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VAR MODELS AS STRUCTURAL APPROXIMATIONS

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ABSTRACT

This paper presents a way of estimating how accurate VAR models are likely to be for answering structural questions. Data are generated from a dynamic deterministic solution of a structural model; a VAR model is estimated using a subset of these data; and the properties of the VAR model are compared to the properties of the structural model. This procedure has the advantage of eliminating the effects of error terms, since the data are generated from a deterministic simulation. The results show that the VAR models do not seem to be good structural approximations.

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VAR MODELS AS STRUCTURAL APPROXIMATIONS

by

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I. Introduction

Although vector autoregressive (VAR) models have traditionally been used for forecasting, Sims (1982) has recently advocated their use for policy analysis.[2] Sims argues that his procedures differ "marginally" from those used for structural models in that "they take account of policy endogeneity and they avoid constructing behavioral stories about each individual equation in the model" (Sims, 1982, p. 150). This added generality comes, of course, at a cost. To estimate a reduced form absent conventional exclusion restrictions, the number of variables that enter the estimated reduced form must be very small relative to the number of variables in the reduced form of a structural model. Sims argues that a small set of variables captures most of the information available to the econometrician about the economy.

In Fair and Shiller (1987) encompassing tests were used to compare VAR models to the structural Fair (1976) model. The results indicate that VAR forecasts contain very little information not in the Fair model forecasts and that the Fair model forecasts contain information not in the VAR forecasts. In this sense VAR models appear to be dominated by the Fair model as forecasting devices. The present paper is, however, concerned with

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[1] I am indebted to Matthew Shapiro for many helpful comments regarding this paper.

[2] See also Doan, Litterman, and Sims (1984). Blanchard and Watson (1986) and Bernanke (1986) use VAR models to ask questions about the structure of the economy, but they impose restrictions on the covariance matrix of innovations that are analogous to exclusion restrictions.

a different question from the forecasting usefulness of VAR models. Even if VAR models do not aggregate information as efficiently as do structural models, they may still be good approximations of the true reduced form. This is the question examined here, namely how accurate are the structural properties of VAR models? Put another way, the question is how costly is the unwillingness to impose a priori restrictions when one attempts to use a VAR model to uncover structural relationships in the economy?

II. The Procedure

The methodology used in this paper is as follows: 1) data are generated from a dynamic deterministic solution of a structural model, 2) a VAR model is estimated using a subset of these data, and 3) the properties of the VAR model are compared to the properties of the structural model. If the properties of the VAR model are quite different from those of the structural model, this is evidence against the VAR model being a good approximation. If the properties are similar, this is evidence in favor of the VAR model.

An important property of this procedure is that it eliminates the effects of error terms. Because the data have been generated from a deterministic simulation, the VAR model can fail to be a good approximation only for two reasons. First, if the structural model is nonlinear, its reduced form equations are nonlinear (and not necessarily analytically tractable). The linear or log linear specification of the VAR model may not capture these nonlinearities. Second, and probably more important, the VAR model does not use all the predetermined variables in the structural model. If some of the left out variables are correlated with the included variables, the coefficient estimates of the included variables will be wrong. The VAR model will thus not capture the structural model's properties if and only if the reduced form equations that it estimates are misspecified. If the estimated reduced form equations are correct (right functional forms and all relevant predetermined variables used), the VAR model will duplicate the structural model exactly. There are no random shocks (in the simulated data) to make the VAR model differ from the structural model if it is correctly specified. All the "error" is solely from the misspecification of the VAR model.

The case of a linear structural model may help clarify the procedure. Let the structural model be

$$(1) \quad YB + X\Gamma = U ,$$

where Y is $T \times m$, B is $m \times m$, X is $T \times n$, Γ is $n \times m$, and U is $T \times m$. X may include lagged endogenous variables. Some of the equations may be identities. The elements of U corresponding to identities are identically equal to zero.

The model in (1) can be solved assuming certainty equivalence, i.e., $U = 0$. Given estimates of B and Γ, denoted $\hat{B}$ and $\hat{\Gamma}$, given values of the exogenous variables, and setting U equal to zero, the model can be solved dynamically over the period 1 through T. Let $\hat{Y}$ and $\hat{X}$ denote these solution values, where $\hat{X}$ differs from X if there are lagged endogenous variables in X.

Now, assume that $m \cdot n$ is less than T, and consider a regression of $\hat{Y}$ on $\hat{X}$. This regression will yield $-\hat{\Gamma}\hat{B}^{-1}$ as the estimated coefficient matrix for $\hat{X}$ and will result in a perfect fit. In other words, the solution data obey

$\hat{Y}\hat{B} = -\hat{X}\hat{\Gamma}$, or $\hat{Y} = -\hat{X}\hat{\Gamma}\hat{B}^{-1}$, and so the regression of $\hat{Y}$ on $\hat{X}$ will simply give back $-\hat{\Gamma}\hat{B}^{-1}$. This is just a round about way of computing the reduced form coefficient matrix. If, on the other hand, $\hat{Y}$ is regressed on a subset of the variables in $\hat{X}$, one will not get back the reduced form coefficient matrix, and a perfect fit will not be achieved. The "estimated" reduced form will only be an approximation to the actual reduced form. The "errors" that are made are not due to any stochastic error terms (since the data were generated from a deterministic simulation), but are due solely to the misspecification of the estimated reduced form equations.

III. The Models

The model in Fair (1984) is used as the structural model. The model is nonlinear, consists of 29 stochastic equations and 98 identities, and has over 100 predetermined variables. The version of the model used here is estimated (by two stage least squares) for the period 1954 I - 1987 I, 133 observations. The overall data set begins in 1952 I. (Some observations before 1954 I are needed because of lagged values in the model.) The generated data set was constructed by simulating the Fair model dynamically for the 1954 I -1987 I period. The outcome of this simulation is a data set consisting of solution values of each of the 127 endogenous variables for each of the 133 quarters.

Three VAR models are considered in this paper. Each consists of eight variables: the real value of government spending (G), the import price deflator (PM), the three-month Treasury bill rate (R), the unemployment rate (U), the money supply (M), the nominal wage rate (W), the GNP deflator (P), and real GNP (Y). All but the unemployment rate and the bill rate are in logs. In the first model, denoted VAR4, each of the eight equations consists of each variable lagged one through four times, a constant, and a time trend, for a total of 34 coefficients per equation. This model is the same as the model used in Sims (1980) except for the addition of the government spending variable and the bill rate. This model is the same as the VAR4 model in Fair and Shiller (1987) except for the addition of the government spending variable.

The second model, denoted VAR2, uses two lags per variable rather than four, for a total of 18 coefficients per equation. It is of interest to see how sensitive the properties of VAR models are to decreasing the number of lags.

