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Fiscal Pressure and Central Bank Policy Objectives

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> *The Federal Reserve has...been able to fashion monetary policy in an impartial and objective manner—free from any sort of partisan or parochial influence. While the long history of the Federal Reserve is not faultless, its policies have consistently been managed by conscientious individuals seeking the nation's permanent welfare—rather than today's fleeting benefit.*
>
> —Arthur F. Burns, *Reflections of an Economic Policy Maker*

> *It seems to me highly dubious that the United States, or for that matter any other country, has in practice ever had an independent central bank in this fullest sense of the term. Even when central banks have supposedly been fully independent, they have exercised their independence only so long as there has been no real conflict between them and the rest of the government.*
>
> —Milton Friedman, "Should There Be an Independent Monetary Authority?"

Statutory independence from government is enjoyed in some measure by each of the central banks entrusted with the execution of monetary policy in industrialized economies. An important feature of the institutional setting concerns the longer planning horizon that may pertain to the central bank by virtue of both the freedom from reelection considerations and the long terms of office typically granted to the governors of the bank. This longer horizon implies an incentive to attach relatively more weight to the eventual inflationary consequences of expansionary policy than is the case with the elected government, which may instead be more concerned with the possible short-run gains in employment associated with an expansionary policy. As discussed in the accompanying box, the fact that the benefits of anti-inflationary policy tend to be delayed, while the costs are more or less immediate, may suffice to make such a policy more attractive to the central bank than to the government.

This perspective on the relative policy goals of central bank and government is used here as the keystone for an analysis of U.S. monetary policy over the post-1960 period. Monetary policy in this case is taken to be affected not just by the unconstrained policy objectives of the central bank but also by the influence of fiscal pressure stemming from the government. Fiscal pressure is the means by which the government may exert an indirect influence on monetary policy, with the objective of the pressure being to move monetary policy closer to that which would accord with the government's own preferences. Central bank response to this pressure is motivated by recognition of the government's ability to undertake legislative reform that would remove the formal independence of the central bank.[1]

The suggested framework is one in which independent central bank stabilization objectives and response to fiscal pressure are joint determinants of monetary policy. In the empirical work, fiscal pressure is proxied by a measure of the full-employment budget deficit. Strong support is obtained

Inflation as a Central Bank Policy Criterion

The initial effects of anti-inflationary policy generally include upward pressure on interest rates and an increase in unemployment. It is frequently asserted, however, that in the long run, these adverse effects will be removed and the effect of a tighter monetary policy will be confined to a permanent reduction in the inflation rate. The policymaker's time horizon is likely to be very important in determining whether anti-inflationary policy is evaluated in terms of its long-run benefits or short-run costs. In turn, central bank freedom from reelection considerations, together with the long terms typically granted the governors of the bank, may lead to a greater willingness to undertake anti-inflationary policy than is the case with the government.

Moreover, if the central bank's reputation for promoting price stability exerts an important influence on the long-term inflation rate, then concern for this reputation itself would be a factor discouraging the central bank from resorting to overexpansionary policy. In a model developed by Robert Barro and David Gordon, it is shown that the policymaker's discount rate is crucial in determining whether the policymaker forgoes the potential current benefits of expansionary policy in favor of securing the gain of low average inflation over the longer haul. Expansionary policy here may temporarily lower the unemployment rate but ultimately results only in an increase in the inflation rate, with unemployment reverting to a long-run equilibrium level that is taken to be independent of monetary policy. In relating the analysis to the respective time horizons of the central bank and government, it is most relevant that, other things equal, the lower the discount rate, the closer is the outcome to the model's optimal solution, in which the policymaker follows a zero money growth rule.[1]

The potential importance of an independent monetary policymaker has been examined by King Banaian, Leroy Laney, and Thomas Willett, who obtain cross-sectional evidence suggesting that central bank autonomy exerts an independent influence on the rate of inflation.[2] The indicated significance of dummy variables for the highly autonomous central banks of Switzerland, the United States, and West Germany also supports the Michael Parkin-Robin Bade finding that these banks, which are independent of central governments both in policymaking and in the appointment of directors, have delivered a lower rate of inflation than other central bank types.[3]

However, acceleration of inflation in the post-World War II period has taken place even in countries having formally independent central banks. This in itself may be indicative of the pressures for monetary expansion to which central banks are subject. The particular pressure stemming from the national government and fiscal policymaker has been addressed by Thomas Sargent and Neil Wallace, in whose model the time paths of both government spending (apart from interest payments on government debt) and tax revenues are taken as fixed.[4] Here, the government is unwilling (or unable) to keep the debt-to-income ratio from rising over time. Financing requirements dictate that a current increase in the stock of government debt must be followed by more rapid money growth either now or at some point in the future. The implication of this setting is that although fighting current inflation with tight monetary policy may work temporarily, such a strategy must eventually give way to higher inflation and delayed monetization of the deficit.

The above discussion relates to a scenario in which fiscal policy is taken as given, and there is a one-way direction of causality running from the fiscal authority to the monetary authority. The pressure arising from the prior setting of fiscal policy, then, may limit the central bank's ability to pursue its price-stability objective. This approach can be generalized to incorporate the full range of stabilization goals, and in the main text, allowance is made for interaction between the expansionary impact of the budget deficit and the more conservative trade-off weights to which the central bank may adhere.

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1. Robert J. Barro and David B. Gordon, "Rules, Discretion and Reputation in a Model of Monetary Policy," *Journal of Monetary Economics* 12 (July 1983): 101-21.

2. King Banaian, Leroy O. Laney, and Thomas D. Willett, "Central Bank Independence: An International Comparison," *Economic Review*, Federal Reserve Bank of Dallas, March 1983, 1-13, and "A Comparative Study of Central Banking Arrangements and Inflation in Industrial Countries," in *Political Business Cycles: The Economics and Politics of Stagflation*, ed. Thomas D. Willett (San Francisco: Pacific Institute for Public Policy Research, forthcoming summer 1986).

3. Michael Parkin and Robin Bade, "Central-Bank Laws and Monetary Policies: A Preliminary Investigation," in *The Australian Monetary System in the 1970s*, ed. Michael G. Porter (Clayton, Australia: Monash University, 1978), 24-39, and especially "Central Bank Laws and Monetary Policy" (Revised paper, Department of Economics, University of Western Ontario, London, Ont., and Hoover Institution, Stanford, Calif., September 1979).

4. Thomas J. Sargent and Neil Wallace, "Some Unpleasant Monetarist Arithmetic," *Federal Reserve Bank of Minneapolis Quarterly Review*, Fall 1981, 1-17. Further discussion is provided by two articles in the Spring 1984 *Federal Reserve Bank of Minneapolis Quarterly Review*: Michael R. Darby, "Some Pleasant Monetarist Arithmetic," 15-20, and Preston J. Miller and Thomas J. Sargent, "A Reply to Darby," 21-26.

for the hypothesized effect of fiscal pressure on the trade-off weights applied to the competing goals of monetary policy. The empirical performance of the model is particularly notable in indicating a stable pattern of Federal Reserve policy over the full 1961-83 period, in contrast to the wide-ranging instability noted in many other studies.[2]

Analysis of the institutional setting

In focusing on the difference between the time horizons relevant to central bank and government, the longer-term outlook arising from the structure of the central bank can be related to the "planner" function that is considered in the context of a model developed by Richard Thaler and H. M. Shefrin.[3] For the individual economic agent, the characterization of a "planner" concerned with lifetime utility is contrasted with that of a "doer" existing only for one period and being completely myopic. Here, the institution of central banking can be interpreted as an instrument of control, with the length and staggered nature of the bank officials' terms of office seen as being associated with incentives to consider future implications of current policy.

