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Gross National Product at Full Employment

By John B. Penson, Jr., and Kerry Webb

Measures of gross national product (GNP) at full employment can be valuable in estimating the budget associated with the full employment of the economy's resources and in shaping policies to reduce the amount of slack in the economy. Traditionally, GNP at full employment has been viewed as "the aggregate supply capability of an economy, or the amount of output that could be expected at full employment."[1] Early estimates of "potential GNP," as it is commonly referred to, reflected the level of GNP associated with a particular full employment unemployment rate. More recent approaches have used a single production function, which at minimum includes a labor input variable and a capital input variable.

The accuracy of estimates of the output that could be expected at full employment has important implications for policymakers. For example, an overestimation of GNP at full employment would overstate the extent to which resources in the economy are currently underutilized. This may lead to policy actions that place too much demand pressure on existing capacity and worsen inflation. Conversely, underestimation of GNP at full employment may lead to policy actions that place too little demand on the economy's resources and hence slow its growth.

Some economists have questioned the meaning and usefulness of the concept of potential GNP because it explicitly ignores demand. Plosser and Schwert, for example, argue that potential GNP has little operational significance because:

> "It is not an equilibrium concept, since there is no relationship with aggregate demand. Consequently, 'potential GNP' cannot be viewed as representing the level of output which would prevail in the absence of any unexpected random shocks to aggregate supply or demand."[2]

[1] Peter K. Clark, "Potential GNP in the United States, 1948-80," *Review of Income and Wealth*, June 1979, pp. 141-65.

[2] Charles I. Plosser and G. William Schwert, "Potential GNP: Its Measurement and Significance, A Dissenting Opinion," *Carnegie-Rochester Conference Series on Public Policy*, Volume 10, supplementary series to the *Journal of Monetary Economics*, 1979, pp. 179-86.

John B. Penson, Jr., is a visiting scholar at the Federal Reserve Bank of Kansas City on leave from Texas A&M University. Kerry Webb is an assistant economist at the Federal Reserve Bank of Kansas City.

Gordon also faults estimates of potential GNP —a term he says has been discredited and is obsolete—because they do not explicitly relate to the behavior of wages and prices.[3] This raises a question as to whether policymakers can realistically expect to see the output levels suggested by estimates of potential GNP if they adopt policies to fully employ available resources, since these estimates explicitly ignore the economic factors influencing producers' and consumers' decisions.

This article presents a new approach to estimating GNP at full employment that explicitly accounts for both supply **and** demand. The first section presents a brief review of existing estimates of potential GNP and illustrates the need to account for the interrelationships between production sectors in the economy and their capacities when estimating GNP at full employment. The second section presents a nontechnical discussion of how supply and demand considerations were accounted for when estimating GNP at full employment in this study. A technical explanation of this approach is presented at the end of this article for the interested reader. Finally, this article presents annual estimates of GNP at full employment during the 1958-71 period and evaluates the national economic policy implications of differences between these estimates and estimates of potential GNP.

EXISTING MEASURES OF POTENTIAL GNP

Use of the gap between actual and potential GNP as a measure of the amount of slack in the economy first gained prominence in the early 1960s due to the efforts of the Council of Economic Advisers (CEA) and Arthur Okun. There are several features which distinguish the CEA's model based upon Okun's law, as it is often called, from the measurement procedures developed in recent years by Clark, Rasche and Tatom, and Perloff and Wachter.

Okun's Law

Okun proposed that potential GNP is the level of aggregate output associated with a full employment unemployment rate of 4 per cent.[4] Okun's law has been used in one way or another by the CEA since the early 1960s to measure potential GNP. In their approach, the CEA substitutes the full employment unemployment rate into an equation explaining the relationship between output and the rate of unemployment. This equation is then solved to determine the output level associated with the full employment unemployment rate. The effect of the full employment unemployment rate on potential GNP reflects not only the number of people working, but also the number of hours worked and productivity as well. Finally, the results are smoothed to remove sharp short-run fluctuations in this series.