The third model, denoted VAR4P, has Bayesian priors imposed on the coefficients of VAR4. The Litterman prior that the variables follow univariate random walks has been imposed. The standard deviations of the prior take the form

(2) $S(i,j,k) = \gamma g(k) f(i,j)(s_j/s_i)$,

where i indexes the left-hand-side variable, j indexes the right-hand-side variables, and k indexes the lag. s_i is the standard error of the unrestricted equation for variable i. The following values are imposed: $f(i,i)=1.0$, $f(i,j) = .5$, $i \neq j$, $g(k) = k^{-1}$, and $\gamma = 0.1$. These are the values imposed by Litterman (1979, p. 49).

The experiments below consist of shocking a particular residual and examining the response of the system to the shock. Because the residuals are correlated across equations, there is no unique way to do this. The standard procedure (see Sims (1980), p. 21) is to choose a particular order of the equations and then triangularize the system. This is what was done here. The equations were ordered 1) government spending, 2) import price, 3) bill rate, 4) unemployment rate, 5) money supply, 6) wage rate, 7) GNP deflator, and 8) real GNP. The triangularization is done by adding the contemporaneous value of the government spending variable to equations 2 through 8, the contemporaneous value of the import price variable to equations 3 through 8, the contemporaneous value of the bill rate variable to equations 4 through 8, and so on. The equations are then estimated in this form.[3]

The VAR models are estimated for the 1954 I - 1987 I period using the simulated data. The data used prior to 1954 I are the actual data. In addition, government spending and the import price deflator are exogenous in the Fair model, and so the actual data are used for these two variables.

For the results in the next section it is of interest to compare the multiplier errors that the VAR models make with the standard errors that could be computed by the model builders. In other words, it is of interest to know if the system-response errors are within what the model builders would expect from their stochastic specifications. For VAR2 and VAR4 it is possible to compute standard errors by stochastic simulation using the procedure in Fair (1980). Let $\hat{\alpha}$ denote the n-component vector of coefficient estimates for VAR2 or VAR4, and let $\hat{V}$ denote the n x n estimated covariance matrix for $\hat{\alpha}$. For VAR2 n is 172, and for VAR4 n is 300. The coefficient vector includes the coefficients of the contemporaneous variables in the equations, which enter because of the triangularization, and $\hat{V}$ is a block diagonal matrix because the residuals are not correlated

[3]For the estimation of VAR4P, the system without the contemporaneous values added was estimated first (with the priors imposed) and then the system was triangularized.

across equations after the triangularization. Let α^* be a particular draw of the coefficient vector. It is assumed that α^* is distributed as $N(\hat{\alpha}, \hat{V})$.

The standard errors are estimated as follows. 1) A value for α^* is drawn from $N(\hat{\alpha}, \hat{V})$. 2) Using this set of coefficient values, the given equation's residual is shocked and the system's responses are recorded. This is one trial. 3) Steps 1) and 2) are repeated J times, where J is the number of trials. In step 2) the shock to the residual is the same from trial to trial; only α^* changes. 4) Given the J values for each variable's response for each quarter, the variance (and standard error) of the response can be computed.

Standard errors were computed for VAR2 and VAR4 below. The number of trials for each computation was 500. This procedure cannot be directly applied to VAR4P because of the Bayesian setup, and so standard errors for VAR4P were not computed.

II. The Experiments and Results

Once the VAR models were estimated, three experiments were performed per model -- one in which the error term in the government spending equation was shocked, one in which the error term in the import price equation was shocked, and one in which the error term in the bill rate equation was shocked. The experiments were performed for the 1980 I - 1982 IV period.

The Government Spending Experiment

The government spending experiment was performed as follows. First, in each VAR model the estimated residuals were added to all the equations and taken to be exogenous. This means that when the model is solved with no shocks, a perfect tracking solution is obtained. Second, the error term in the government spending equation (equation 1) was shocked by .016 for the first quarter (1980 I). The government spending equation is in logs, and this is a shock of about 10 billion dollars at an annual rate. The model was then solved for the 1980 I - 1982 IV period. The difference between the predicted value from this simulation and the actual value of each variable for each quarter is an estimate of the effect of the shock on the variable.

The results of this experiment are presented in Table 1 for the three VAR models. The "changes" in Table 1 are the differences between the solution value after the shock and the actual value. They are not the changes from quarter to quarter. Note first that the initial change in G is \$10.0 billion, but that after the first quarter the changes are different from the initial change. This is simply the government spending equation in each VAR model at work.

The change in real GNP (Y) in the first quarter in response to this shock is \$6.2 billion for VAR4, \$6.4 billion for VAR2, and \$7.5 billion for VAR4P. The changes in the second quarter are, respectively, \$7.7, \$7.6, and \$8.9 billion. The changes become negative between the fifth and seventh quarters. The changes in the bill rate are positive except for the last four quarters for VAR2 and the last three quarters for VAR4P. The changes in the money supply are all negative, as are the price changes. The changes in the unemployment rate are initially negative and then essentially zero after about seven quarters.

The VAR properties in Table 1 need to be compared to the properties of the structural model. Remember that the VAR models are misspecified because they incorrectly omit variables from the reduced form and because

