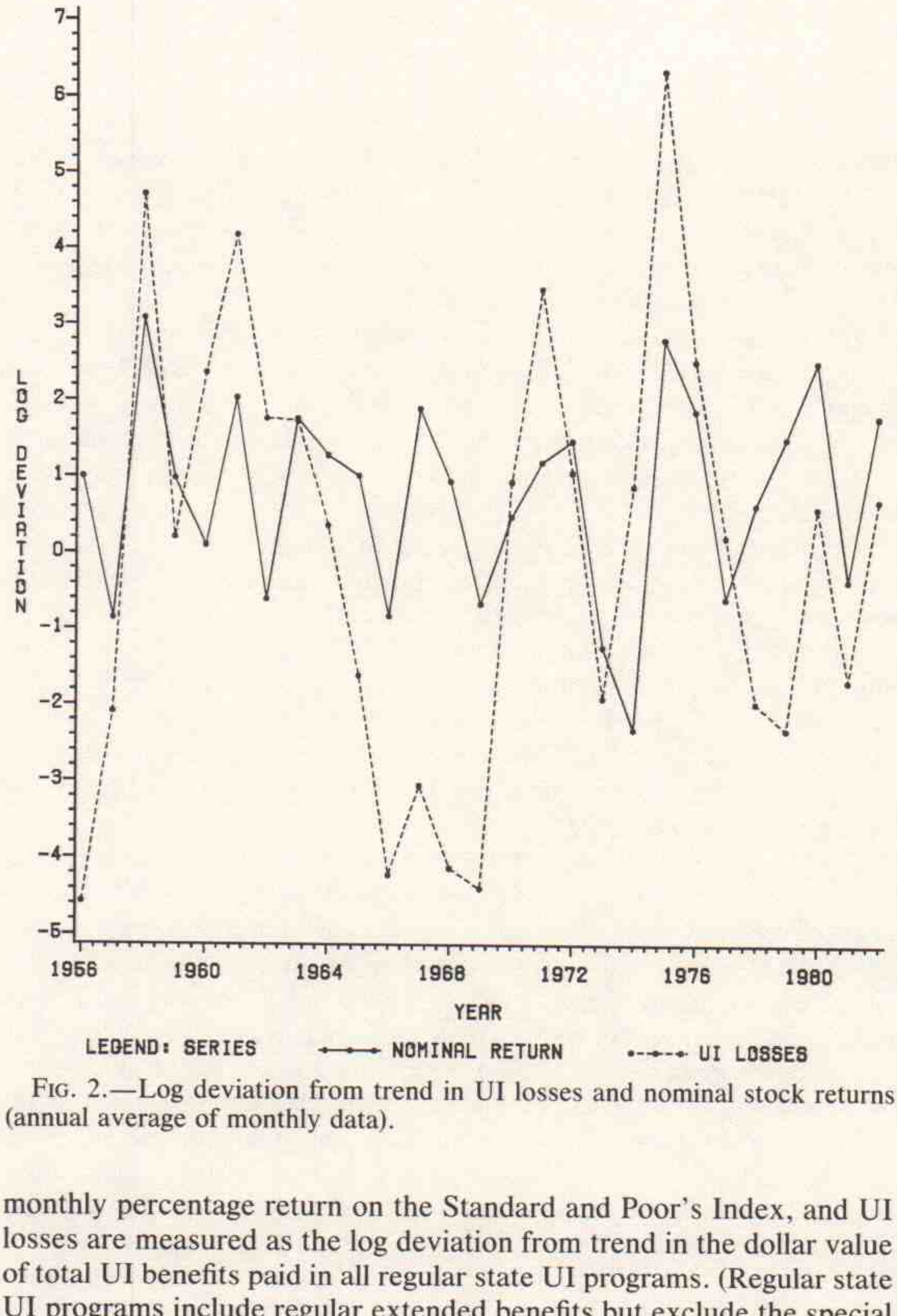

FIG. 2.—Log deviation from trend in UI losses and nominal stock returns (annual average of monthly data).

monthly percentage return on the Standard and Poor's Index, and UI losses are measured as the log deviation from trend in the dollar value of total UI benefits paid in all regular state UI programs. (Regular state UI programs include regular extended benefits but exclude the special federal supplemental benefit programs.) Figure 2 indicates that below average nominal returns typically precede above average growth in UI losses. The contemporaneous correlation between monthly nominal stock returns and monthly UI losses is .18. (Coincidentally the contemporaneous correlation between real stock returns and insured unemployment is also .18.)