The procedures used by the CEA assume that only the availability of labor and its productivity determine potential GNP. As Perry notes, however, "it is hard to argue that capital should not be included in estimating potential output because everyone **knows** it belongs in the calculation."[5] Okun, in fact, also recognized that capital should be incorporated into the measurement of potential GNP when he stated, "I shall feel much more satisfied with the

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[3] R. J. Gordon, "A Comment on the Perloff and Wachter Paper," *Carnegie-Rochester Conference Session Public Policy,* Volume 10, pp. 187-94.

[4] Arthur M. Okun, "Potential GNP: Its Measurement and Significance," in American Statistical Association, *Proceedings of the Business and Economics Section,* 1962, pp. 98-104.

[5] George L. Perry, "Potential Output and Productivity," *Brookings Papers on Economic Activity,* The Brookings Institution, Washington, D.C., 1977, p. 11.

estimation of potential output when our data and our analysis have advanced to the point where . . . the capital factor can be explicitly taken into account."[6]

Other Measures

Several alternative procedures to measuring potential GNP which explicitly account for capital have been introduced since 1976. The first of these studies was completed by Clark while on the CEA staff.[7] The capacity shortages evidenced in 1973 and other factors had led the CEA to conclude that potential GNP should measure the output of the economy that could be produced under conditions not only of high labor utilization, but also of high capital utilization. Potential GNP as reported in the 1977 and 1978 *Economic Report of the President* represented the "output in 1972 dollars that the economy would produce if the Department of Commerce manufacturing capacity utilization rate were 86 per cent and the unemployment rate was 4.9 per cent."[8] Clark's explicit accounting of capital in measuring potential GNP was accomplished through the use of a single Cobb-Douglas production function for the whole economy, where the input shares for labor and capital were assumed to be two-thirds and one-third, respectively. As a result of Clark's study, significant reductions in the annual growth rate and level of potential GNP were reported in 1977.[9]

Rasche and Tatom also used an aggregate Cobb-Douglas production function to estimate potential GNP.[10] Their production function differed from Clark's because they (1) specifically included energy as a factor of production and (2) statistically estimated the input shares for the labor, capital, and energy inputs.[11] Perloff and Wachter used a translog production function to measure potential output to avoid the assumptions underlying the Cobb-Douglas production functions used in the Clark and Rasche-Tatom studies.[12]

Still another procedure for measuring potential GNP is the one presently practiced by the CEA. In the 1979 *Economic Report of the President,* the CEA expressed the feeling that productivity growth had not shown the significant improvement expected two years earlier. Hence, the CEA decided to revise downward its estimates of potential GNP during the 1970s. Further revisions were made in 1980 and 1981 in response to new information on productivity.[13] Two approaches were used in making these revisions. The first approach was based upon the use of Okun's law as described earlier. The

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6 Okun, page 104.

7 Peter K. Clark, "Potential GNP in the United States, 1948-80," *U.S. Productive Capacity: Estimating the Utilization Gap,* St. Louis Center for the Study of American Business, Washington University, December 1979, p. 21.

8 *Economic Report of the President,* January 1977, p. 52.

9 Using Okun's procedure, the CEA had pegged the annual rate of growth in potential GNP at 4 per cent from the fourth quarter of 1968 to the fourth quarter of 1975, and 3.75 per cent thereafter. This led to a 1976 estimate of potential GNP of $1,422 billion, expressed in 1972 dollars. The Clark estimates, however, resulted in a 3.5 per cent growth rate from the fourth quarter of 1968 onward and an estimate of potential GNP in 1976 of $1,364 billion in 1972 dollars.

10 Robert H. Rasche and John A. Tatom, "Potential Output and Its Growth Rate—The Dominance of Higher Energy Costs in the 1970s," *U.S. Productive Capacity: Estimating the Utilization Gap,* pp. 67-120.

11 Thanh criticized both the Clark and Rasche-Tatom studies for their use of a Cobb-Douglass production function in a macro setting. See Pham Chi Thanh, "U.S. Productive Capacity: A Comment," both in *U.S. Productive Capacity: Estimating the Utilization Gap, pp. 157-65.*

12 *J. M. Perloff and M. L. Wachter, "A Production Function—Nonaccelerating Inflation Approach to Potential Output: Is Measured Potential Output Too High?" Carnegie-Rochester Conference Series on Public Policy,* Volume 10, p. 113.