TABLE 1

Results of Government Spending Shock

VAR4

		1980				1981				1982			
		I	II	III	IV	I	II	III	IV	I	II	III	IV
VAR and ACTUAL	ΔG	10.0	9.0	7.1	6.1	5.2	4.2	4.0	3.3	2.7	2.0	1.5	1.1
VAR	ΔPM/PM	.13	.23	-.30	-.90	-1.14	-1.06	-1.07	-1.03	-.96	-.87	-.80	-.73
ACTUAL	ΔPM/PM	0	0	0	0	0	0	0	0	0	0	0	0
ERROR		.13	.23	-.30	-.90	-1.14	-1.06	-1.07	-1.03	-.96	-.87	-.80	-.73
SE		(.18)	(.29)	(.36)	(.43)	(.49)	(.52)	(.54)	(.56)	(.57)	(.59)	(.61)	(.63)
VAR	ΔR	.10	.15	.13	.10	.03	.02	.02	.03	.02	.01	.00	.01
ACTUAL	ΔR	.12	.16	.14	.11	.07	.05	.03	.03	.02	.01	.01	-.00
ERROR		-.02	-.01	-.01	-.01	-.04	-.03	-.01	.00	.00	.00	-.00	.01
SE		(.04)	(.06)	(.08)	(.09)	(.10)	(.10)	(.10)	(.10)	(.10)	(.10)	(.10)	(.10)
VAR	ΔU	-.10	-.14	-.16	-.10	-.05	-.02	-.01	-.00	.01	.01	.01	.00
ACTUAL	ΔU	-.07	-.15	-.16	-.14	-.11	-.08	-.05	-.03	-.01	.00	.01	.01
ERROR		-.03	.01	.00	.04	.06	.06	.04	.03	.02	.01	.00	-.01
SE		(.02)	(.04)	(.05)	(.06)	(.07)	(.07)	(.07)	(.07)	(.07)	(.07)	(.07)	(.07)
VAR	ΔM	.0	-.5	-.2	-.6	-.7	-.8	-.7	-.8	-.8	-.9	-.9	-.9
ACTUAL	ΔM	-.1	-.2	-.3	-.4	-.4	-.4	-.4	-.4	-.4	-.3	-.3	-.3
ERROR		.1	-.3	.1	-.2	-.3	-.4	-.3	-.4	-.4	-.6	-.6	-.6
SE		(.2)	(.3)	(.3)	(.4)	(.4)	(.5)	(.6)	(.7)	(.8)	(.9)	(1.0)	(1.1)
VAR	ΔW/W	-.03	-.06	-.06	-.06	-.09	-.12	-.16	-.18	-.20	-.22	-.23	-.24
ACTUAL	ΔW/W	-.00	.01	.02	.03	.04	.04	.04	.04	.04	.04	.03	.03
ERROR		-.03	-.07	-.08	-.09	-.13	-.16	-.20	-.22	-.24	-.26	-.26	-.27
SE		(.01)	(.02)	(.03)	(.04)	(.05)	(.06)	(.07)	(.07)	(.08)	(.09)	(.10)	(.10)
VAR	ΔP/P	-.09	-.08	-.10	-.09	-.11	-.15	-.20	-.22	-.23	-.25	-.25	-.25
ACTUAL	ΔP/P	.00	.02	.02	.05	.06	.06	.06	.06	.06	.05	.05	.04
ERROR		-.09	-.10	-.12	-.14	-.17	-.21	-.26	-.28	-.29	-.30	-.30	-.29
SE		(.03)	(.04)	(.04)	(.05)	(.06)	(.07)	(.09)	(.10)	(.11)	(.11)	(.12)	(.13)
VAR	ΔY	6.2	7.7	7.3	4.3	0.3	-1.0	-1.8	-2.2	-2.8	-3.2	-3.0	-2.4
ACTUAL	ΔY	8.3	11.8	11.3	9.2	6.6	4.1	2.5	1.2	.3	-.6	-1.2	-1.5
ERROR		-1.9	-4.1	-4.0	-4.9	-6.3	-5.1	-4.3	-3.4	-3.1	-2.6	-1.8	-.9
SE		(1.4)	(2.6)	(3.2)	(3.6)	(3.7)	(3.6)	(3.4)	(3.6)	(3.8)	(4.0)	(4.2)	(4.2)

TABLE 1 (continued)

VAR2

		1980				1981				1982			
		I	II	III	IV	I	II	III	IV	I	II	III	IV
VAR and ACTUAL	ΔG	10.0	9.1	7.5	6.3	5.6	4.7	3.9	3.3	2.7	2.2	1.9	1.8
VAR	ΔPM/PM	.06	.03	-.16	-.32	-.45	-.55	-.65	-.77	-.89	-1.01	-1.11	-1.20
ACTUAL	ΔPM/PM	0	0	0	0	0	0	0	0	0	0	0	0
ERROR		.06	.03	-.16	-.32	-.45	-.55	-.65	-.77	-.89	-1.01	-1.11	-1.20
SE		(.20)	(.34)	(.42)	(.44)	(.45)	(.45)	(.44)	(.43)	(.43)	(.43)	(.44)	(.45)
VAR	ΔR	.13	.19	.19	.18	.13	.09	.05	.02	-.01	-.03	-.04	-.05
ACTUAL	ΔR	.12	.16	.15	.11	.08	.05	.03	.02	.02	.01	.01	.01
ERROR		.01	.03	.04	.07	.05	.04	.02	.00	-.03	-.04	-.05	-.06
SE		(.04)	(.06)	(.07)	(.08)	(.09)	(.09)	(.09)	(.09)	(.08)	(.08)	(.08)	(.08)
VAR	ΔU	-.11	-.16	-.16	-.12	-.08	-.03	-.00	.02	.02	.02	.02	.00
ACTUAL	ΔU	-.07	-.15	-.17	-.15	-.12	-.08	-.05	-.03	-.01	.00	.01	.01
ERROR		-.04	-.01	.01	.03	.04	.05	.05	.05	.03	.02	.01	-.01
SE		(.02)	(.04)	(.05)	(.06)	(.06)	(.06)	(.06)	(.06)	(.06)	(.06)	(.05)	(.05)
VAR	M	.1	-.3	-.4	-.7	-.9	-1.0	-1.2	-1.2	-1.3	-1.3	-1.3	-1.3
Actual	M	-.1	-.2	-.4	-.4	-.4	-.4	-.4	-.4	-.4	-.4	-.3	-.3
ERROR		.2	-.1	.0	-.3	-.5	-.6	-.8	-.8	-.9	-.9	-1.0	-1.0
SE		(.2)	(.3)	(.3)	(.3)	(.4)	(.5)	(.6)	(.6)	(.7)	(.8)	(.9)	(1.0)
VAR	ΔW/W	-.03	-.06	-.07	-.07	-.08	-.09	-.11	-.14	-.16	-.19	-.22	-.24
ACTUAL	ΔW/W	-.00	.01	.02	.03	.04	.04	.05	.05	.04	.04	.03	.03
ERROR		-.03	-.07	-.09	-.10	-.12	-.13	-.16	-.19	-.20	-.23	-.25	-.27
SE		(.01)	(.02)	(.03)	(.04)	(.05)	(.05)	(.06)	(.07)	(.07)	(.08)	(.08)	(.09)
VAR	ΔP/P	-.09	-.07	-.07	-.06	-.07	-.08	-.10	-.12	-.15	-.18	-.22	-.25
ACTUAL	ΔP/P	.00	.02	.02	.05	.06	.06	.06	.06	.06	.06	.05	.04
ERROR		-.09	-.09	-.09	-.11	-.13	-.14	-.16	-.18	-.21	-.24	-.27	-.29
SE		(.03)	(.04)	(.04)	(.05)	(.06)	(.07)	(.08)	(.09)	(.10)	(.10)	(.11)	(.11)
VAR	ΔY	6.4	7.6	5.8	2.7	-.6	-3.3	-5.2	-6.2	-6.2	-5.7	-4.8	-3.7
ACTUAL	ΔY	8.3	11.8	11.6	9.6	7.1	4.7	2.7	1.2	.1	-.6	-.9	-.9
ERROR		-1.9	-4.2	-5.8	-6.9	-7.7	-8.0	-7.9	-7.4	-6.3	-5.1	-3.9	-2.8
SE		(1.5)	(2.6)	(3.2)	(3.4)	(3.2)	(3.1)	(3.0)	(3.1)	(3.1)	(3.3)	(3.4)	(3.4)

TABLE 1 (continued)