A more complete time-series model of the business cycle was estimated using the monthly data summarized in figure 1. A vector autoregression model of industrial production, insured unemployment, and real stock market returns was estimated for the period 1956–82. (Complete results of the vector autoregression are presented in App. table A2.) A lag length of 18 months was imposed for all variables in the autoregression. This lag length was chosen by beginning with a 6-month lag for all variables and adding additional lags in 6-month increments until all additional lags were insignificantly different from zero at the .05 significance level.

Table 1 summarizes the moving average representation of the estimated time-series model. The first three columns of table 1 indicate the effects of a one-standard-deviation innovation in industrial production (Y_t) on the variables in the model. An innovation in Y_t is followed by future increases in Y_t and an initial reduction in unemployment. (For example, an increase of 1.16% in Y_t leads to a reduction in U_t of about 2.62% after 5 months.) It is surprising that unemployment increases sharply about 12–18 months after the innovation in Y_t. Real stock returns do not seem to be greatly influenced by innovations in Y_t.

The second three columns of table 1 indicate the effects of a one-standard-deviation innovation in insured unemployment (U_t) on the variables in the model. An innovation in U_t is followed by future increases in U_t and small reductions (.5% after 6 months) in industrial production. Real stock returns do not appear to be greatly influenced by innovations in U_t.

The final three columns of table 1 indicate the effects of a one-standard-deviation innovation in real stock market returns (r_t) on variables in the model. An innovation in real stock market returns leads to a 1% increase in Y_t and a 5% decrease in U_t after 12 months.

Table 1 summarizes the time-series behavior of output, unemployment, and stock market returns over the business cycle. Stock market innovations appear to cause movements in future output and unemployment, but future stock market returns cannot be predicted by lagged changes in output, unemployment, or stock returns. (This is clearly shown by the low R^2 and high marginal significance levels of the explanatory variables in the stock return autoregression in table A2.) For the purpose of this paper, it is interesting to note that a change in stock market returns leads changes in insured unemployment by about 12 months.

UI Premiums and Risks

Actuarially fair UI premiums in a CAPM model are a function of the contemporaneous covariance between UI losses and the market return. Assume that both UI losses and stock returns are log normally distributed. UI losses, $\tilde{L}_t$, can be written as $\ln \tilde{L}_t = \ln \overline{L}_t + \epsilon_{Lt}$, where

TABLE 1

Moving Average Representation of a Time-Series Model of Real Stock Returns, Industrial Production, and Unemployment
(Monthly Data, 1956–82)

	Effect of a One-Standard-Deviation Innovation in Y_t on:			Effect of a One-Standard-Deviation Innovation in U_t on:			Effect of a One-Standard-Deviation Innovation in r_t on:		
Lag	Y_t	U_t	r_t	Y_t	U_t	r_t	Y_t	U_t	r_t
0	1.1588	...	...	...	4.1613	...	...	...	4.0445
1	1.4782	−.5739	−.2909	−.1477	5.4081	.0766	.0801	−.3814	−.0396
2	1.5979	−1.7975	−.2383	−.1796	4.8867	.2790	.1335	−1.0125	−.3624
3	1.4131	−2.0875	−.0558	−.3779	4.8337	.2907	.2511	−1.5065	.2566
4	1.3983	−2.4304	.2769	−.3411	4.7055	.3543	.3739	−1.9360	.0550
5	1.3300	−2.6193	−.1859	−.3207	4.8163	.1531	.5281	−2.4562	.1467
6	1.0371	−2.4499	−.5054	−.5074	4.7626	−.2077	.7685	−3.1914	−.4580
12	.8547	.6696	.0462	−.1315	4.0949	−.0373	1.0515	−5.0718	.0032
18	.0710	2.5265	−.3377	−.2340	3.0863	−.0840	.7149	−3.2792	−.2545
24	−.1993	4.4017	.2525	−.1454	2.8470	.0548	.5408	−2.3982	−.2323
30	−.4252	4.0418	−.1694	−.2352	2.6165	−.0332	.2861	−1.2654	−.0568
36	−.2980	3.7096	.0760	−.1756	2.3862	.0613	.0642	−.3571	.0018

NOTE.—Y_t = industrial production index (100* log deviation from trend), U_t = insured unemployment (100* log deviation from trend), and r_t = monthly percentage return on the Standard & Poor's composite stock index.

$\ln \bar{L}_t$ is the deterministic (predictable) component of losses and ϵ_{Lt} is a normally distributed forecast error. Then, β'_L, the systematic risk of UI losses with the market return, is $\beta'_L = \text{cov}(\epsilon_{Lt}, \ln R_{mt})/\sigma^2 (\ln R_{mt})$. Thus, in a competitive insurance market, premiums will differ from expected losses if β'_L is nonzero.