13 See *Economic Report of the President,* January 1980 and 1981.

second procedure related cyclically adjusted labor productivity to potential output. Both estimates were then used as guides to establishing the published growth rates and levels of potential GNP.

Sector Capacities and Bottlenecks in GNP

All the procedures for estimating potential GNP, therefore, either explicitly ignore the role of the current capital stock in the economy or implicitly assume the input shares for capital and labor are the same in each production sector of the economy. The existing procedures also ignore the interrelationships among the production sectors and the possibility that one sector can limit the output of other sectors and hence the level of GNP. Klein and Long suggest that, "Capacity is a general equilibrium concept, which should be altered in light of bottlenecks whose effects can be traced through an input-output analysis."[14] This, they state, "is the whole point in using capacity utilization measures as signals of inflationary pressure, and accounts for (our) view that other measures strongly overstate the amount of spare capacity available by not taking account of interrelationships among industries." For example, an increase in the demand for automobiles will lead to an increase in the production of automobiles, which in turn requires more iron ore. The availability of labor for mining or the current capacity of the mining sector, however, may limit the amount of ore that can be produced in the short run.

If either the availability of labor or the current capacity of firms limits the output of just one production sector that supplies goods and services to other sectors, the economy's potential aggregate output will be limited. The mix of goods and services used in production by the individual production sectors will also change from one period to the next as the cost and availability of primary inputs and intermediate products change and as technology changes.

DESIRED GNP AT FULL EMPLOYMENT

Even if these factors are accounted for, one must still question whether producers in the economy at full employment would actually have desired to operate at the final demand levels suggested by existing estimates of potential GNP. As Greenspan suggests, the input-output analysis suggested by Klein and Long "requires not only some judgements about engineering relationships, but also a price vector that determines which materials or processes will be used."[15] In measuring GNP at full employment, it is not enough to account only for the physical production process. One must also account for the changes in the relative prices of products and resources as the economy moves from current GNP to full employment GNP, and for the effects these price changes will have upon the economic decisions of producers and consumers.

Measurement of Desired GNP at Full Employment

This study uses a series of annual input-output models of the U.S. economy to estimate GNP at the general equilibrium associated with the full employment of available labor (or capital, should it become limiting before labor is fully employed). The economy is in general equilibrium when a set of prices exist at which

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[14] Lawrence R. Klein and Virginia Long, "Capacity Utilization: Concept, Measurement and Recent Estimates," *Brookings Papers on Economic Activity,* The Brookings Institution, Washington, D.C., 1973, pp. 45-56.

[15] Alan Greenspan, "Comments and Discussions," *Brookings Papers on Economic Activity,* The Brookings Institution, Washington, D.C., 1973, pp. 757-9.

the quantities of goods and services demanded by consumers are satisfied by the quantities supplied by producers who have used resources supplied at the going prices and wages. To distinguish between these estimates of GNP at full employment and the estimates of potential GNP, these estimates are referred to as "desired" GNP at full employment, reflecting the fact that, at this particular level of GNP, producer profits are maximized and consumer demands are satisfied.

Data used to develop the annual models used in this study were obtained from the 85-sector input-output transaction tables published by the U.S. Department of Commerce. There are eight production sectors in these annual models: agriculture, mining and quarrying, construction, manufacturing, processed food and tobacco, energy, services, and trade and transportation. A technical description of the model is presented in the Appendix.

To find desired GNP at full employment for selected years during the 1958-71 period, the annual models first had to be constrained by the capacity of selected production sectors and the availability of labor.[16] The next step was to assure that the demand for labor completely exhausted the full employment labor force. The objective of each annual model thus was to find that particular final demand for goods and services where: (1) the demand for labor fully exhausts the full employment labor force, or the output of selected production sectors is limited by their capacities, and (2) the economy is in general equilibrium—that is, producer profits are maximized and consumer demand is satisfied at the going wages and prices. Any other level of GNP at full employment would necessarily imply that the quantity that producers were willing to supply at the going wages and prices differed from the quantity demanded by consumers.