VAR4P

		1980				1981				1982			
		I	II	III	IV	I	II	III	IV	I	II	III	IV
VAR and ACTUAL	ΔG	10.0	9.4	8.5	7.7	7.0	6.2	5.6	4.9	4.3	3.7	3.3	3.1
VAR	ΔPM/PM	.04	.05	-.31	-.74	-.87	-.92	-.94	-.93	-.94	-.96	-1.01	-1.07
ACTUAL	ΔPM/PM	0	0	0	0	0	0	0	0	0	0	0	0
ERROR		.04	.05	-.31	-.74	-.87	-.92	-.94	-.93	-.94	-.96	-1.01	-1.07
VAR	ΔR	.13	.18	.18	.15	.11	.08	.05	.03	.01	-.01	-.02	-.03
ACTUAL	ΔR	.12	.17	.16	.13	.10	.08	.06	.05	.04	.03	.03	.02
ERROR		.01	.01	.02	.02	.01	.00	-.01	-.02	-.03	-.04	-.05	-.05
VAR	ΔU	-.12	-.17	-.19	-.13	-.09	-.06	-.04	-.02	-.01	-.00	-.00	-.01
ACTUAL	ΔU	-.07	-.15	-.18	-.17	-.14	-.11	-.08	-.06	-.04	-.02	-.01	-.00
ERROR		-.05	-.02	-.01	.04	.05	.05	.04	.04	.03	.02	.01	-.01
VAR	M	.0	-.4	-.3	-.7	-.9	-.9	-1.1	-1.1	-1.2	-1.2	-1.2	-1.3
Actual	M	-.1	-.2	-.4	-.4	-.5	-.5	-.5	-.5	-.5	-.5	-.5	-.5
ERROR		.1	-.2	.1	-.3	-.4	-.4	-.6	-.6	-.7	-.7	-.7	-.8
SE		(.2)	(.3)	(.3)	(.3)	(.4)	(.5)	(.6)	(.6)	(.7)	(.8)	(.9)	(1.0)
VAR	ΔW/W	-.03	-.06	-.06	-.07	-.09	-.11	-.15	-.18	-.21	-.24	-.26	-.28
ACTUAL	ΔW/W	-.00	.01	.02	.03	.04	.05	.05	.05	.05	.05	.05	.04
ERROR		-.03	-.07	-.08	-.10	-.13	-.16	-.20	-.23	-.26	-.29	-.31	-.32
VAR	ΔP/P	-.09	-.06	-.0	-.08	-.10	-.12	-.16	-.19	-.22	-.24	-.26	-.28
ACTUAL	ΔP/P	.00	.02	.02	.05	.06	.06	.07	.07	.07	.07	.07	.06
ERROR		-.09	-.08	-.11	-.13	-.16	-.18	-.23	-.26	-.29	-.31	-.33	-.34
VAR	ΔY	7.5	8.9	8.6	5.7	2.7	1.0	-1.6	-3.0	-3.9	-4.4	-4.4	-3.9
ACTUAL	ΔY	8.3	12.1	12.5	11.2	9.0	6.8	4.8	3.2	1.9	.9	.3	.1
ERROR		-.8	-3.2	-3.9	-5.5	-6.3	-5.8	-6.4	-6.2	-5.8	-5.3	-4.7	-4.0

Notation:

Δ = estimated effect of the shock on the variable
G = real value of government spending
PM = import price deflator
R = three-month Treasury bill rate
U = unemployment rate
M = money stock (M1)
W = nominal wage rate
P = GNP deflator
Y = real GNP
SE = estimated standard error from stochastic simulation

Notes: Units are percentage points except for G, M, and Y. For G and Y the units are billions of 1982 dollars, and for M the units are billions of current dollars.

they are not likely to be using the correct functional forms. The "actual" values in Table 1 are the properties of the Fair model when government spending is changed by the amounts of the VAR changes in the table. Because each VAR model has a slightly different change in government spending after the first quarter, the "actual" values differ slightly by model.[4]

The actual values were computed as follows. First, the estimated residuals in the Fair model were added to the equations and taken to be exogenous. This means that when the model is solved using the actual values of the exogenous variables, a perfect tracking solution is obtained. Second, government spending was changed in each of the quarters by the amount in Table 1 and the model was solved. The difference between the solution value and the actual value for each endogenous variable and quarter is the estimated effect of the change on the endogenous variable. These differences are the actual values in Table 1. As noted above, three solutions were obtained corresponding to the three sets of government spending values.

The standard errors from the stochastic simulations are also presented in Table 1 for VAR4 and VAR2. One should be careful in interpreting what these standard errors are. They are the errors that the model builders could compute from the data. They are the errors that the model builders would presumably use in deciding how much confidence to place on the

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[4]As noted above, both government spending and the import price deflator are exogenous in the Fair model. When government spending was changed in the Fair model for the first experiment, the import price deflator was <u>not</u> changed. One could have, for example, changed PM by the amounts of the VAR changes in Table 1. It seemed best not to do this, however, since in the generated data PM is exogenous. In the world that has been created, the VAR models erroneously takes PM to be endogenous, and this is simply another type of specification error whose quantitative importance is being estimated.

results. In fact, of course, the errors would be zero if the VAR models were correctly specified because the data have been generated with no random shocks. In other words, if the VAR models were correctly specified, the coefficients would be estimated exactly and thus the estimated covariance matrix of the coefficient estimates would be zero.

The key question is whether the errors in Table 1 are large or small. Although the errors can be compared to the standard errors, the answer to this question is in part a matter of judgment. Do the response properties of the VAR models seem to be close enough to the actual properties to have them be a useful policy tool? For most variables, the answer from Table 1 would seem to be no. The GNP response is considerably underestimated, and the price and wage responses are of the wrong sign. The money supply responses are generally overestimated, although the interest rate and unemployment rate responses are fairly accurate. For GNP, wages, and prices, the initial errors are generally larger than the estimated standard errors.

The Import Price Experiment

For the second experiment the error term in the import price equation in each VAR model was shocked by .10 in the first quarter. The import price equation is in logs, and this is a shock in the import price deflator (PM) of 10.52 percent. The results are presented in Table 2. For VAR4 the change in PM is 13.09 percent in the second quarter, and it declines to -2.05 percent by the twelfth quarter. This is the PM equation at work. The changes in PM after the first quarter are slightly different for the other two VAR models because the PM equations are different.