Meanwhile, the government remains subject to short-term incentives related to the transitory benefits from expansionary policy and to the attractiveness of inflationary finance as a means of reducing the real value of government debt. The government would, therefore, be characterized in this context as the doer, constrained by the institutional structure from direct intervention in the process of monetary policy.

Although the set of rules defining central bank independence represents a less than definitive constraint—given the government's ultimate scope for instituting legal reform and removal of the formal independence—the costs involved in removing independence imply that only under conditions of persistent conflict would such steps be in the government's own best interests. At the same time, to the extent that the central bank recognizes the existence of conditions of conflict sufficient to induce retributive action on the part of the government, it would be rational for the bank to limit the exercise of its discretionary powers so as not to threaten its autonomous status.

This paper does not directly address the optimality of the limited form of "independence" that may be enjoyed by the Federal Reserve System. Kenneth Rogoff, for example, shows that in the presence of a labor market distortion, it is optimal to have a central bank that places a greater weight on inflation than does society as a whole.[4] Under this approach, fiscal pressure that reduces the central bank's commitment to fighting inflation would have the disadvantage of increasing the equilibrium rate of wage inflation—with wage setters seeking pay increases that will compensate them for higher expected rates of inflation.

On the other hand, a situation in which the Federal Reserve has less than complete autonomy may alleviate certain technical defects associated with a genuinely independent central bank. Milton Friedman describes such technical defects as being dispersal of responsibility, "an extraordinary dependence on personalities," and an undue emphasis given to the point of view of bankers.[5] These considerations at least suggest that, in terms of the optimal institutional setting, the question of too much independence may be as relevant as that of excessive subordination to the government.

Development of the empirical procedure

The central bank and government are each assumed to be concerned with stabilization of a common set of economic variables. The objective is to ensure that such key economic variables as inflation and unemployment stay as close as possible to given target levels. In view of trade-offs between the different policy goals, however, the actual policy preferences remain a function of the relative weights adhered to by each body in assessing the importance of, say, employment stability versus price stability. A particularly relevant issue is that the inflationary effects of an expansionary policy are generally delayed, whereas any positive impact on employment tends to be much more immediate. Given this setting, a difference in the time horizons appears sufficient to imply that the government will indeed attach more weight to unemployment than the central bank and less weight to inflation.

The ability of the government to apply pressure to the central bank indicates that monetary policy will be a function of both sets of trade-off weights. (Details of this approach are discussed in the Appendix.) That is, the stress that the central bank would otherwise place on price stability is modified by government pressure arising whenever monetary policy departs from the strategy implied by the more short-term objectives of the fiscal authorities. Indeed, as the central bank responds to this pressure, it could in effect be viewed as compromising its unconstrained trade-off weights so as to conform more with those of the government and, in this way, alleviate the source of the pressure.

With the deficit serving as the proxy for fiscal pressure, government preferences are then infused into the monetary policy process to an extent that varies positively with observed data on government fiscal policy, the precise measure being the cyclically adjusted deficit divided by trend

GNP (DEF).[6] Monetary policy is itself represented by the rate of growth of the monetary base (DMB). The goals of price, interest rate, and employment stability are represented by series on the rate of growth of the GNP price deflator (DP), the three-month U.S. Treasury bill rate (TB), and the unemployment rate (UN). Furthermore, the composition of federal spending, as reflected in the rate of growth of real government purchases (DG), is introduced into the model.[7]

The response to these variables is then taken to interact with the deficit, the result being that each economic variable is placed alongside a corresponding interaction term in the equation to be estimated.[8] Including lagged values of the monetary base and the deficit taken separately, this equation has the form set out below:

$$
\begin{aligned}
DMB_t = \beta_0 &+ \sum_{g=1}^{m} \beta_g DMB_{t-g} + \sum_{h=1}^{n} \gamma_h DEF_{t-h} \\
&+ \sum_{i=1}^{p} \delta_{i1} DG_{t-i} + \delta_{i2}(DEF \cdot DG)_{t-i} \\
&+ \sum_{j=1}^{q} \kappa_{j1} DP_{t-j} + \kappa_{j2}(DEF \cdot DP)_{t-j} \\
&+ \sum_{k=1}^{r} \xi_{k1} TB_{t-k} + \xi_{k2}(DEF \cdot TB)_{t-k} \\
&+ \sum_{l=1}^{s} \tau_{l1} UN_{t-l} + \tau_{l2}(DEF \cdot UN)_{t-l} \\
&+ u_t ,
\end{aligned}
$$

where the lag structure of the interaction terms is stipulated as being synonymous with that of the basic economic variables. Greek letters in the equation represent parameters that are to be estimated; u_t is an error term.

The hypothesis that the government places less weight on price stability than the central bank and more weight on unemployment implies that the interaction effects for both inflation and unemployment will be positive. That is, in the case of the policy response to higher inflation, fiscal pressure has an expansionary effect by offsetting the contraction in monetary base growth otherwise following from the central bank's desire to bring down inflation. In the case of the policy response to increased unemployment, the positive countercyclical response is exacerbated as fiscal pressure induces the central bank to place more weight on this stabilization objective.[9]

In general, the theory implies that fiscal pressure leads to the countercyclical response being exacerbated for the variables to which the administration attaches relatively greater weight. At the same time, the countercyclical response should be damped with respect to policy objectives that are of relatively greater concern to the central bank.

Therefore, it is also true that if the central bank cares relatively more about rising interest rates than does the administration, the theory implies that the interaction effect should be negative with respect to the Treasury bill rate. This proposition has some justification because the central bank has a banking "constituency" whose interests must necessarily be closely tied to the state of financial markets.[10] At the same time, the hypothesized response to higher interest rates remains less clearly defined than is the case for the inflation and unemployment variables. No strong *a priori* arguments can be advanced in respect of government purchases.

Estimation results for the United States

In applying the model to the U.S. monetary policy setting,[11] it is apparent that the actual length of the lags attached to the economic variables is indeterminate from a theoretical perspective. Here, appeal is made to a decision rule suggested by Hirotugu Akaike, which is based on the minimum final prediction error (FPE) criterion. The selected lag structure discussed in the text follows directly from the results of applying this criterion to the model above.[12]

The estimation itself is carried out with data for the first quarter of 1961 to the fourth quarter of 1983, using ordinary least squares. In the final specification the lag length selections on the economic variables range between one and four quarters. The significance of the FPE selected lags is addressed in Table 1, with the results themselves presented in Table 2.[13]

Table 1 shows each of the sets of lags to be significant at the 1-percent level. Furthermore, the joint significance of the set of interaction terms is confirmed by an F test:

$$F_{9,68} = 5.35 > F^{critical}_{(.01)} = 2.68 .$$

In this way, the hypothesized modification of the central bank's response to the economy due to the deficit is indeed supported in the results.