Differences From Other Approaches

This approach to measuring GNP at full employment differs from the approaches used to estimate potential GNP in three major ways.

First, since input-output analysis traces the direct and indirect effects of changes in the demand and supply of products and resources in the economy, the interrelationships among the production sectors can be taken into account. This means that, rather than using one equation to represent all production activity, each key production sector in the economy has a separate production function. By limiting the output of selected sectors to their current capacity, this disaggregated approach can identify the effects that sector capacity can have upon the level of GNP.[17] During the time period covered by this study, however, the capacity of the individual production sectors never placed a limit on the size of GNP before the full employment labor force was completely put to work. Instead, the size of the full employment labor force suggested by Clark's annual full employment unemployment rates was the limiting factor. This result does not diminish either the need to account for the effects that sector capacity can have upon the level of GNP, or the uniqueness of the model used in this study. As indicated earlier, capacity shortages have been evidenced since the time period covered by this study. In addition, the

[16] This time period was determined by the availability of input-output tables when this model was developed.

[17] To measure the current manufacturing capacity of the manufacturing, food processing and tobacco, mining and quarrying, and energy sectors, their total output was divided by specific capacity utilization indices published by the Federal Reserve Board. It was assumed that the output of the construction, services, and transportation and trade sectors would not be capacity limiting. Finally, the capacity of the agriculture sector was found using the "trends-through-peaks" method described by Klein and Long.

approach taken to measure GNP at full employment in this study differs from previous approaches in two other ways.

The second major departure is that the model developed in this study accounts for annual changes in the input shares for labor, capital, and other inputs resulting from technological advances as well as changes in relative prices. By using annual systems of sector level production functions instead of a single production function for the entire economy, this study accounts for the year-to-year substitution among inputs in each production sector.

The third major departure from previous approaches is that this study explicitly accounts for demand as well as supply. Relative prices play a role in determining not only the intermediate demand for specific goods and services at full employment, but final demand as well. Intermediate demand by a production sector for the output of other sectors will change as the demand for its own goods and services changes. The final demand for a particular sector's product by other producers as well as by consumers will be influenced by the product's price and the price of substitute products. The estimates of desired GNP at full employment developed in this study, therefore, reflect the general equilibrium combination of goods and services associated with the going prices and wages and the full employment of labor.[18]

[18] Remember that there was the possibility that the capacities of one or more key production sectors would have been reached before the full employment labor force was employed. As indicated earlier, however, this did not occur during the time period covered by this study. The difference between the concept of potential GNP and the concept of desired GNP at full employment developed in this study is similar to the difference between the concepts of engineering capacity and economic capacity at the firm or sector level. See Lawrence R. Klein, "Some Theoretical Issues in the Measurement of Capacity," *Econometrica*, 1960, pp. 272-86.

COMPARISON OF ALTERNATIVE ESTIMATES

Estimates of desired GNP at full employment given by the annual models in this study are presented in Table 1, along with actual GNP and the estimates of potential GNP given by the CEA's model based upon Okun's law, the Clark model, and the Rasche-Tatom model. The annual growth rates for each GNP measure are presented here as well.

Both the Clark and Rasche-Tatom models, which explicitly account for the role of capital, result in substantially lower estimates of potential GNP than the published CEA estimates based on Okun's law. The annual estimates of desired GNP at full employment developed in this study deviate substantially from all the potential GNP estimates, however. There are two major reasons for the deviation. First, models not explicitly accounting for the interrelationships among the production sectors will overstate the total amount of spare capacity in the economy. As indicated in the previous section, the annual models used in this study to estimate desired GNP at full employment take these interrelationships into account. Second, these estimates also reflect the general equilibrium GNP associated with the full employment of available labor. While labor could possibly have been allocated differently among the sectors to increase GNP, this would have meant lower profits for producers in light of the going wages and prices.