TABLE 2

Results of Import Price Shock
VAR4

		1980				1981				1982			
		I	II	III	IV	I	II	III	IV	I	II	III	IV
VAR	ΔG	0	.1	-8.7	-7.6	-5.9	-3.1	.8	4.4	7.9	10.8	13.5	15.5
ACTUAL	ΔG	0	0	0	0	0	0	0	0	0	0	0	0
ERROR		0	.1	-8.7	-7.6	-5.9	-3.1	.8	4.4	7.9	10.8	13.5	15.5
SE		0	(3.8)	(5.4)	(6.0)	(7.1)	(7.6)	(8.1)	(8.8)	(9.3)	(9.8)	(10.5)	(11.3)
VAR and ACTUAL	ΔPM/PM	10.52	13.09	13.01	12.22	10.41	8.00	5.40	3.02	.81	-.90	-2.05	-2.88
VAR	ΔR	.32	.50	.55	.63	.46	.40	.39	.33	.22	.09	-.04	-.17
ACTUAL	ΔR	.44	.41	.24	.12	-.03	-.18	-.31	-.41	-.49	-.52	-.51	-.54
ERROR		-.12	.09	.31	.51	.49	.58	.70	.74	.81	.61	.47	.37
SE		(.17)	(.27)	(.36)	(.43)	(.49)	(.52)	(.53)	(.53)	(.53)	(.53)	(.52)	(.52)
VAR	ΔU	-.01	-.05	-.01	-.02	-.03	-.11	-.21	-.30	-.34	-.33	-.29	-.23
ACTUAL	ΔU	-.05	-.08	-.08	-.05	-.01	.04	.10	.15	.20	.21	.21	.19
ERROR		.04	.03	.07	.03	-.02	-.15	-.31	-.45	-.54	-.54	-.50	-.42
SE		(.09)	(.17)	(.24)	(.27)	(.29)	(.31)	(.31)	(.33)	(.35)	(.37)	(.38)	(.37)
VAR	ΔM	2.1	2.0	1.8	.2	-.8	-1.4	-2.2	-3.2	-3.8	-4.2	-4.4	-4.3
ACTUAL	ΔM	-.6	-1.5	-1.5	-1.6	-1.6	-1.4	-1.1	-.7	-.2	.4	.9	1.5
ERROR		2.7	3.5	3.3	1.8	.8	.0	-1.1	-2.5	-3.6	-4.6	-5.3	-5.8
SE		(1.0)	(1.2)	(1.4)	(1.5)	(2.0)	(2.4)	(3.0)	(3.4)	(4.0)	(4.5)	(5.1)	(5.5)
VAR	ΔW/W	.13	.22	.46	.80	1.01	1.08	1.10	1.08	.97	.81	.61	.40
ACTUAL	ΔW/W	.22	.58	.93	1.22	1.43	1.54	1.56	1.48	1.34	1.14	.92	.68
ERROR		-.09	-.36	-.47	-.42	-.42	-.46	-.46	-.40	-.37	-.33	-.31	-.28
SE		(.06)	(.10)	(.13)	(.16)	(.20)	(.24)	(.29)	(.33)	(.38)	(.41)	(.44)	(.48)
VAR	ΔP/P	.31	.30	.76	1.44	1.61	1.70	1.79	1.71	1.51	1.27	1.00	.68
ACTUAL	ΔP/P	.52	1.02	1.41	1.74	2.00	2.12	2.10	2.01	1.84	1.60	1.33	1.06
ERROR		-.21	-.72	-.65	-.30	-.39	-.42	-.31	-.30	-.33	-.33	-.33	-.38
SE		(.12)	(.16)	(.20)	(.22)	(.28)	(.33)	(.39)	(.45)	(.50)	(.55)	(.59)	(.62)
VAR	ΔY	-2.1	-2.1	-10.5	-16.9	-23.0	-22.9	-19.0	-15.4	-13.2	-13.8	-15.3	-17.6
ACTUAL	ΔY	-2.4	-6.3	-11.2	-17.0	-22.5	-27.4	-31.1	-33.2	-33.4	-31.8	-28.6	-24.4
ERROR		.3	4.2	.7	.1	-.5	4.5	12.1	17.8	20.2	18.0	13.3	6.8
SE		(6.3)	(11.8)	(14.1)	(14.9)	(15.8)	(15.6)	(15.3)	(16.6)	(18.7)	(20.7)	(22.0)	(22.8)

TABLE 2 (continued)

VAR2

		1980				1981				1982			
		I	II	III	IV	I	II	III	IV	I	II	III	IV
VAR	ΔG	0	-1.1	-1.4	-.5	1.3	3.8	6.6	9.2	11.4	12.9	14.3	15.4
ACTUAL	ΔG	0	0	0	0	0	0	0	0	0	0	0	0
ERROR		0	-1.1	-1.4	-.5	1.3	3.8	6.6	9.2	11.4	12.9	14.3	15.4
SE		0	(3.4)	(4.6)	(5.4)	(6.4)	(7.3)	(8.0)	(8.5)	(8.8)	(8.9)	(9.3)	(9.7)
VAR and ACTUAL	ΔPM/PM	10.52	14.92	14.92	12.75	9.99	7.37	5.17	3.40	1.97	.77	-.29	-1.27
VAR	ΔR	.33	.57	.78	.85	.81	.70	.55	.39	.22	.04	-.12	-.28
ACTUAL	ΔR	.44	.48	.29	.10	-.08	-.23	-.34	-.41	-.46	-.48	-.49	-.53
ERROR		-.11	.09	.49	.75	.89	.93	.89	.80	.68	.52	.37	.25
SE		(.17)	(.24)	(.34)	(.41)	(.47)	(.50)	(.52)	(.52)	(.50)	(.48)	(.46)	(.44)
VAR	ΔU	-.04	-.09	-.17	-.24	-.27	-.28	-.27	-.25	-.21	-.18	-.15	-.13
ACTUAL	ΔU	-.05	-.09	-.09	-.06	-.00	.06	.12	.16	.20	.21	.20	.18
ERROR		.01	.00	-.08	-.18	-.27	-.34	-.39	-.41	-.41	-.39	-.35	-.31
SE		(.09)	(.17)	(.23)	(.28)	(.30)	(.31)	(.32)	(.32)	(.31)	(.31)	(.30)	(.30)
VAR	ΔM	1.2	1.6	.9	-.4	-1.8	-3.1	-4.3	-5.1	-5.6	-5.9	-6.0	-5.8
VAR	ΔM	-.6	-1.2	-1.7	-1.8	-1.7	-1.4	-1.1	-.7	-.2	.2	.8	1.3
ERROR		1.8	2.8	2.6	1.4	-.1	-1.7	-3.2	-4.4	-5.4	-6.1	-6.8	-7.1
SE		(1.0)	(1.0)	(1.3)	(1.6)	(2.0)	(2.3)	(2.8)	(3.3)	(3.8)	(4.2)	(4.7)	(5.1)
VAR	ΔW/W	.12	.30	.55	.83	1.07	1.22	1.27	1.24	1.13	.97	.77	.55
ACTUAL	ΔW/W	.21	.62	1.02	1.33	1.52	1.61	1.60	1.53	1.41	1.25	1.07	.87
ERROR		-.09	-.32	-.47	-.50	-.45	-.39	-.33	-.29	-.28	-.28	-.30	-.32
SE		(.06)	(.09)	(.13)	(.16)	(.20)	(.24)	(.28)	(.31)	(.35)	(.38)	(.40)	(.43)
VAR	ΔP/P	.38	.52	.92	1.32	1.65	1.84	1.90	1.85	1.71	1.51	1.27	.99
ACTUAL	ΔP/P	.53	1.11	1.55	1.88	2.10	2.19	2.16	2.09	1.95	1.78	1.57	1.35
ERROR		-.15	-.59	-.63	-.56	-.45	-.35	-.26	-.24	-.24	-.27	-.30	-.36
SE		(.14)	(.16)	(.19)	(.22)	(.26)	(.31)	(.37)	(.41)	(.46)	(.49)	(.53)	(.56)
VAR	ΔY	-2.4	-3.1	-5.3	-9.3	-13.6	-17.6	-21.4	-24.1	-27.7	-30.1	-31.5	-31.8
ACTUAL	ΔY	-2.4	-6.6	-11.9	-18.2	-24.1	-29.1	-32.6	-34.5	-34.7	-33.5	-31.0	-27.7
ERROR		.0	3.5	6.6	8.9	10.5	11.5	11.2	10.4	7.0	3.4	-.5	-4.1
SE		(6.3)	(10.8)	(14.4)	(16.2)	(16.6)	(16.8)	(17.3)	(17.7)	(17.9)	(18.2)	(18.4)	(18.8)