Further testing was undertaken with respect to a possible "critical threshold" in the effect of the deficit on central bank policy. However, the results of a grid search test procedure showed the effect to be continuous across the full range of values for the deficit, with no particular lower bound ap-

Table 1
SIGNIFICANCE OF SELECTED LAGS FOR THE U.S. MONETARY POLICY REACTION FUNCTION

Variable	Lag length	Test statistic	Critical value (.05/.01)
DMB	2 quarters	$F_{2,68} = 11.69$	3.13/4.92
DEF	3 quarters	$F_{3,68} = 6.45$	2.74/4.08
DG and (*DEF* • *DG*)	2 quarters	$F_{4,68} = 3.62$	2.50/3.60
DP and (*DEF* • *DP*)	2 quarters	$F_{4,68} = 7.00$	2.50/3.60
TB and (*DEF* • *TB*)	4 quarters	$F_{8,68} = 5.39$	2.07/2.77
UN and (*DEF* • *UN*)	1 quarter	$F_{2,68} = 5.79$	3.13/4.93

DIRECTORY OF VARIABLES

DMB = rate of growth of the monetary base.

DEF = cyclically adjusted federal budget deficit divided by trend GNP.

DG = rate of growth of real Federal Government purchases.

DP = rate of growth of the GNP price deflator.

TB = three-month U.S. Treasury bill rate.

UN = unemployment rate.

parently required in order to bid forth a significant role for government pressure.

Allowance for a possible reaction by the Federal Reserve to international developments was also rejected. Neither balance of payments nor exchange rate effects were found to be significant in influencing monetary base growth.[14]

In interpreting the results given in Table 2, the analysis focuses on the sign pattern for the sum of the lags on each variable. The sign pattern observed in the results is listed below:

Policy response at zero deficit	Effect of an increase in the deficit
$\frac{\partial DMB}{\partial DG} < 0.$	$\frac{\partial(\partial DMB/\partial DG)}{\partial DEF} > 0.$
$\frac{\partial DMB}{\partial DP} < 0.$	$\frac{\partial(\partial DMB/\partial DP)}{\partial DEF} > 0.$
$\frac{\partial DMB}{\partial TB} > 0.$	$\frac{\partial(\partial DMB/\partial TB)}{\partial DEF} < 0.$
$\frac{\partial DMB}{\partial UN} > 0.$	$\frac{\partial(\partial DMB/\partial UN)}{\partial DEF} < 0.$

The partial derivatives depicted in the first column measure the policy responses observed at a zero level of the deficit. These policy responses are interpreted as reflecting the strategy pursued by the central bank when no pressure is exerted by the government. The findings include a negative response to government purchases, a result that suggests a tendency by the Federal Reserve to offset increases in federal spending by contracting monetary base growth.[15] The standard precepts of countercyclical policy, meanwhile, are satisfied by a contractionary movement of the monetary base in response to inflation and by positive responses to the interest rate and unemployment variables.

The second-column signs indicate how the Federal Reserve's stabilization policy is affected by an increase in the deficit. In terms of government purchases, administration pressure is, in fact, shown in the second column to induce Federal Reserve policy to support rather than offset movements in federal spending.

The second-column's positive interaction between the deficit and the response to inflation is consistent with the postulated effect of the administration's shorter time horizon on the relative emphasis attached to price stability.

Table 2
RESULTS FOR THE U.S. MONETARY POLICY REACTION FUNCTION

Variable, quarterly lag		Coefficient	*t* statistic
Constant		-.008	-1.62
DMB:	1	.158	1.63
	2	.428	4.42
DEF:	1	.860	3.12
	2	-1.080	-3.79
	3	.704	3.14
DG:	1	-.116	-1.54
	2	-.163	-1.83
DEF • *DG*:	1	3.240	.83
	2	13.651	3.20
DP:	1	.793	3.48
	2	-1.071	-4.84
DEF • *DP*:	1	-29.590	-2.50
	2	39.832	3.19
TB:	1	.015	.17
	2	-.231	-1.98
	3	.496	5.30
	4	-.153	-3.42
DEF • *TB*:	1	-4.268	-1.04
	2	11.559	2.20
	3	-17.807	-4.36
	4	2.757	2.28
UN:	1	.222	3.30
DEF • *UN*:	1	-4.205	-1.81

Dependent variable = *DMB*.

Sample period = 1961:Q1–1983:Q4.

$\bar{R}^2$ = .63; DW = 1.97; SEE = .004.

NOTE: $\bar{R}^2$ is the coefficient of determination adjusted for degrees of freedom.
DW is the Durbin-Watson autocorrelation test statistic.
SEE is the standard error of the equation.

Here, the Federal Reserve is seen as having to "bend with the wind" and reduce the size of the contraction that would otherwise follow an increase in the inflation rate.

The negative sign on the interaction term for the Treasury bill rate suggests that the administration also cares less about persistently rising interest rates than does the Federal Reserve. The implication is not that the administration *wants* higher interest rates (and such an event would certainly increase its debt burden) but, rather, that it attaches *relatively* less weight to interest rates than would be the case for a member of the financial community.[16]

The results described above certainly appear to be consistent with the theoretical model of Federal Reserve behavior. It is, however, in the effect of the deficit on the response to unemployment that the findings appear somewhat implausible. Indeed, rather than the expansionary impetus that would be expected to follow from administration focus on the full-employment objective, a negative effect is observed instead. At the same time, it should be pointed out that the (one-quarter) interaction effect is insignificant at the 5-percent level, leaving only weak opposition to the ascribed role for the deficit in the Federal Reserve's feedback rule.

The results are distinguished by strong evidence of stability in the model of monetary policy. A stable response pattern is, in fact, indicated throughout an extensive series of Chow tests for structural change. Testing over the different presidential administrations, and also over the tenure of the different Federal Reserve chairmen, in each case provides results consistent with continuity over the full sample. Two further tests for potential breaks, coinciding with the transition to floating exchange rates in 1973 and with the October 1979 announced change in Federal Reserve operating procedures, once again provide test statistics that are insignificant at both the 5-percent and 10-percent levels.

The apparent robustness of the specification with respect to sample-period changes certainly offers valuable support for the model's applicability to the U.S. monetary policy setting.[17] There is strong empirical backing for the hypothesized effect of the federal budget deficit on central bank stabilization policy.

Conclusions

The analysis has modeled monetary policy as a joint product of central bank trade-off weights and government pressure. In particular, the budget deficit is seen as the signal to the monetary authority of the nature of the policy stance sought by government. The demonstrable influence that government pressure appears to exert on stabilization objectives is perhaps no more than the imposition of a shorter-term outlook on the long-run planning horizon otherwise relevant to the central bank. Such a perspective is consistent with George Bach's observation that "in the postwar world, whenever unemployment has risen substantially..., Federal Reserve officials have moved solidly toward monetary ease, even when they still warned of the danger of inflation."[18]

The empirical performance of the model is distinguished in particular by its stability across regime changes. Such stability has generally not been featured in other studies that have modeled Federal Reserve policy over the same post-1960 period. Indeed, the present framework, in which the central bank is seen to "bend with the wind" represented by fiscal pressure, is one that also may quite plausibly explain the general absence of sustained conflicts to be observed between the monetary and fiscal authorities.

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1. The potential consequences of sustained central bank opposition to government policy are illustrated by the "Coyne affair" in Canada, where the forced resignation of the Governor of the Bank of Canada was ultimately followed by amending the Bank of Canada Act in 1967 to grant the Minister of Finance the power to issue directives to the bank. The Coyne crisis is discussed by J. W. O'Brien, *Canadian Money and Banking* (New York: McGraw-Hill, 1964), 199-201.