Estimates of β'_L are obtained by modeling the joint time-series behavior of UI losses and nominal stock returns. A vector autoregression of ϵ_{Lt}, the log deviation from trend in UI benefits paid in regular state programs, and R_{mt}, the nominal percentage return on the Standard and Poor's index, was estimated using monthly data from 1956–82. A deterministic trend and deterministic seasonal components (using monthly dummy variables) were removed from the UI loss series, but the stock return series did not exhibit a trend or seasonal pattern. Lag lengths of 30 months for ϵ_{Lt} and 12 months for R_{mt} were chosen, because additional lags in each autoregression were insignificantly different from zero at the .05 significance level. (Complete results of this autoregression are presented in App. table A3.)

The regression results indicate that the nominal stock market return, R_{mt}, is essentially a white noise error term over the sample period. (This is clear from the low R^2 and high marginal significance levels for the F-tests reported in table A3.) Given this restriction, the time-series model of UI losses and stock market returns can be written:

$$\begin{aligned} [1 - \delta(L)]\epsilon_{Lt} &= \theta(L)R_{mt} + U_{1t} \\ R_{mt} &= U_{2t}, \end{aligned} \tag{7}$$

where $\delta(L)$ and $\theta(L)$ are polynomials in the lag operator and U_{1t} and U_{2t} are serially uncorrelated error terms.

Table 2 summarizes the moving average representation of this time-series model; that is, it indicates the effects of innovations in U_{1t} and U_{2t} on future realizations of ϵ_{Lt}. Column 1 of table 2 shows that an innovation in U_{1t} (ϵ_{Lt}) increases ϵ_{Lt} by about 7.4% after 5 months, and this effect gradually diminishes over time. Column 2 of table 2 shows that an innovation in R_{mt} initially *increases* the level of UI losses, but the effect turns negative after 8 months, with the largest decline in UI losses occurring after 11 months.

Table 2 clearly shows the time-series relationship between stock market returns and UI losses. Stock market returns are negatively correlated with unemployment insurance losses at lags of more than 8 months, but at shorter lag lengths stock market returns and UI losses are positively correlated. According to the CAPM model, it is the contemporaneous covariance between UI losses and the stock market that determines the competitive level of UI premiums. We now turn to the problem of estimating this contemporaneous covariance.

Consider an alternative representation of (7) where the innovations

TABLE 2 **Moving Average Representation of a Time-Series Model of UI Losses and Nominal Stock Market Returns**
(Monthly Data, 1956–82)

Lag	Effect of a One-Standard-Deviation Innovation in ϵ_{Lt} on ϵ_{Lt}	Effect of a One-Standard-Deviation Innovation in R_{mt} on ϵ_{Lt}
0	6.1982	. . .
1	6.1629	4.2537
2	6.2932	3.4809
3	6.8422	3.9827
4	6.6849	2.8682
5	7.4263	3.0345
6	7.1094	2.1732
7	6.4933	.5441
8	5.5652	−.7377
9	5.3289	−1.9553
10	4.8703	−2.5784
11	4.5966	−3.0179
12	6.3983	−2.2106
18	5.1803	−1.9594
24	3.8946	−2.3836
30	2.6660	−2.4388
36	1.2771	−1.9269

are orthogonalized;[7] $U_{1t} = \beta R_{mt} + V_t$, and V_t and $R_{mt}(U_{2t})$ are orthogonal. The time-series model is then

$$[1 - \delta(L)]\epsilon_{Lt} = \beta R_{mt} + \theta(L)R_{mt} + V_t \qquad (8)$$
$$R_{mt} = U_{2t}.$$

Thus the contemporaneous covariance between the innovation in UI losses and R_{mt} is measured by β. Equation (8) was estimated using least squares, with the following results:[8] $\beta = .0333$, $SE(\beta) = .0948$, $R^2 = .9618$, $df = 249$, F-ratio $= 145.88$. The estimated β is insignificantly different from zero at the .05 significance level, implying no significant contemporaneous covariance between the innovation in UI losses and the return on the stock market portfolio.

Rewrite (8) in moving average form to obtain

$$\epsilon_{Lt} = \frac{\beta + \theta(L)}{1 - \delta(L)} R_{mt} + \frac{1}{1 - \delta(L)} V_t. \qquad (9)$$

From (9) it can be shown that the k-step ahead forecast of ϵ_{Lt} is an infinite order moving average of R_m's and V's through period $t - k$. Since R_m and V are orthogonal at all lags, and since R_m is orthogonal

7. Sargent (1978) describes vector autoregressions and the orthogonalization of innovations in an AR process.

8. Only the coefficient β is reported because all other coefficients are virtually the same as in table A3.

with lagged R_m, the covariance between the k-step ahead forecast error of UI losses in period t and the stock market return in period t is $\beta \cdot \mathrm{var}(R_m)$ for all k. In other words, if insurance companies use all available information concerning UI losses and market returns when forecasting UI losses in period $t - k$, unanticipated UI losses (the forecast error) will have a systematic risk of β, the coefficient reported above. (If insurance companies did not use all available information or if R_{mt} was influenced by lagged variables, β would not necessarily be the systematic risk factor for all k-step ahead forecasts.)