TABLE 2 (continued)

VAR4P

		1980				1981				1982			
		I	II	III	IV	I	II	III	IV	I	II	III	IV
VAR	ΔG	0	-.7	-1.6	-1.6	-1.1	-.1	1.3	2.8	4.2	5.5	6.6	7.5
ACTUAL	ΔG	0	0	0	0	0	0	0	0	0	0	0	0
ERROR		0	-.7	-1.6	-1.6	-1.1	-.1	1.3	2.8	4.2	5.5	6.6	7.5
VAR and ACTUAL	ΔPM/PM	10.52	11.80	12.17	11.46	9.52	7.44	5.38	3.50	1.89	.57	-.51	-1.37
VAR	ΔR	.35	.46	.74	.72	.70	.62	.50	.36	.21	.05	-.09	-.22
ACTUAL	ΔR	.44	.36	.23	.11	-.04	-.17	-.28	-.37	-.42	-.46	-.46	-.50
ERROR		-.09	.10	.51	.61	.74	.79	.78	.73	.63	.51	.37	.28
VAR	ΔU	-.00	-.04	-.13	-.12	-.15	-.16	-.18	-.17	-.15	-.12	-.09	-.06
ACTUAL	ΔU	-.05	-.08	-.07	-.04	-.00	.04	.09	.14	.18	.19	.19	.17
ERROR		.05	.04	-.06	-.08	-.15	-.20	-.27	-.31	-.33	-.31	-.28	-.23
VAR	ΔM	1.0	1.2	.9	-.3	-1.5	-2.4	-3.5	-4.2	-4.8	-5.2	-5.3	-5.2
ACTUAL	ΔM	-.6	-1.1	-1.4	-1.5	-1.5	-1.3	-1.0	-.7	-.3	.2	.7	1.2
ERROR		1.6	2.3	2.3	1.2	.0	-1.1	-2.5	-3.5	-3.5	-5.4	-6.0	-6.4
VAR	ΔW/W	.14	.23	.45	.76	.95	1.06	1.09	1.04	.95	.81	.65	.47
ACTUAL	ΔW/W	.21	.56	.88	1.15	1.34	1.44	1.46	1.41	1.31	1.16	.99	.80
ERROR		-.07	-.33	-.43	-.39	-.39	-.38	-.37	-.37	-.36	-.35	-.34	-.32
VAR	ΔP/P	.30	.21	.66	1.31	1.47	1.65	1.72	1.66	1.51	1.31	1.08	.82
ACTUAL	ΔP/P	.53	.96	1.33	1.64	1.87	1.98	1.99	1.93	1.81	1.64	1.44	1.23
ERROR		-.23	-.75	-.67	-.33	-.40	-.33	-.27	-.27	-.30	-.33	-.36	-.41
VAR	ΔY	-1.8	-1.4	-2.2	-10.9	-16.3	-18.1	-20.3	-23.0	-24.9	-26.5	-28.0	-28.6
ACTUAL	ΔY	-2.4	-6.1	-10.8	-16.2	-21.4	-25.8	-29.3	-31.3	-31.8	-30.9	-28.7	-25.6
ERROR		.6	4.7	8.6	5.3	5.1	7.7	9.0	8.3	6.9	4.4	.7	-3.0

Notes: See Table 1.

To compute the actual values for each VAR model for this experiment, PM was changed in the Fair model in each of the quarters by the amount in Table 2 and the model was solved. Again, because the changes in PM differ across VAR models after the first quarter, the actual values are slightly different across models.[5]

Increasing the import price of deflator in the Fair model results in an increase in wages and prices and a decrease in GNP. The VAR models underestimate the fall in GNP and the rise in prices and wages. The eventual rise in the unemployment rate was completely missed; the models had the unemployment falling throughout the period. The fall in the interest rate after four quarters (as the Fed in the Fair model lowered interest rates to help counter the fall in output) was also missed. The fall was not predicted to take place until the tenth quarter.

Some of the estimated standard errors are quite large in Table 2. For example, the four-quarter-ahead standard error for GNP for VAR4 is $14.9 billion, which is large compared to the actual effect on GNP of -$17.0 billion. A model builder might conclude from the estimated standard errors that very little confidence could be placed on the results.

The Bill Rate Experiment

The third experiment, where the error term in the bill rate equation in each VAR model is shocked, requires a little more explanation. In the Fair model the bill rate is determined by an interest rate reaction function, where the Fed is estimated to "lean against the wind." Monetary policy is

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[5]In this case the government spending variable was not changed in the Fair model, for reasons similar to those discussed in the previous footnote.

thus endogenous in the model; the Fed uses open market operations (variable AG in the model) to achieve its bill rate target each quarter. Both AG and the bill rate are endogenous. The bill rate is thus endogenous in the generated data that have been used for the first two experiments. For the third experiment the bill rate should be exogenous, and so a new data set was generated by solving the Fair model with the interest rate reaction function dropped and the bill rate taken to be exogenous (and equal to the historical values). Each of the three VAR models was then reestimated using this data set, and these are the versions that were used for the third experiment.

The error term in the bill rate equation in each VAR model was shocked by 1.0 in the first quarter. This is a shock of one percentage point. The results are presented in Table 3. For VAR4 the bill rate change was 1.0 in the first quarter, 1.22 in the second quarter, and then gradually lower after that. The pattern for the other two VAR models is similar.
and then it gradually diminished after that.

The actual values for the third experiment for each model were obtained by changing the bill rate in the Fair model each quarter by the amount in Table 3 and solving the model. For these calculations the interest rate reaction function was dropped from the Fair model and the bill rate was taken to be exogenous.[6] Again, the actual values differ slightly across VAR models in Table 3 because the bill rate changes differ across models after the first quarter.

An increase in the bill rate in the Fair model results in a contraction

[6]Neither government spending nor the import price deflator was changed in the third experiment for the Fair model, which is consistent with the treatment for the other two experiments.