2. This aspect of the literature is addressed by Thomas M. Havrilesky, who further points to shifts in monetary policy that are specifically related to the redistributive component of fiscal policy. Havrilesky's empirical work suggests that increases in the ratio of social expenditures to aggregate income result in expanded rates of money supply growth. It is postulated that a greater propensity for redistribution leads liberal parties to attempt more monetary surprises than is the case with conservative parties, implying that redistributive phenomena may explain why money growth is often faster under left-of-center governments. See "A Partisanship Theory of Fiscal and Monetary Regimes," Working Paper Series, no. 86-08, Department of Economics, Duke University (Durham, N.C., 1986).

3. Richard H. Thaler and H. M. Shefrin, "An Economic Theory of Self-Control," *Journal of Political Economy* 89 (April 1981): 392-406.

4. By the same token, a country that has a perfectly "benevolent" central bank (one that attaches the same weight to inflation as society does) may suffer from having an inflation rate that is systematically too high. In the presence of a distortion causing the market rate of employment to be suboptimal, inflation arises because wage setters rationally fear that the central bank will undertake expansionary policy aimed at raising employment systematically. Hence, a central bank with (known) above-average commitment to fighting inflation is needed in order to induce less inflationary wage bargains. See Kenneth Rogoff, "The Optimal Degree of Commitment to an Intermediate Monetary Target," *Quarterly Journal of Economics* 100 (November 1985): 1169-89.

5. These arguments are presented in Milton Friedman, "Should There Be an Independent Monetary Authority?" in *In Search of a Monetary Constitution*, ed. Leland B. Yeager (Cambridge: Harvard University Press, 1962), 219-43.

6. Specifically, trend GNP (gross national product) is middle-expansion trend GNP as computed by Frank de Leeuw and Thomas M. Holloway, "Cyclical Adjustment of the Federal Budget and Federal Debt," *Survey of Current Business* 63 (December 1983): 25-40.

7. The inclusion of the government purchases variable accords with certain optimal public finance considerations raised by Robert J. Barro, "On the Determination of the Public Debt," *Journal of Political Economy* 87 (October 1979, pt. 1): 940-71.

8. Interaction between the set of monetary policy coefficients and the budget deficit has previously been suggested by Alan S. Blinder, "On the Monetization of Deficits," in *The Economic Consequences of Government Deficits*, ed. Laurence H. Meyer (Boston: Kluwer-Nijhoff, 1983), 39-73.

9. Formal derivation of the signs on the interaction terms is provided by Richard C. K. Burdekin, "Interaction Between Central Bank Behavior and Fiscal Policymaking: The Case of the U.S.," Federal Reserve Bank of Dallas Research Paper no. 8602 (Dallas, March 1986), app. A.

10. The importance to the Fed of support from its banking constituency has been stressed by Neil T. Skaggs and Cheryl L. Wasserkrug, "Banking Sector Influence on the Relationship of Congress to the Federal Reserve System," *Public Choice* 41, no. 2 (1983): 295-306.

11. The results discussed in this section are taken from Richard C. K. Burdekin, "The Interaction of Central Bank Behavior with Fiscal Policymaking and the Political Business Cycle: A Multi-Country Study" (Ph.D. diss., University of Houston, 1985), chap. 3.

12. In applying Akaike's FPE criterion to the model, the maximum lag length was set at six quarters. Each variable was then tested in turn, initially holding the lag length on the other variables at the maximum. The six-quarter limit received some justification in that in no case did the procedure choose a lag length of more than four for any variable. It may be added that in order to correct for the large number of right-hand-side variables, the initial selections were used as the maxima in a second application of the procedure. This correction actually had little effect on the final specification, resulting only in the elimination of the third and fourth lags on *DP* (both of which had a t statistic below 1). For details of the FPE criterion, see Hirotugu Akaike, "Statistical Predictor Identification," *Annals of the Institute of Statistical Mathematics* 22 (1970): 203-17.

13. The macroeconomic variables appearing on the right-hand side of the monetary policy reaction function, by their very nature, tend to move together over time. This tendency suggests the presence of multicollinearity, a phenomenon that generally makes it difficult to identify the individual variables' contribution to the overall goodness of fit of the equation. Multicollinearity leads to reduced values for the individual t statistics, and the F statistics for the sets of variables depicted in Table 1 may also be understated. However, since each set is significant at the 1-percent level, the importance of each group of variables appears, in any event, to be clearly demonstrated.

14. Indeed, when the balance of payments deficit and the exchange rate with the United Kingdom are added to the specification, the FPE criterion in each case selects a lag length of zero.

15. It should be noted that because the deficit is held constant, this result applies to the specific case of a *balanced budget* increase in government purchases.

16. As John T. Woolley puts it: "Even if bankers do not shape Federal Reserve decisions in an ongoing, detailed way,...the Federal Reserve is still a central *bank*. It is socially and politically close to banks and banking" (*Monetary Politics: The Federal Reserve and the Politics of Monetary Policy* [Cambridge: Cambridge University Press, 1984], 87).

17. For results for Canada, France, the United Kingdom, and West Germany, see Richard C. K. Burdekin, "Cross-Country Evidence on the Relationship Between Central Banks and Governments," Federal Reserve Bank of Dallas Research Paper no. 8603 (Dallas, March 1986).

18. G. L. Bach, *Making Monetary and Fiscal Policy* (Washington, D.C.: Brookings Institution, 1971), 165.

Appendix

Formal Treatment of the Relationship Between Central Bank and Government

The central bank and government are depicted as having distinct loss functions related to the range of economic variables embodied in the vector Y_t, which are themselves associated with the corresponding set of target values Y^*_t. The respective weights attached to deviations from the targets can be represented by Q_1 and Q_2 below:

$$LCB = (Y_t - Y^*_t)'Q_1(Y_t - Y^*_t) \tag{1}$$

and

$$LGOV = (Y_t - Y^*_t)'Q_2(Y_t - Y^*_t), \tag{2}$$

where LCB is the loss function of the central bank and $LGOV$ is the loss function of the government.

The longer view that has been ascribed to the central bank would be expected to result in Q_1 not being equal to Q_2. The problem faced by each policymaker is that of minimizing the relevant loss function subject to the constraint represented by the structure of the economy. The stochastic process determining the set of endogenous variables for the system is represented by equation 3.

$$Y_t = AW_t + BX_t + u_t, \tag{3}$$

where Y_t = a vector of economic variables
W_t = a vector of policy instruments
X_t = a vector of predetermined variables (lagged values of the economic variables and policy instruments)
A = a matrix of coefficients of the instruments
B = a matrix of coefficients of the predetermined variables
u_t = a disturbance vector.

It can be shown that the solution to the policymaker's problem collapses to a closed-loop rule of the form given in (4) below:

$$W^*_t = CX_t + \varepsilon, \tag{4}$$

where C is a coefficient matrix and ε is an error term containing Y^*_t.

In this closed-loop rule, both C and ε are a function not only of the system's matrices given in (3) but also of the relevant weightings of the trade-offs between target variables, as embodied in Q_1 and Q_2. Therefore, a difference in trade-off weights (that is, $Q_1 \neq Q_2$) necessarily implies a similar distinction between the respective optimal response patterns—even were the perceived structure of the economy to be identical and both policymakers to use the same model.