A comparison of the annual growth rates suggested by the various estimates of potential GNP and the estimates of desired GNP at full employment made in this study helps illustrate the inherent differences between these approaches. All the approaches which explicitly account for capital show *declining* annual rates of growth in GNP at full employment during 1968-69 and 1969-70, while the CEA's estimates based upon Okun's law suggest *increasing*

annual rates of growth. The annual rates of growth in desired GNP at full employment estimated in this study also exhibit greater volatility than the estimates of potential GNP. In 1969, when interest rates rose substantially and corporate profits declined somewhat, the rate of growth in desired GNP at full employment fell from 4.3 to 2.4 per cent. Only the Clark model indicated a slower rate of growth in potential GNP from the year before. And in 1970, when interest rates rose still further and corporate profits declined sharply, the rate of growth in desired GNP at full employment suggests that consumers and producers would have desired only 1 per cent more in GNP at full employment than they desired in the previous year. Thus, the annual rates of growth in desired GNP at full

Table 1
ESTIMATES OF GNP AT FULL EMPLOYMENT, LEVEL, AND RATE OF GROWTH
Selected Years, 1958-71

Year	(1) Actual GNP	(2) Potential GNP: CEA (Okun's law)	(3) Potential GNP: Clark Model	(4) Potential GNP: Rasche-Tatom Model	(5) Desired GNP at full Employment
Level of GNP	-Billions of 1972 Dollars-				
1958	679.5	728.0	721.5	723.1	694.6
1961	755.3	807.1	801.1	793.5	773.4
1963	830.7	865.9	858.6	842.8	841.9
1966	981.0	967.0	957.8	953.0	973.2
1967	1,007.7	1,003.0	994.8	990.8	999.7
1968	1,051.8	1,040.9	1,031.8	1,030.0	1,043.0
1969	1,078.8	1,081.6	1,069.2	1,076.4	1,067.6
1970	1,075.3	1,124.9	1,106.0	1,114.9	1,077.8
1971	1,107.5	1,169.9	1,145.4	1,152.8	1,120.4
Growth Rate in GNP	-Per Cent-				
1958-61*	3.7	3.6	3.7	3.3	3.8
1961-63*	5.0	3.6	3.7	3.3	4.4
1963-66*	6.0	3.9	3.9	4.4	5.2
1966-67	2.7	3.8	3.9	4.0	2.7
1967-68	4.4	3.8	3.9	4.0	4.3
1968-69	2.6	3.9	3.6	4.5	2.4
1969-70	−0.3	4.0	3.4	3.4	1.0
1970-71	3.0	4.0	3.6	3.0	4.0

*Annual average growth rate during the period.

employment reflect the growth rates in *actual* GNP observed during the 1958-71 period more closely than they do the growth rates in the estimates of potential GNP. This is because the approach to measuring desired GNP at full employment incorporates not only the longer-run decisions of producers to expand their existing capital stock as the Clark and Rasche-Tatom models do, but also the short-run decisions of producers to utilize that portion of their existing capital stock which maximizes their profits.

Inflation and GNP at Full Employment

Economists recognize that inflation doesn't wait for full employment. That is, prices in general begin to rise before full employment is reached, as growth in economic activity puts increasing demand pressure on the capacity of key production sectors in the economy. Which measure of GNP at full employment—potential GNP or desired GNP at full employment—most closely reflects the inflationary pressures which existed during the 1958-71 period?

One way to address this question is to compute the gaps between actual GNP and the GNP levels at full employment suggested by the various estimates and then relate these annual gaps to the annual rates of inflation observed during the 1958-71 period. The gaps suggested by the CEA's estimates based upon Okun's law, the Clark model, the Rasche-Tatom model, and the annual models developed in this study are presented in Table 2.