TABLE 3

Results of the Bill Rate Shock

VAR4

		1980				1981				1982			
		I	II	III	IV	I	II	III	IV	I	II	III	IV
VAR	ΔG	0	.6	1.4	1.6	1.4	2.0	1.8	1.6	1.6	1.6	1.4	1.3
ACTUAL	ΔG	0	0	0	0	0	0	0	0	0	0	0	0
ERROR		0	.6	1.4	1.6	1.4	2.0	1.8	1.6	1.6	1.6	1.4	1.3
SE		0	(.9)	(1.3)	(1.5)	(1.7)	(1.9)	(2.0)	(2.3)	(2.4)	(2.6)	(2.8)	(3.0)
VAR	ΔPM/PM	0	-.26	-.13	.43	.67	.92	1.02	.71	.23	-.27	-.87	-1.39
ACTUAL	ΔPM/PM	0	0	0	0	0	0	0	0	0	0	0	0
ERROR		0	-.26	-.13	.43	.67	.92	1.02	.71	.23	-.27	-.82	-1.39
SE		0	(.18)	(.30)	(.38)	(.46)	(.52)	(.58)	(.63)	(.67)	(.70)	(.72)	(.75)
VAR and ACTUAL	ΔR	1.0	1.22	.72	.71	.73	.59	.44	.37	.28	.18	.08	.00
VAR	ΔU	-.04	-.09	-.10	-.03	.04	.11	.18	.22	.22	.21	.20	.17
ACTUAL	ΔU	.01	.04	.09	.13	.16	.18	.19	.19	.18	.16	.13	.09
ERROR		-.05	-.13	-.19	-.16	-.12	-.09	-.01	.03	.04	.05	.07	.08
SE		(.02)	(.04)	(.06)	(.07)	(.07)	(.08)	(.09)	(.09)	(.10)	(.11)	(.11)	(.11)
VAR	ΔM	-2.1	-2.8	-4.1	-4.7	-5.5	-6.0	-6.9	-7.2	-7.6	-7.9	-8.3	-8.4
ACTUAL	ΔM	-1.1	-2.3	-3.2	-3.8	-4.5	-5.1	-5.4	-5.7	-5.8	-5.8	-5.8	-5.8
ERROR		-1.0	-.5	-.9	-.9	-1.0	-.9	-1.5	-1.5	-1.8	-2.1	-2.5	-2.6
SE		(.2)	(.3)	(.4)	(.6)	(.7)	(.9)	(1.1)	(1.3)	(1.5)	(1.7)	(2.0)	(2.3)
VAR	ΔW/W	.04	.04	.04	.04	.04	.03	.02	.00	-.03	-.08	-.14	-.21
ACTUAL	ΔW/W	.00	-.00	-.00	-.00	-.02	-.03	-.04	-.05	-.06	-.07	-.08	-.08
ERROR		.04	.04	.04	.04	.06	.06	.06	.05	.03	-.01	-.05	-.13
SE		(.01)	(.02)	(.03)	(.04)	(.05)	(.06)	(.07)	(.08)	(.09)	(.10)	(.11)	(.12)
VAR	ΔP/P	.05	.02	.03	.02	.05	.10	.09	.07	.06	.02	-.05	-.13
ACTUAL	ΔP/P	-.00	-.01	-.02	-.04	-.05	-.06	-.08	-.10	-.11	-.12	-.13	-.13
ERROR		-.05	.03	.05	.06	.10	.16	.17	.17	.17	.14	.08	.00
SE		(.03)	(.04)	(.05)	(.06)	(.07)	(.08)	(.10)	(.11)	(.12)	(.14)	(.15)	(.16)
VAR	ΔY	3.9	6.5	2.7	-3.3	-9.1	-15.6	-20.9	-23.6	-24.0	-23.8	-22.6	-20.5
ACTUAL	ΔY	-1.2	-4.1	-7.4	-10.1	-12.2	-13.5	-13.9	-13.5	-12.6	-11.2	-9.4	-7.3
ERROR		5.1	10.6	10.1	6.8	3.1	-2.1	-7.0	-10.1	-11.4	-12.6	-13.2	-13.2
SE		(1.3)	(2.5)	(3.2)	(3.5)	(3.6)	(3.8)	(4.1)	(4.6)	(5.3)	(5.9)	(6.4)	(6.9)

TABLE 3 (continued)

VAR2

		1980				1981				1982			
		I	II	III	IV	I	II	III	IV	I	II	III	IV
VAR	ΔG	0	.1	.8	1.3	1.4	1.3	1.1	1.1	1.1	1.2	1.4	1.8
ACTUAL	ΔG	0	0	0	0	0	0	0	0	0	0	0	0
ERROR		0	.1	.8	1.3	1.4	1.3	1.1	1.1	1.1	1.2	1.4	1.8
SE		0	(.8)	(1.0)	(1.2)	(1.4)	(1.6)	(1.7)	(1.8)	(1.9)	(2.0)	(2.1)	(2.3)
VAR	ΔPM/PM	0	-.01	.35	.82	1.11	1.14	.93	.56	.09	-.43	-.95	-1.44
ACTUAL	ΔPM/PM	0	0	0	0	0	0	0	0	0	0	0	0
ERROR		0	-.01	.35	.82	1.11	1.14	.93	.56	.09	-.43	-.95	-1.44
SE		0	(.17)	(.28)	(.36)	(.43)	(.48)	(.52)	(.54)	(.56)	(.56)	(.57)	(.59)
VAR and ACTUAL	ΔR	1.00	1.06	.85	.71	.61	.51	.40	.29	.19	.11	.04	-.00
VAR	ΔU	-.03	-.07	-.06	.00	.07	.13	.17	.19	.19	.17	.15	.12
ACTUAL	ΔU	.01	.04	.09	.13	.18	.19	.18	.17	.14	.11	.08	.04
ERROR		-.04	-.11	-.15	-.13	-.11	-.06	-.01	.02	.05	.06	.07	.08
SE		(.02)	(.03)	(.05)	(.06)	(.07)	(.08)	(.08)	(.08)	(.08)	(.08)	(.09)	(.09)
VAR	ΔM	-1.7	-2.6	-3.8	-4.6	-5.3	-5.8	-6.4	-6.8	-7.0	-7.2	-7.4	-7.5
ACTUAL	ΔM	-1.1	-2.2	-3.2	-3.8	-4.4	-4.9	-5.1	-5.4	-5.3	-5.3	-5.3	-5.2
ERROR		-.6	-.4	-.6	-.8	-.9	-.9	-1.3	-1.4	-1.7	-1.9	-2.1	-2.3
SE		(.2)	(.3)	(.4)	(.5)	(.7)	(.9)	(1.0)	(1.2)	(1.4)	(1.6)	(1.8)	(2.0)
VAR	ΔW/W	.03	.03	.04	.05	.05	.05	.04	.01	-.02	-.07	-.12	-.19
ACTUAL	ΔW/W	.00	-.00	-.00	-.00	-.02	-.03	-.04	-.05	-.06	-.07	-.07	-.08
ERROR		.03	.03	.04	.05	.07	.08	.08	.06	.04	.00	-.05	-.11
SE		(.01)	(.02)	(.03)	(.03)	(.04)	(.05)	(.06)	(.07)	(.07)	(.08)	(.09)	(.10)
VAR	ΔP/P	.04	.04	.07	.09	.11	.12	.12	.10	.08	.03	-.04	-.12
ACTUAL	ΔP/P	-.00	-.01	-.02	-.03	-.05	-.06	-.08	-.10	-.11	-.12	-.12	-.12
ERROR		.04	.05	.09	.12	.16	.18	.20	.20	.19	.15	.08	.00
SE		(.03)	(.04)	(.04)	(.05)	(.06)	(.07)	(.08)	(.09)	(.11)	(.12)	(.13)	(.14)
VAR	ΔY	2.7	4.1	.2	-5.8	-11.7	-16.5	-19.7	-21.4	-21.4	-20.5	-18.8	-16.6
ACTUAL	ΔY	-1.2	-3.9	-7.2	-10.0	-11.9	-13.0	-13.3	-12.7	-11.6	-9.9	-8.0	-6.0
ERROR		3.9	8.0	7.4	4.2	.2	-3.5	-6.4	-8.7	-9.8	-10.6	-10.8	-10.6
SE		(1.4)	(2.3)	(2.9)	(3.3)	(3.8)	(4.1)	(4.3)	(4.6)	(4.8)	(5.2)	(5.6)	(6.0)