Estimated in this way, β corresponds to β_L' in the theoretical section. This means that although market returns help to predict future UI losses, there is no evidence of any contemporaneous covariance risk in the UI loss time series. Therefore (in my model) private insurers could charge premiums equal to $(1/R)$ times expected losses and still earn a normal rate of return for their investors. That is, no adjustment for risk premiums would be necessary in the UI market if insurers were allowed to vary premiums over the business cycle.

Because it is very uncertain that insurers could accurately forecast UI losses (i.e., forecast business conditions), it is also uncertain that premiums could be adjusted over the business cycle to reduce insurers' undiversifiable risk. Accordingly, I shall consider an alternative rule for setting premiums: assume that over the cycle, premiums are set to cover average UI losses, but that premiums can be varied only infrequently (i.e., they are fixed for periods longer than one cycle). With this hypothesis, ϵ_{Lt} becomes the relevant forecast error for insurance companies. Insurers forecast losses using a deterministic trend and seasonal dummy variables, but premiums cannot be adjusted to account for new information acquired during the business cycle. The level of reserves required for firms to remain solvent will then be higher, reserves will have a larger variance over the business cycle, and the relevant risk factor for UI is no longer represented by β in equations (8) and (9).

Given these assumptions, the beta for UI can be estimated by examining the unconditional contemporaneous covariance between ϵ_{Lt} and R_{mt}. Ordinary least squares estimation of the regression function of ϵ_{Lt} on R_{mt} was performed with the following result:

$$\underset{}{\hat{\epsilon}_{Lt}} = \underset{(1.7208)}{0.6489} + \underset{(.4103)}{1.2415}\, R_{mt},$$

$R^2 = .0305$, F-ratio $= 9.16$, $df = 291$, standard errors in parentheses.

The estimated beta for UI is 1.2415, implying that UI losses tend to be above trend when the market yield is above its mean. (This is clear from the time-series model presented in table 2 and the data in fig. 2.) This surprising finding apparently results from the fact that stock returns lead the business cycle (i.e., output and unemployment).

TABLE 3 **Competitive UI Premiums Given Two Alternative Forecasting Rules for UI Losses**

	Deterministic Forecast	Autoregressive Forecast
Competitive premium per dollar of expected loss	.915	.948
Implicit annual interest rate for UI reserves	9.34%	5.49%
UI loss beta	1.2415	.0333

Over the sample period 1956–82, the average annual risk-free return (90-day Treasury bill) was 5.4%, while the Standard and Poor's composite index had an average annual yield of 8.3%. Using this 2.9% yield differential as an estimate of λ, the UI pricing formula becomes $(P/\bar{L}) = (1/1.054)[1 - \beta_L'(.029)]$.

Table 3 calculates the implied premium per expected dollar of loss which would appear in a hypothetical private UI market. In these calculations the premium per dollar of expected loss is equal to the inverse of one plus the expected interest rate insured firms would earn on reserves in their UI account in a competitive market. Thus, if premiums were set by a deterministic rule, the insured would pay 91.4 cents per dollar of expected loss each period and on average earn a 9.34% annual return on their UI account. Notice that a competitive insurance firm implicitly pays a higher than risk-free rate on deposits in UI accounts because supplying UI reduces the risk in its portfolio.[9] (The beta for the deterministic forecast error is 1.2415.)

The surprising result that UI losses have a positive unconditional covariance with the market portfolio does not appear to be sensitive to the particular time period chosen. When the sample period was divided into different subsamples, and the UI loss series detrended for each subsample, the estimated unconditional betas were still in excess of unity.[10] When betas were estimated using real returns and actual unemployment, rather than the nominal data presented in this paper, the conditional betas estimated in vector autoregressions remained insignificantly different from zero, while the unconditional betas remained above one.

9. A shift in UI financing from the federal government to the private sector could change the risk-free rate and the market price of risk in capital market equilibrium. In this paper I assume that the total amount of borrowing and lending would be unchanged by privatization, so that the effect on relative prices would be negligible. If premiums were set by an autoregressive forecast of losses, the insured would pay 94.8 cents per dollar of expected loss and earn the risk-free rate on its UI account. In this case expected losses and premiums would vary from month to month over the business cycle.

10. The UI loss series was divided into the periods 1956–66 and 1967–82. For these tests 1966 was chosen as the division for the subsamples by examining plotted UI loss data.