There is a substantial difference between the size of the gaps suggested by these estimates of full employment output. In 1970, for example, the CEA's published estimate of the gap was +$49.6 billion—that is, actual GNP was nearly $50 billion less than estimated potential GNP. Thus, producers may have been expected to supply an additional $50 billion to final

Table 2
GAPS BETWEEN ACTUAL GNP AND VARIOUS MEASURES OF GNP AT FULL EMPLOYMENT, AND THE RATE OF INFLATION,
Selected Years, 1958-71†

	(1)	(2)	(3)	(4)	(5)
	----------Potential GNP----------				
Year	CEA (Okun's law)	Clark Model	Rasche-Tatom Model	Desired GNP at full employment	Rate of Inflation
	-Billions of 1972 Dollars-				-Per Cent-
1958	+48.5	+42.0	+43.6	+15.1	1.8
1961	+51.8	+45.9	+38.2	+18.1	1.5
1963	+35.2	+27.9	+12.1	+11.2	1.6
1966	−14.0	−23.2	−28.0	− 7.8	3.4
1967	− 4.7	−12.9	−16.9	− 8.0	3.0
1968	−10.9	−20.0	−21.8	− 8.8	4.7
1969	+ 2.8	− 9.6	− 2.4	−11.2	6.1
1970	+49.6	+30.7	+39.6	+ 2.5	5.5
1971	+62.4	+37.9	+45.3	+12.9	3.4

† A positive gap means that actual GNP is less than GNP at full employment.
A negative gap means that actual GNP is greater than GNP at full employment.

Table 3
STATISTICAL ANALYSIS OF RELATIONSHIP BETWEEN INFLATION AND PER CENT GAP BETWEEN ACTUAL GNP AND GNP AT FULL EMPLOYMENT[a]

Model	B_0	B_1	DW	Rho	F	$\bar{R}^2$
Penson-Webb model	1.2619 (4.796)	−38.3757 (− 2.815)	2.04	.52	7.92	.46
Clark model	1.3011 (3.646)	−12.8437 (− 2.013)	1.92	.60	4.05	.28
CEA (Okun's law) model	1.4183 (3.181)	−11.5605 (− 1.757)	1.87	.65	3.09	.21
Rasche-Tatom model	1.2422 (2.827)	− 9.9856 (− 1.389)	1.76	.65	1.93	.10

[a] The estimating equation used in this analysis is of the form $\log p = B_0 + B_1 (PGAP)$, where log p represents the per cent change in the Consumer Price Index and PGAP represents the per cent gap between potential and actual GNP associated with the various models. The values reported in the parentheses below the B_0 and B_1 coefficients represent the ratio of the coefficient to its standard error. DW represents the Durbin-Watson test statistic, Rho is the coefficient associated with the first order autocorrelation correction scheme, F represents the F ratio, and $\bar{R}^2$ represents the corrected coefficient of multiple correlation.

demand if full employment of labor was achieved. The gap suggested by the estimate of desired GNP at full employment of +$2.5 billion, however, suggests that producers would not have appreciably expanded their output in 1970 even if labor were fully employed.[19] And in 1969, all the estimates of potential GNP suggested either a declining inflationary gap (less negative than the previous year) or a deflationary gap (actual GNP below GNP at full employment) even though the rate of inflation jumped from 4.7 to 6.1 per cent. Only the estimate of desired GNP at full employment developed in this study suggests an increasing inflationary gap, which is consistent with an increasing rate of inflation.

The statistical relationship between the annual rate of inflation and the percentage gap between actual GNP and the various measures of GNP at full employment is examined in Table 3.[20] Of those models estimating potential output, the Clark model did a better job of highlighting the inflationary pressures which existed during 1958-71 than either the CEA's model based upon Okun's law or the Rasche-Tatom model. The results presented in Table 3, however, show that the concept of desired GNP at full employment explained more of the

[19] The additional labor utilized was allocated among the sectors so as to maximize the gain (or minimize the loss) in the economic well-being of producers and consumers in general.

[20] This is not to suggest that the gap between potential or desired GNP and actual GNP is the only cause of inflation. Our interest is in the partial relationship between these two variables. For an extended analysis of inflation, which includes other variables like the expected inflation rate, see Robert J. Gordon, "A Consistent Characterization of a Near-Century of Price Behavior," *American Economic Review*, May 1980, pp. 243-8, and Jon Frye and Robert J. Gordon, "Government Intervention in the Inflation Process: The Econometrics of Self-Inflicted Wounds," *American Economic Review*, May 1981, pp. 288-94.

inflationary pressures which existed during the 1958-71 period than the concept of potential GNP. This equation not only had the highest corrected R-square, but also was the only equation which had a statistically significant F-ratio at the 5 per cent level of significance.