The implications for monetary policy can now be addressed initially in terms of the decision rule that would be selected by the government. The relevant monetary policy instrument is taken to be the change in the monetary base:

$$DMB_t^{gov} = \alpha^{gov}X_t + \varepsilon^{gov}, \tag{5}$$

where DMB_t is the change in the monetary base.

Following from the arguments above, the coefficient vector α^{gov} is dependent, first, on the perceived structure of the economy and, second, on Q_2 from the government's loss function. This is true also of the error term ε^{gov}.

However, the central bank is, of course, the institution entrusted with direct control over monetary policy. Were the central bank itself able to set policy in an unconstrained manner, then formulation of policy would be related to Q_1 from the bank's own loss function (equation 1)—and not at all to Q_2. The reaction function is written as

$$DMB_t^{cb} = \alpha^{cb}X_t + \varepsilon^{cb}. \tag{6}$$

To the extent that Q_1 is not equal to Q_2, it could be expected that α^{gov} is not equal to α^{cb} and ε^{gov} is not equal to ε^{cb}. However, given that the central bank is perceived to face a constraint on the extent of government displeasure it may engender, then both sets of coefficients will play a role in the determination of monetary policy.

This proposition is examined in the context of an extended loss function for the central bank that allows for an influence of pressure exerted by the government. The extent of the pressure is taken to depend on the gap between the monetary policy that the government would have selected itself (from equation 5) and the monetary policy actually followed.

The extended loss function has the form

$$(7) \qquad \hat{LCB} = (Y_t - Y^*_t)'\hat{Q}_1(Y_t - Y^*_t),$$

$$\hat{Q}_1 = q(p_t) \text{ and}$$

$$q(0) = Q_1, \quad q(\infty) = Q_2,$$

where p_t is the pressure exerted on the bank by the government.

In this framework the impact of pressure on the central bank's loss function is embodied in the function q and implies an altered response pattern for the loss function. Indeed, as pressure increases, the central bank departs further and further from the policy response consistent with its unconstrained trade-off weights, such that in the limit the observed trade-off weights approach the weights represented in Q_2.

In examining the influence of government pressure on the central bank's feedback rule, the proxy for this pressure is the cyclically adjusted deficit divided by trend GNP (*DEF*). Here, the government's feedback rule for the deficit, like the desired reaction function for monetary policy (5), would be a function of the trade-off weights embodied in Q_2, while the unconstrained policy reaction function for the central bank (6) is instead a function of Q_1 from the central bank's own loss function (1). This suggests that an increase in *DEF* would be associated with an increase in pressure because it implies an increase in the gap between actual monetary policy and the policy that would have been set by the government.[1]

With the deficit serving as the proxy for government pressure, we depart from the unconstrained feedback rule (6) in favor of the general form given by

$$(8) \qquad D\hat{M}B_t = \alpha^{def}X_t + \varepsilon^{def},$$

where α^{def}, rather than being a fixed parameter, is related explicitly to the observed value of *DEF* (with a lag structure corresponding to that of X_t). In this way, the government's loss function now affects monetary policy through the indirect channel provided by the deficit, and this effect is associated with central bank response to the implied government pressure.

The nature of the dependence of α^{def} on the deficit can be expressed most simply by the linear approximation

$$(9) \qquad \alpha^{def} = \alpha_1 + \alpha_2 DEF_t,$$

which provides the formal underpinning for the empirical analysis discussed in the text.

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1. In the model, minimum government pressure exists when the deficit is zero. The effect of the deficit is further assumed to be symmetric in that, just as a budget deficit implies pressure for more expansionary policy, a budget surplus would be associated with pressure for a more contractionary policy by the central bank.

Energy's Contribution to the Growth of Employment in Texas, 1972-1982

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Texas employment increased at an average annual rate of 5.2 percent from 1972 to 1982. In comparison, employment in the United States rose only 2.3 percent per year. Much of the rapid growth in Texas can be attributed to the prominent role of energy production in the state and to the fact that energy production worldwide was encouraged by a sharp rise in energy prices.

Chart 1 shows how Texas employment in two key energy industries increased over the period. Employment in oil and gas extraction, which includes engineers as well as roughnecks, rose at an annual rate of 11.6 percent. Texas was also an important supplier of machinery used in energy extraction, and employment in oil field machinery manufacturing grew at a rate of 9.9 percent per year. The employment gains in these two industries alone accounted for 12 percent of the total rise in private nonagricultural employment over the 1972-82 period.

The influence of energy on Texas employment was not limited to the direct gains in energy-producing industries. As extraction employment increased, so did the demand for professional, financial, and business services. The growing oil field machinery industry increased the demand for primary and fabricated metal products. And the rise in state personal income as a result of expansion in the energy sector increased the demand for health care, education, and other consumer products.

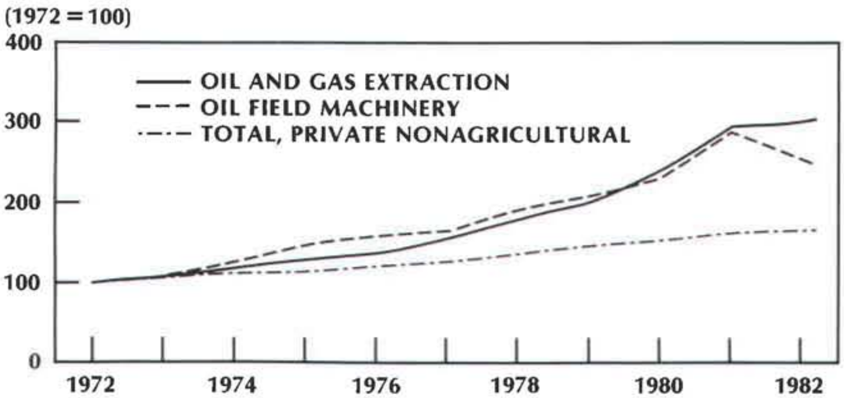
This article provides an estimate of energy's contribution to employment growth in Texas during the 1972-82 period. An input-output table is used to determine the employment effects of growth in two energy-producing industries: oil and gas extraction and oil field machinery manufacturing. The effects include not only the intermediate demands these industries make on other industries in the state but also the additional employment gains arising as increases in state personal income expand the demand for consumer goods and services.

The results suggest that during the 1972-82 period, growth in the two energy industries accounted for as much as 45 percent of the increase in total Texas employment. Energy, then, would have contributed as much as 2 percentage points to the annual growth rate of Texas employment. Despite the importance of energy to the state's growth, the gains in energy employment do leave unexplained a substantial portion of the rapid expansion that occurred in Texas manufacturing.

The input-output model

The analysis is based on an input-output table that was developed for the Texas economy.[1] The table shows how goods and services produced in each Texas industry during 1979 were distributed to other industries, households, and governments. With this information, it is possible to mea-

Chart 1
Texas Employment in Energy-Producing Industries



SOURCE OF PRIMARY DATA: U.S. Bureau of Labor Statistics.

sure the extent of economic interdependence among the various sectors of the Texas economy.