Industry Differences

Insured unemployment varies substantially in its seasonal and cyclical pattern across industries. Therefore UI betas may differ substantially across industries, and the competitive premium should reflect this.[11] Unfortunately the U.S. Department of Labor does not report UI benefits paid by industry. However, insured unemployment data by industry attachment is available monthly from May 1968 to June 1979.

Two sets of unemployment betas are reported by industry in table 4. The conditional beta is estimated in an autoregressive forecasting equation, where monthly industry unemployment is predicted by lagged values of industry and aggregate unemployment and lagged real stock returns. The conditional beta represents the contemporaneous covariance between real returns and innovations in industry unemployment and corresponds to β_i in the following forecasting equation:

$$1 - \delta_i(L)\epsilon_{U_{it}} = \theta_i(L)r_t + \eta_i(L)\epsilon_{Ut} + \beta_i r_t + V_{it}. \tag{10}$$

$\delta_i(L)$, $\theta_i(L)$, and $\eta_i(L)$ are polynomials in the lag operator for the unemployment equation in industry i. ϵ_{Ut} is the log deviation from trend in aggregate unemployment; $\epsilon_{U_{it}}$ is the log deviation from trend in industry i's unemployment; and r_t is the real return on the Standard and Poor's stock index. The estimated β_i for each industry and its corresponding standard error are reported in the first two columns of table 4.

An additional set of unconditional unemployment betas were estimated across industries using the following model:

$$\epsilon_{U_{it}} = \beta_i' r_t + V_{it}', \tag{11}$$

where β_i' is a measure of the unconditional covariance between unemployment in industry i and the real market return. The estimated unconditional betas and their standard errors are reported in columns 3 and 4 of table 4.

The industry betas in table 4 do not differ substantially across industries, and in general the results support the earlier findings. Unconditional betas are generally large and positive, while the betas constructed from autoregressive forecasts are positive but much smaller in magnitude.

11. Fair UI premiums differ across industries due to two factors: first, expected losses differ across industries; second, the fair premium per dollar of expected loss should be a function of the industry's loss beta. Cross-subsidization in the actual UI system occurs through incomplete experience rating, so that premiums are not proportional to expected losses (see Feldstein 1976; Topel and Welch 1980). Additional cross-subsidization occurs because, even with complete experience rating, premiums per dollar of loss should differ across industries. A shift to fair UI pricing would reduce profits and wages in subsidized industries and shift resources to equalize rates of return across industries.

TABLE 4 **Unemployment Betas by Industry**

Industry	Conditional Beta	(SE)	Unconditional Beta	(SE)
Mining	−.1031	(.3589)	.9485	(.4735)
Construction	.2646	(.1599)	.7478	(.3947)
Durable goods	.2026	(.2069)	1.9963	(.6692)
Lumber	.1112	(.2519)	1.0335	(.5185)
Furniture	.2548	(.2503)	1.5169	(.6624)
Stone, clay, and glass	.3986	(.2666)	1.5550	(.5208)
Primary metal	.4989	(.3701)	2.8481	(.9992)
Fabricated metal	.1120	(.1857)	1.7348	(.6051)
Machinery	.7668	(.5005)	2.8533	(.9523)
Electric equipment	.2919	(.2392)	2.2188	(.7398)
Transportation equipment	.4965	(.4906)	2.1243	(.8816)
Instruments	.1349	(.5331)	2.0136	(.7327)
Miscellaneous	.1817	(.1890)	1.1863	(.4496)
Nondurable goods	.0025	(.1339)	1.0293	(.3662)
Food	.0389	(.1549)	.5138	(.2192)
Tobacco	1.1388	(.3882)	1.1555	(.4433)
Textiles	−.1785	(.1884)	1.7907	(.6497)
Apparel	−.0874	(.1734)	.8023	(.3931)
Paper	.3559	(.2463)	1.4328	(.5208)
Printing	.3541	(.1769)	.9725	(.3387)
Chemicals	.1636	(.1658)	1.4687	(.5164)
Petroleum	−.2156	(.3713)	.8079	(.4300)
Rubber	.2447	(.2171)	1.8019	(.6194)
Leather	.4424	(.2032)	.9237	(.4224)
Public utilities	.1204	(.2030)	1.1513	(.4036)
Wholesale and retail trade	.0947	(.0858)	.8411	(.3047)
Services	.0283	(.1201)	1.6735	(.9877)
Finance, insurance, real estate	.1199	(.1062)	.8331	(.2994)
State and local government	.5118	(.2179)	.2864	(.3463)
Aggregate unemployment	.1514	(.0994)	1.1760	(.3849)

V. Conclusion

In this paper a dynamic model of unemployment insurance was presented. Because of the high correlation in unemployment across firms and individuals, a realistic model of UI must allow for borrowing and lending in the capital market to finance UI benefits. In a world of aggregate risk, the competitive UI premium depends not only on expected losses but on the systematic risk component of losses. The empirical results presented here indicate that *innovations* in UI losses have little if any systematic risk with the market portfolio, while UI losses themselves have a *positive* covariance with the market return. This surprising result holds across the entire time period of 1956–82, in subperiods thereof, and across major industrial classifications.