TABLE 3 (continued)

VAR4P

		1980				1981				1982			
		I	II	III	IV	I	II	III	IV	I	II	III	IV
VAR	ΔG	0	.2	.6	1.0	1.3	1.4	1.4	1.4	1.3	1.2	1.3	1.4
VAR	ΔG	0	0	0	0	0	0	0	0	0	0	0	0
ERROR		0	.2	.6	1.0	1.3	1.4	1.4	1.4	1.3	1.2	1.3	1.4
VAR	ΔPM/PM	0	.07	.27	.50	.68	.75	.65	.41	.06	-.36	-.83	-1.29
ACTUAL	ΔPM/PM	0	0	0	0	0	0	0	0	0	0	0	0
ERROR		0	.07	.27	.50	.68	.75	.65	.41	.06	-.36	-.83	-1.29
VAR and ACTUAL	ΔR	1.00	.99	.78	.71	.64	.57	.47	.37	.28	.19	.12	.05
VAR	ΔU	-.04	-.08	-.07	-.02	.05	.11	.16	.20	.21	.21	.20	.17
ACTUAL	ΔU	.01	.04	.08	.12	.15	.17	.18	.18	.17	.15	.12	.09
ERROR		-.05	-.12	-.15	-.14	-.10	-.06	-.02	.02	.04	.06	.08	.08
VAR	ΔM	-1.8	-2.3	-4.0	-4.2	-5.1	-5.7	-6.5	-6.9	-7.3	-7.6	-7.9	-8.1
ACTUAL	ΔM	-1.1	-2.1	-3.0	-3.6	-4.2	-4.9	-5.1	-5.5	-5.6	-5.6	-5.7	-5.7
ERROR		-.7	-.2	-1.0	-.6	-.9	-.8	-1.4	-1.4	-1.7	-2.0	-2.2	-2.4
VAR	ΔW/W	.04	.04	.05	.06	.06	.05	.04	.02	-.02	-.07	-.13	-.19
ACTUAL	ΔW/W	.00	-.00	-.00	-.01	-.02	-.03	-.04	-.05	-.06	-.07	-.07	-.08
ERROR		.04	.04	.05	.07	.08	.08	.08	.07	.04	.00	-.06	-.11
VAR	ΔP/P	.04	.03	.03	.03	.08	.10	.10	.09	.06	.01	-.05	-.12
ACTUAL	ΔP/P	-.00	-.01	-.02	-.03	-.05	-.06	-.08	-.10	-.11	-.12	-.12	-.12
ERROR		.04	.04	.05	.06	.13	.16	.18	.19	.17	.13	.07	.00
VAR	ΔY	4.3	5.6	1.6	-2.7	-8.6	-14.8	-18.7	-21.3	-22.3	-22.4	-21.3	-19.5
ACTUAL	ΔY	-1.2	-3.9	-6.9	-9.5	-11.5	-12.7	-13.2	-13.0	-12.2	-11.0	-9.3	-7.5
ERROR		5.5	9.5	8.5	6.8	2.9	-2.1	-5.5	-8.3	-10.1	-11.4	-12.0	-12.0

Notes: See Table 1.

in GNP from the first quarter on. All three VAR models, on the other hand, have an expansion in GNP for the first three quarters, before the contraction sets in. By the end of the period the contraction is considerably overestimated by all three models. The changes for the GNP deflator are positive for the first ten quarters for the VAR models, whereas the actual values are negative. The actual changes in the unemployment rate are positive from the first quarter on, whereas the VAR models do not pick this up until the fifth quarter. The results for the money supply changes are fairly accurate.

General Remarks

What should one conclude from the results in Tables 1 - 3? First, the results are generally fairly similar across the three VAR models. This conclusion is consistent with the forecasting comparisons in Fair and Shiller (1987), where the three VAR models performed about the same. Second, the estimated standard errors are generally much larger for the import price experiment than they are for the other two. Clearly, a model builder using a VAR model for policy analysis would put less confidence on the response of the system to import price shocks than to government spending or interest rate shocks. Third, the VAR models do not appear to be good approximations. The errors are generally large, and many misleading conclusions would be drawn from the responses. A partial exception to this are the results for the money supply, which at times are fairly accurate.

IV. Conclusion

This paper has presented a way of estimating how accurate VAR models are likely to be for answering structural questions. The results are generally quite negative. The models do not seem to be good structural approximations.

The results in this paper are to some extent specific to the Fair model, and it would be interesting in future work to see how well VAR models approximate other structural models. The results are not, however, as specific to the Fair model as one might at first think. Although the Fair model has been assumed to be the "truth" in this study, the methodology is not based on the assumption that the model is literally the truth. No comparison is ever made, or needs to be made, of the actual values and the Fair-model predicted values. What is needed for the results in this study to be trustworthy is that the actual way in which the data are generated in the economy is similar to the way in which the data are generated in a large scale structural model like the Fair model. If instead, say, the actual data are generated from a model like VAR2 or VAR4, then the present results are not of much interest. The results in Fair and Shiller (1987), however, indicate that the data are not generated in this simple way, which thus provides some support to the present results.

The forecasting results in Fair and Shiller (1987) and the structural results in this paper thus call into question the usefulness of VAR models for macroeconomic purposes. As forecasting devices the models appear to be dominated by the Fair model, and as structural approximations the models do not seem to be very accurate.

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