The input-output table can be represented by the following system of equations:

$$(1) \qquad X_i = \sum_{j=1}^{N} a_{ij}X_j + c_iY + D_i, \qquad i = 1, 2, ..., N,$$

$$Y = \sum_{j=1}^{N} s_jX_j + M,$$

where

X_i = state production in industry i
a_{ij} = output from industry i purchased by producers in industry j, expressed as a fraction of X_j
Y = state personal income
c_i = household demand for output from industry i, expressed as a fraction of Y
D_i = autonomous demand for output from industry i (including purchases by federal, state, and local governments; capital formation; and exports to out-of-state buyers)
s_j = income paid to state households by producers in industry j, expressed as a fraction of X_j
M = other state income (including government transfer payments and income from out-of-state producers).

The first set of equations divides industry outputs into their intermediate and final uses. The intermediate demands on industry i by industry j are written as $a_{ij}X_j$. Final demands are of two types. Household demand is expressed as a proportion of state personal income. The other category of final demand, D_i, includes government expenditures and exports. These purchases are not assumed to vary with state income. The last equation details the contributions of all industries to state personal income. Income not derived from state production is denoted by M.

In addition to displaying information about the Texas economy, the input-output table can be used to determine the economy-wide impact of a given industrial expansion. To do this, it is assumed that the expansion has a negligible effect on the autonomous demands in other industries (D_i), the income derived from out-of-state production (M), the intermediate input coefficients (a_{ij}), and the propensities to consume (c_i). Of particular note is the implicit assumption that there be no associated changes in relative prices, changes that might lead to technical substitution among factors of production or substitution among commodities in household demand. This constraint requires the economy in question to face highly elastic supplies of tradable commodities and primary factors of production. In view of this requirement, input-output analysis is seen to be more readily applicable to state economies than to national economies.

The specific purpose of this article is to determine how expansion in two energy-producing industries—oil and gas extraction and oil field machinery—affected employment in other state industries. The details of this procedure can now be briefly sketched. Let indexes 1 and 2 denote the two energy-producing industries. Given the above assumptions, the equations in (1) can be rewritten to express the changes in non-energy production and personal income in terms of given changes in the two energy outputs.

$$(2) \qquad \Delta X_i - \sum_{j=3}^{N} a_{ij}\Delta X_j - c_i\Delta Y = a_{i1}\Delta X_1 + a_{i2}\Delta X_2,$$

$$i = 3, 4, ..., N;$$

$$-\sum_{j=3}^{N} s_j\Delta X_j + \Delta Y = s_1\Delta X_1 + s_2\Delta X_2.$$

This system of equations can be solved simultaneously for the changes in non-energy outputs. A conversion from outputs to employment is made by using information on industry labor-output ratios.[2] These ratios will be constant and independent of changes in energy production, given the earlier assumption of constant relative prices.

The solutions described above are intricate and complex. To provide some understanding of the economic relationships involved, the accompanying box works through a solution for a simple example involving one energy industry and two non-energy industries.

Adjustments for induced construction

In static input-output models, like the one used here, there is no means of analyzing capital formation. Changes in industry outputs do not induce construction of new homes, buildings, or plants. This section outlines a simple method for estimating the additional employment generated when the construction sector is allowed to respond fully to the energy expansion.

Suppose that each unit increase in total employment can be associated with the employment of α additional construction workers. Ignore any differences in capital-labor ratios across industries, and assume that the construction induced by an economic expansion is independent of the industry composition of that expansion. In practice, α will be taken to be 0.08, the ratio of observed gains in construction employment to observed gains in total employment over the 1972-82 period. In addition to the direct gains in construction employment, there will be indirect gains of the kind summarized in the input-output model. Let m denote the construction employment multiplier. Then the change in employment attributable to the induced gains in construction is given by $m\alpha\Delta L^*$, where ΔL^* is the total change in employment. If ΔL is used to denote the energy-related gains derived earlier from the input-output model, ΔL^* can be expressed as

$$(3) \qquad \Delta L^* = \Delta L + m\alpha\Delta L^*.$$

By solving equation 3 for ΔL^*, it is possible to obtain a more complete account of the effect of rising energy production on state employment.

The above discussion has concentrated on changes in total state employment. For a breakdown by industry, the analogue to equation 3 is

$$(4) \qquad \Delta L_i^* = \Delta L_i + m_i\alpha\Delta L^*,$$

where ΔL_i denotes the narrow estimate of energy-related gains in industry i and m_i is the construction multiplier for industry i. Equation 4 can be evaluated using ΔL^* from equation 3 together with information on ΔL_i and m_i from the input-output model.

Energy employment multipliers

To measure the dependence of the Texas economy on energy production, employment multipliers were derived for each of two key energy industries: oil and gas extraction and oil field machinery. In the original calculations, 46 individual Texas industries were identified. The results were then aggregated into nine major sectors for easier interpretation. Table 1 shows the effects on private nonagricultural Texas employment of an increase of 1,000 workers in each of the two energy industries. The "unadjusted" columns display the narrow estimates that were obtained directly from the input-output table, while the "adjusted" columns show data allowing for induced construction.

The figures in Table 1 represent the combined influence of changes in intermediate and final demands on industry employment. For some industries, particularly those in the manufacturing sector, the effects are composed primarily of changes in the intermediate demands made by other industries. But for other industries, such as retail trade and many of the service industries, the effects are principally the result of changes in consumer demand that are generated by changes in state income. With the exception of the energy industries themselves, the largest employment gains tend to be found in industries that cater more to household demand than to business demand.

Regardless of the figures used, the total employment multiplier for oil and gas extraction is larger than the multiplier for oil field machinery. Although many factors contribute to this result, the most compelling reason involves

A Simple Exercise in Input-Output Analysis

An example will serve to clarify the nature of the economic interdependencies expressed in the input-output model. Consider a state with three production sectors. First, there is an energy-producing industry, denoted by the index E. Second, there are industries whose outputs are used as intermediate inputs by energy-producing firms. Let the index I represent a composite of these industries. The last group to consider is composed of industries that produce consumer goods and services. A rise in energy employment will increase state personal income, which, in turn, will expand the demand for final products. Use the index F to represent state industries that produce final goods and services.

With this simple model in mind, it is possible to work through the employment effects of a given increase in state energy production. Let ΔX_E denote the change in energy output and b_j the amount of labor required per unit of output in industry j. The most direct employment gains are the $b_E \Delta X_E$ new jobs created in the energy industry. Then additional workers will be needed to produce the intermediate inputs required by energy-producing firms. The increase in intermediate production is given by $a_{IE} \Delta X_E$, so employment in sector I rises by $b_I a_{IE} \Delta X_E$. The last source of employment to consider is the final goods sector. An increase in state personal income expands consumer demand by $c_F \Delta Y$, which raises employment in the final goods sector by $b_F c_F \Delta Y$.

The changes in employment described above are totaled in equation A.1:

$$\text{(A.1)} \qquad \Delta L = b_E \Delta X_E + b_I a_{IE} \Delta X_E + b_F c_F \Delta Y.$$

What remains is to relate the change in state income to the change in state energy production. Begin with the incremental income generated in the energy and intermediate goods sectors, $s_E \Delta X_E$ and $s_I a_{IE} \Delta X_E$, respectively. These gains are autonomous, being derived from production that is not responsive to changes in state income. For ease of notation, denote the sum of these two gains by ΔY_A. The process by which income is generated in the final goods sector is more complicated. Through their effect on consumer demand, the autonomous changes in income increase income in the final goods sector by the amount $(s_F c_F) \Delta Y_A$. But this gain itself expands consumer spending, thus leading to a second round of income gains in the amount $(s_F c_F)^2 \Delta Y_A$. The process continues indefinitely, with income gains of $(s_F c_F)^i \Delta Y_A$ in any ith round leading to additional gains of $(s_F c_F)^{i+1} \Delta Y_A$ in the next round.