Currently all borrowing and lending between state UI funds and insured firms occurs at a zero interest rate. The empirical results presented indicate that in the hypothetical private UI market presented here, insurance companies could pay an interest rate on UI accounts at least as large as the risk-free rate and still earn a normal rate of return on invested capital. An important issue in determining fair premiums in a private UI market is whether or not insurance firms were able to alter premiums over the business cycle. In the UI market the surprising empirical result is that premiums per dollar of loss would be lower if insurance firms set premiums according to a deterministic rule and did not vary them over the cycle.

Much more research in this area remains to be done before making recommendations for UI policy. Dynamic models of the UI market are essential since premium income does not equal total benefits paid in any given period. This observation demonstrates the importance of interest rate variables in UI pricing equations. The proper risk-adjusted interest rate to use in the UI market can be derived in a CAPM framework. Given the extensive serial correlation in UI losses, it may be useful to consider a multiperiod capital asset pricing model in future work.

Appendix

TABLE A1 Annual Averages of Monthly Data, 1956–82

Year	Output*	Unemployment*	Real Return	UI Losses*	Nominal Return
1956	10.86	−26.49	.74	−45.70	1.00
1957	6.14	−22.31	−1.11	−20.89	−.86
1958	−6.37	36.59	2.94	47.13	3.08
1959	−.75	−1.31	.85	2.04	.98
1960	−4.10	17.51	−.02	23.64	.10
1961	−8.83	34.67	1.98	41.75	2.03
1962	−5.97	14.04	−.72	17.61	−.61
1963	−5.26	15.11	1.62	17.31	1.76
1964	−3.56	3.56	1.18	3.59	1.28
1965	1.27	−15.03	.85	−16.15	1.01
1966	5.23	−37.00	−1.10	−42.21	−.83
1967	3.17	−24.08	1.62	−30.53	1.89
1968	5.15	−36.13	.55	−41.28	.94
1969	5.59	−38.06	−1.16	−43.91	−.67
1970	−1.32	10.35	.04	9.32	.48
1971	−3.42	24.00	.92	34.62	1.19
1972	2.02	2.18	1.19	10.57	1.47
1973	6.78	−14.66	−1.95	−19.13	−1.24
1974	3.22	12.30	−3.28	8.73	−2.32
1975	−12.51	61.35	2.23	63.35	2.80
1976	−2.12	25.94	1.47	25.10	1.86
1977	.68	5.94	−1.14	2.05	−.60
1978	3.90	−14.32	−.09	−19.74	.63
1979	6.58	−19.55	.46	−23.21	1.50
1980	.88	2.60	1.52	5.89	2.50
1981	1.53	−17.84	−1.05	−16.82	−.36
1982	−8.82	.65	1.46	6.89	1.78
Average	...	...	.37	...	.77

*Measured as 100 × ln (deviation from trend).

TABLE A2 Vector Autoregression of Output, Unemployment, and Real Returns (Monthly Data, 1956–82)