When taken to the limit, the summation of all income gains, including the autonomous ones, can be expressed as

$$\text{(A.2)} \qquad \Delta Y = [(s_E + s_I a_{IE})/(1 - s_F c_F)] \Delta X_E.$$

By substituting (A.2) into (A.1), the change in state employment can be expressed solely in terms of the change in energy output. And by substituting $\Delta L_E / b_E$ for ΔX_E and then writing the result as a ratio of the change in energy employment, we have an algebraic rule for determining the effect on total employment of a unit change in energy employment.

$$\text{(A.3)} \quad \Delta L / \Delta L_E = 1 + (b_I / b_E) a_{IE} + (b_F / b_E) c_F [(s_E + s_I a_{IE})/(1 - s_F c_F)].$$

Equation A.3 reveals three elements that are crucial to the size of the energy employment multiplier. First, there are the terms (b_I / b_E) and (b_F / b_E), which compare the labor requirements in energy production with those in other sectors of the economy. The more labor-intensive the energy sector, the smaller will be its employment multiplier. Second, there is the parameter a_{IE}, which measures the interdependence of energy and intermediate goods production. The greater this interdependence, the larger are the employment gains in the intermediate goods sector and, given the contribution intermediate goods production makes to state income, the larger are the employment gains in the final goods sector. The other important parameter is c_F, the propensity to consume state products. The larger the propensity to consume, the greater is the income generated from a given energy expansion and, therefore, the greater are the employment gains in the final goods sector.

Table 1
ENERGY EMPLOYMENT MULTIPLIERS FOR TEXAS

Sector	Employment generated by an increase of 1,000 workers in respective energy industry			
	Oil and gas extraction		Oil field machinery	
	Unadjusted	Adjusted[1]	Unadjusted	Adjusted[1]
Mining	1,008	1,034	6	22
Construction	27	432	20	268
Nondurable manufacturing	115	161	61	89
Durable manufacturing	72	158	1,151	1,204
Transportation and public utilities	179	225	114	143
Wholesale trade	154	195	104	129
Retail trade	696	845	360	451
Finance, insurance, and real estate	217	271	106	139
Services	643	827	280	392
Total private nonagricultural employment	3,111	4,148	2,202	2,837

1. For induced construction.
SOURCE OF PRIMARY DATA: Texas Department of Water Resources.

the labor intensities of the two industries. The oil field machinery industry uses 2 1/2 times as much labor per given value of output as does the extraction industry.[3] As explained in the box, labor-intensive industries tend to have smaller employment multipliers.

Finally, note the relatively small size of the construction figures in the unadjusted columns. As discussed earlier, this is due to an omitted linkage between capital stock and output in static input-output models. Equations 3 and 4 were used to adjust the employment figures for a more complete response in construction employment.[4] As can be seen from Table 1, the adjustments had a significant effect on the multipliers. The most dramatic revisions were, of course, in the construction sector. The construction figures were raised by a factor of 16 in the case of oil and gas extraction and 13 in the case of oil field machinery. The average effect of the revisions was to raise the extraction multipliers by a factor of 1.33 and the machinery multipliers by a factor of 1.29.

Estimates of energy-related growth

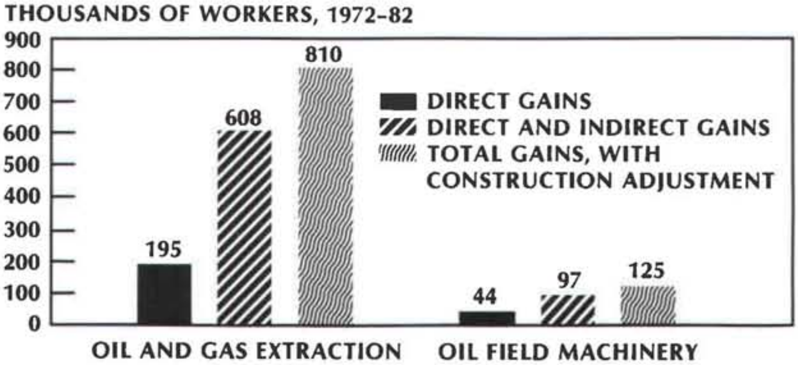
Reported in this section are estimates of the gains in Texas employment from 1972 to 1982 that, either directly or indirectly, can be accounted for by growth in the state's oil and gas extraction and oil field machinery industries. The estimates were obtained by multiplying the actual changes in energy employment over this period by the appropriate employment multipliers and then adding up over the two energy industries.

Chart 2 reveals the individual employment contributions of the two energy industries. As can be seen, the bulk of the energy-related growth was the result of gains in oil and gas extraction. Extraction employment itself rose 195,000 workers. And when allowance is made for induced changes in intermediate and final demands, the rise in extraction employment ultimately was responsible for as many as 810,000 state jobs. In comparison, the oil field machinery industry added only 44,000 workers to its payrolls, with a total employment impact of 125,000 jobs.

Table 2 details the combined influence of the two energy industries on Texas employment. Of the 2.1 million additional workers in the state, as many as 935,000, or 45 percent, were the direct or indirect result of expansion in energy-producing industries. With the exception of mining and construction, the relative contributions made by energy ranged from 20 to 35 percent for the unadjusted figures and 26 to 43 percent when employment was adjusted for induced construction.[5] The largest percentage contributions were in nondurable manufacturing, retail trade, and transportation and public utilities. Energy was less important to the growth in wholesale trade, services, and durable manufacturing.

It is of interest to know how fast employment would have risen in Texas without the growth in its energy industries and whether the gains that were unrelated to energy were suffi-

Chart 2
Employment Contributions of Major Texas Energy Industries



SOURCES OF PRIMARY DATA: Texas Department of Water Resources. U.S. Bureau of Labor Statistics.

cient in themselves to allow the state to grow more rapidly than the nation. These questions were addressed by calculating hypothetical growth rates, using only the employment gains that could not be accounted for by energy growth. Selected figures for the construction-adjusted case are shown in Chart 3.[6] The results suggest that without the rise in energy production, total employment in Texas would have increased at a rate of 3.2 percent per year, rather than the rate of 5.2 percent actually recorded. The lower rate still exceeds the national average but by a much smaller margin.[7] When broken down by sector, the results show that employment in most sectors grew faster in Texas than in the United States, even when the energy-related gains were removed. An important exception is services. Service