	Dependent Variable					
	Y_t		U_t		r_t	
	Coefficient	SE	Coefficient	SE	Coefficient	SE
Constant	−.1206	(.0749)	.3848	(.2691)	.3220	(.2615)
Y_{t-1}	1.2756	(.0727)	−.4952	(.2612)	−.2510	(.2538)
Y_{t-2}	−.2609	(.1143)	−.2996	(.4104)	.1212	(.3988)
Y_{t-3}	−.2328	(.1161)	.9676	(.4170)	.1661	(.4053)
Y_{t-4}	.2926	(.1168)	−.6974	(.4195)	.2535	(.4077)
Y_{t-5}	−.1712	(.1180)	.3973	(.4238)	−.4280	(.4119)
Y_{t-6}	−.1349	(.1173)	.2529	(.4212)	−.1322	(.4093)
Y_{t-7}	.3526	(.1146)	−.3794	(.4117)	.6270	(.4001)
Y_{t-8}	−.2036	(.1169)	.1367	(.4196)	−.7115	(.4079)
Y_{t-9}	−.0374	(.1169)	.3833	(.4199)	−.3787	(.4081)
Y_{t-10}	.1715	(.1167)	−.3311	(.4190)	.9169	(.4072)
Y_{t-11}	−.1371	(.1193)	.1188	(.4282)	−.7183	(.4162)
Y_{t-12}	.1899	(.1132)	.3779	(.4066)	.5193	(.3952)
Y_{t-13}	−.1912	(.1123)	−.0680	(.4031)	−.3960	(.3918)
Y_{t-14}	−.0435	(.1122)	−.0493	(.4028)	.0693	(.3915)
Y_{t-15}	.1693	(.1113)	−.2330	(.3999)	.1573	(.3886)
Y_{t-16}	−.0141	(.1113)	−.0521	(.3997)	−.3149	(.3885)
Y_{t-17}	.0122	(.1088)	−.3857	(.3908)	−.0150	(.3798)
Y_{t-18}	−.0560	(.0730)	.3102	(.2621)	.2261	(.2548)
U_{t-1}	−.0355	(.0204)	1.2996	(.0732)	.0184	(.0711)
U_{t-2}	.0479	(.0324)	−.5305	(.1164)	.0344	(.1117)
U_{t-3}	−.0670	(.0337)	.3014	(.1211)	−.0008	(.1177)
U_{t-4}	.0843	(.0339)	−.1550	(.1217)	.0176	(.1182)
U_{t-5}	−.0461	(.0341)	.1243	(.1224)	−.0383	(.1189)
U_{t-6}	−.0383	(.0342)	−.0538	(.1226)	−.0800	(.1192)
U_{t-7}	.0709	(.0341)	−.1040	(.1225)	.0437	(.1190)
U_{t-8}	.0015	(.0344)	−.0245	(.1236)	.0390	(.1201)
U_{t-9}	−.0662	(.0340)	.1422	(.1222)	−.0504	(.1188)

U_{t-10}	.0560	(.0339)	.0268	(.1216)	.0650	(.1182)
U_{t-11}	−.0009	(.0342)	.0085	(.1228)	−.0301	(.1194)
U_{t-12}	−.0156	(.0340)	.1965	(.1221)	−.0668	(.1186)
U_{t-13}	.0258	(.0339)	−.1846	(.1218)	.1587	(.1184)
U_{t-14}	−.0155	(.0341)	−.0918	(.1225)	−.1802	(.1190)
U_{t-15}	−.0207	(.0342)	.0805	(.1228)	.0359	(.1194)
U_{t-16}	.0140	(.0336)	−.0632	(.1206)	−.0369	(.1172)
U_{t-17}	−.0048	(.0319)	−.0269	(.1145)	.0184	(.1113)
U_{t-18}	.0105	(.0197)	.0261	(.0707)	.0254	(.0687)
r_{t-1}	.0198	(.0182)	−.0943	(.0653)	−.0098	(.0634)
r_{t-2}	.0046	(.0180)	−.1189	(.0647)	−.0830	(.0629)
r_{t-3}	.0226	(.0183)	−.0845	(.067)	.0755	(.0638)
r_{t-4}	.0183	(.0184)	−.0830	(.0661)	.0312	(.0642)
r_{t-5}	.0244	(.0184)	−.0753	(.0660)	.0770	(.0642)
r_{t-6}	.0486	(.0185)	−.1189	(.0664)	−.0735	(.0645)
r_{t-7}	.0173	(.0186)	−.1014	(.0666)	−.1177	(.0648)
r_{t-8}	.0204	(.0186)	−.1452	(.0669)	−.1248	(.0650)
r_{t-9}	.0357	(.0186)	−.1194	(.0668)	.0305	(.0649)
r_{t-10}	−.0181	(.0186)	−.0248	(.0669)	−.0120	(.0651)
r_{t-11}	.0154	(.0187)	−.0405	(.0670)	.0502	(.0651)
r_{t-12}	−.0058	(.0185)	.0109	(.0665)	.0710	(.0646)
r_{t-13}	.0043	(.0184)	−.0451	(.0662)	.0066	(.0643)
r_{t-14}	.0119	(.0184)	.0028	(.0662)	−.1252	(.0643)
r_{t-15}	.0291	(.0186)	−.0994	(.0667)	.0260	(.0648)
r_{t-16}	.0145	(.0187)	.0521	(.0672)	−.0425	(.0653)
r_{t-17}	−.0027	(.0185)	−.0150	(.0665)	.1366	(.0646)
r_{t-18}	−.0356	(.0185)	.0178	(.0666)	.0118	(.0647)
R^2	.9639	...	.9792	...	.2358	...
F-ratio	123.75	...	217.66	...	1.43	...
df	250	...	250	...	250	...
Marginal significance:						
of lagged Y's	.0001	...	.0388	...	.0809	...
of lagged U's	.0839	...	.0001	...	.8661	...
of lagged r's	.1722	...	.2140	...	.2500	...