Table 2
IMPORTANCE OF ENERGY TO TEXAS EMPLOYMENT GROWTH, 1972-82

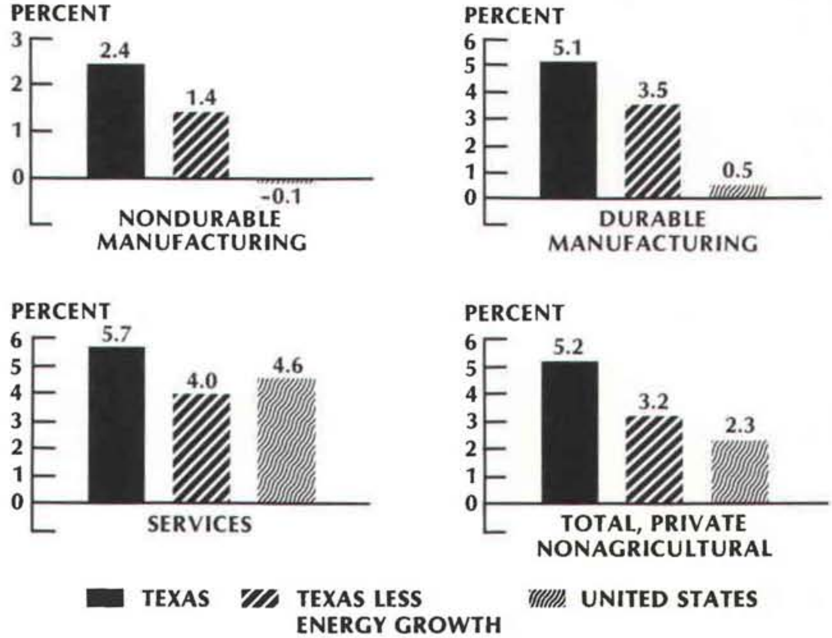
Sector	Change in employment (Thousands of workers) — Energy-related: Unadjusted	Energy-related: Adjusted[1]	Actual	Energy-related as percent of actual: Unadjusted/actual	Adjusted/actual
Mining	197	203	200	98.5	101.5
Construction	6	96	172	3.5	55.8
Nondurable manufacturing	25	35	82	30.5	42.7
Durable manufacturing	65	84	225	28.9	37.3
Transportation and public utilities	40	50	121	33.1	41.3
Wholesale trade	35	44	172	20.3	25.6
Retail trade	152	185	437	34.8	42.3
Finance, insurance, and real estate	47	59	156	30.1	37.8
Services	138	179	506	27.3	35.4
Total private nonagricultural employment	705	935	2,071	34.0	45.1

1. For induced construction.
SOURCES OF PRIMARY DATA: Texas Department of Water Resources. U.S. Bureau of Labor Statistics.

Chart 3

Employment Growth in Texas and the United States

(ANNUALIZED RATES FOR 1972-82)



SOURCES OF PRIMARY DATA: Texas Department of Water Resources.
U.S. Bureau of Labor Statistics.

employment would have grown at a slightly lower rate in Texas had energy production in the state not increased. The margins by which Texas outpaced the nation are largest in durable and nondurable manufacturing. And this is true whether or not energy-related gains are excluded.

Qualifications

Our analysis of the employment impact of Texas energy growth suffers from two principal shortcomings. First, the model fails to recognize any "crowding out" that may have occurred as increases in energy production raised factor prices in the state. Second, the model does not account for any of the positive effects on industrial location of low rates of business and personal taxation made possible by oil and gas severance tax revenues. The first omission serves to overstate the effect of energy growth on total state employment. The second results in employment estimates that are downward biased.

Input-output analysis is based on the assumption that the supplies of factors of production are highly elastic. Ignored is the possibility that a given industrial expansion may so raise the prices of labor or land as to "crowd out" production in other industries. The converse assumption would require that factors be fixed in supply. Increased production in one industry would then alter only the composition of employment, not its overall level. Except during periods of significant unemployment of resources, the second perspective is the more appropriate one for national economies. But for states such as Texas, which competes for labor in a national market and for which constraints on the quantity of usable land have never been very binding, the first perspective would seem more accurate. The substantial increase in Texas employment in recent years is evidence that the supply of labor to the state is highly elastic.

A second shortcoming of the analysis is that no attention was paid to the effect of state and local taxes on industrial location. Tax revenues from oil and gas production accounted for an average of 20 percent of total tax receipts in

Texas during the 1972-82 period. This contributed to the fact that, excluding severance taxes, which strike only a small subset of state industries, Texas ranked 47th lowest among 48 U.S. states in effective rates of business taxation.[8] It is likely, then, that gains in energy employment promoted further economic growth by keeping taxes on other state industries lower than they otherwise would have been.

The importance of this tax effect to Texas economic growth is difficult to establish. But it likely was not of the same order of magnitude as the employment effects identified by the input-output model. To a large extent, tax effort in Texas has been light because the state provides a relatively low level of services. And an absence of services is in itself an impediment to economic growth. Even so, studies of the effect of taxes on business location suggest that state and local taxes are only moderately important in decisions about plant locations. Of much greater importance in these decisions is the strength of local union activity.[9]

Conclusion

The rapid economic growth in Texas during the 1970s and early 1980s is often attributed to the important role of energy production in the state economy. Indeed, the results presented here indicate that gains in energy employment during this period were responsible for as much as 45 percent of the increase in state employment. But the analysis leaves unexplained a significant portion of the state's growth, particularly in manufacturing. After abstracting from the direct and indirect effects of rising energy production, the annual rate of growth in Texas manufacturing employment was found to be some 2 percentage points greater than the national average.

It may be unreasonable to expect this rate of manufacturing growth to persist in coming years. The energy price hikes of the 1970s hastened the obsolescence of energy-inefficient plants, providing an enlarged pool of relocation candidates. But the fact remains that many owners of manufacturing facilities chose Texas as a location site. This suggests that other locational attributes, such as low union activity or a large supply of immigrant labor, also made significant contributions.

Given the recent collapse in world oil prices and the expected layoffs in energy-producing industries, the near-term outlook for the Texas economy is not encouraging. But the results of this article provide some basis for optimism concerning the long-term prospects for growth in the state.

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1. Mickey L. Wright, Albert H. Glasscock, and Roy Easton, *The Texas Input-Output Model, 1979* (Austin: Texas Department of Water Resources, 1983). For a general discussion of input-output tables and their use in economic analysis, see Hollis B. Chenery and Paul G. Clark, *Interindustry Economics* (New York: John Wiley & Sons, 1959).

2. Data on ratios of employment to output are presented in Wright, Glasscock, and Easton, *Texas Input-Output Model.*

3. In 1979 the number of employees per $1 million of output was 5.6 in oil and gas extraction and 13.7 in oil field machinery. See Wright, Glasscock, and Easton, *Texas Input-Output Model.*

4. The individual construction multipliers needed to make these adjustments came from the input-output model. They can be obtained from the information presented in Table 1.

5. In the case of mining, the energy-related gains were more than 100 percent of the actual gains. This means that mining employment would have fallen had employment in energy-producing industries remained constant.

6. The actual growth rates in Chart 3 were derived by regressing the natural logarithm of annual employment on a linear function of time. The rates of non-energy growth were based on the level of employment predicted for 1972 from the earlier regressions and on the change in employment predicted for 1972-82, deflated by the ratio of energy-related to actual employment gains.

7. The non-energy margin would be larger than the numbers in Chart 3 indicate had the effects of energy growth also been removed from the national figures. But because the national labor market is more closed than the Texas labor market, it would be misleading to make a similar adjustment for the United States. With severe crowding out at the national level, additional employment growth would have been forthcoming in other sectors had energy production not increased.

8. The ranking was based on 1977 data. See William C. Wheaton, "Interstate Differences in the Level of Business Taxation," *National Tax Journal* 36 (March 1983): 83-94.

9. See Timothy J. Bartik, "Business Location Decisions in the United States: Estimates of the Effects of Unionization, Taxes, and Other Characteristics of States," *Journal of Business & Economic Statistics* 3 (January 1985): 14-22.

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