TABLE A3 **Vector Autoregression of UI Losses and Nominal Stock Returns**
(Monthly Data, 1956–82)

	Dependent Variable			
	ϵ_L		R_m	
	Coefficient	SE	Coefficient	SE
Constant	1.0381	(.4619)	.8623	(.3807)
$\epsilon_{Lt\text{-}1}$	.9943	(.0631)	.0570	(.0422)
$\epsilon_{Lt\text{-}2}$	.0267	(.0891)	.0055	(.0595)
$\epsilon_{Lt\text{-}3}$	.0678	(.0885)	−.0845	(.0592)
$\epsilon_{Lt\text{-}4}$	−.1136	(.0881)	.0312	(.0589)
$\epsilon_{Lt\text{-}5}$	.1404	(.0883)	.0463	(.0590)
$\epsilon_{Lt\text{-}6}$	−.1722	(.0863)	−.0829	(.0577)
$\epsilon_{Lt\text{-}7}$	−.0439	(.0827)	.0649	(.0553)
$\epsilon_{Lt\text{-}8}$	−.0696	(.0805)	.0334	(.0538)
$\epsilon_{Lt\text{-}9}$	.1498	(.0803)	−.0123	(.0537)
$\epsilon_{Lt\text{-}10}$	−.0461	(.0803)	−.0568	(.0537)
$\epsilon_{Lt\text{-}11}$	.0587	(.0805)	.0292	(.0538)
$\epsilon_{Lt\text{-}12}$	.3188	(.0818)	.0414	(.0547)
$\epsilon_{Lt\text{-}13}$	−.4755	(.0842)	−.0386	(.0563)
$\epsilon_{Lt\text{-}14}$	.1507	(.0890)	−.0329	(.0595)
$\epsilon_{Lt\text{-}15}$	−.0827	(.0894)	.0420	(.0597)
$\epsilon_{Lt\text{-}16}$	.0697	(.0894)	−.0254	(.0597)
$\epsilon_{Lt\text{-}17}$	.0168	(.0892)	−.0194	(.0596)
$\epsilon_{Lt\text{-}18}$	.0376	(.0814)	.0255	(.0544)
$\epsilon_{Lt\text{-}19}$	−.0601	(.0773)	−.0171	(.0517)
$\epsilon_{Lt\text{-}20}$	.0758	(.0770)	−.0075	(.0515)
$\epsilon_{Lt\text{-}21}$	−.1304	(.0770)	.0090	(.0515)
$\epsilon_{Lt\text{-}22}$	.0494	(.0767)	.0227	(.0512)
$\epsilon_{Lt\text{-}23}$	.3199	(.0793)	.0202	(.0512)
$\epsilon_{Lt\text{-}24}$	−.4102	(.0828)	−.0798	(.0530)
$\epsilon_{Lt\text{-}25}$	.3113	(.0848)	.0222	(.0553)
$\epsilon_{Lt\text{-}26}$	−.1028	(.0848)	.0667	(.0567)
$\epsilon_{Lt\text{-}27}$	−.0661	(.0855)	−.0607	(.0571)
$\epsilon_{Lt\text{-}28}$	−.0012	(.0860)	−.0064	(.0575)
$\epsilon_{Lt\text{-}29}$	.0479	(.0862)	.0027	(.0576)
$\epsilon_{Lt\text{-}30}$	.0044	(.0587)	.0187	(.0392)
$R_{Mt\text{-}1}$	.0325	(.0943)	−.0183	(.0630)
$R_{Mt\text{-}2}$	−.2074	(.0945)	−.0643	(.0631)
$R_{Mt\text{-}3}$	.0307	(.0970)	.0307	(.0649)
$R_{Mt\text{-}4}$	−.2420	(.0970)	.0496	(.0648)
$R_{Mt\text{-}5}$	−.0623	(.0993)	.0648	(.0664)
$R_{Mt\text{-}6}$	−.1639	(.0981)	−.0846	(.0656)
$R_{Mt\text{-}7}$	−.2448	(.0981)	−.1280	(.0656)
$R_{Mt\text{-}8}$	−.1693	(.1001)	−.0771	(.0669)
$R_{Mt\text{-}9}$	−.2239	(.1008)	.0338	(.0674)
$R_{Mt\text{-}10}$	−.0883	(.1016)	−.0392	(.0679)
$R_{Mt\text{-}11}$	−.0575	(.1009)	.0325	(.0674)
$R_{Mt\text{-}12}$	−.1130	(.1007)	.0778	(.0673)
R^2	.9618	...	.1379	...
F-ratio	149.88	...	.95	...
df	250	...	250	...
Marginal significance:				
of lagged ϵ_L's	.0001	...	.6331	...
of lagged R_M's	.0118	...	.4326	...

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