POLICY IMPLICATIONS

The estimates of desired GNP at full employment presented in this study suggest several factors of interest for economic policy. First, estimates of potential GNP at full employment based largely on an aggregate relationship between output and one or more inputs will overstate the economy's output at full employment, particularly in periods of weak economic conditions. Producers simply may not desire to supply the output at full employment suggested by estimates of potential GNP because the cost of producing additional output exceeds the additional returns they would receive.

In 1970, for example, the CEA estimate of potential GNP suggests a gap between actual and potential GNP of about $50 billion. With a GNP gap of that size, economic policy could afford to be expansionary in order to put unused resources to work without much of an increase in inflation. But if the gap were only $2.5 billion, as suggested by the estimate of desired GNP at full employment, the same amount of policy stimulus would exert too much demand pressure on the economy's capacity to produce, and thus subtantially increase inflation.

The estimates of potential GNP suggest specific levels of output that would be forthcoming if resources were fully employed. Thus fiscal policymakers, in taking action to move the economy to full employment, would expect a particular level of tax revenue at full employment. If producers desired to supply less output at full employment than the estimated level of potential GNP, however, tax revenues would fall short of expectations, as would the actual budget surplus. If a budget deficit existed, there would be further inflationary implications.

Finally, policymakers would be in a better position to aim specific programs toward those sectors which represent bottlenecks to GNP if they were provided with estimates of GNP at full employment on a disaggregated basis. By using an approach to measuring GNP at full employment which captures the interdependencies that exist among production sectors, a sector which limits the output of other sectors can be discovered more easily. Furthermore, an examination of the added economic benefits to producers and consumers from the expansion of specific sectors in the economy can help policymakers design specific programs to expand the economy that will most benefit producers and consumers in general. Such an analysis is impossible with existing models, not only because of their aggregate nature, but also because they explicitly ignore demand.[21]

SUMMARY

Estimates of GNP at full employment can be valuable in estimating the output lost due to idle resources in the economy, and in shaping short term policies that will eliminate this gap. Although several methods have been used to estimate potential GNP, these methods ignore the interrelationships between the production sectors in the economy and the demand for

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21 One obvious disadvantage to the approach taken in this study to measure GNP at full employment is the dated nature of available input-output tables. While this issue was not pursued in this article, several techniques are available for projecting the technical coefficients beyond those presently available which insure a consistency with up-to-date totals for total output and labor use. Future research plans include development of annual input-output models to estimate desired GNP at full employment during the 1972-80 period, and the development of an input-output model capable of projecting future desired GNP under specific policy assumptions.

goods and services.

An approach to measuring the final demand levels desired by producers and consumers at full employment that accounts for these sector interrelationships was presented in this article. The annual estimates of GNP at full employment reported for the 1958-71 period showed more year-to-year volatility than existing estimates of potential GNP because the measurement approach taken accounts for (1) the interrelationships among the production sectors and (2) the demand for goods and services, as well as producers' desires to utilize their existing capital stock at going wages and prices, if labor is fully employed. The resulting estimates of desired GNP at full employment were shown to more fully explain the inflationary pressures which existed during the 1958-71 period. Future research designed to extend this analysis to the present is under way.

TECHNICAL APPENDIX

The approach taken to estimate desired GNP at full employment involved the development and use of a set of annual quadratic input-output models. A quadratic input-output model, by incorporating econometric estimates of the final demand and primary input supply functions into an input-output model's general equilibrium framework, overcomes a major objection to the Leontief model: perfectly elastic product supply curves and an exogenously determined final demand. The model used in this study is formulated as follows:

(1) Maximize $Z = C'Q + 1/2\, Q'DQ$

subject to:

(2) $SQ \leq 0$

(3) $Q \geq 0$

(4) $X \leq M_X$

(5) $R_\lambda \leq M_\lambda$

where

Z = value of the objective function,

Q = (m + 2n)-element column vector of quantities,

C = (m + 2n)-element column vector of price intercepts for the inverse primary input supply and final demand functions,

D = (m + 2n) × (m + 2n) negative definite or negative semi-definite matrix of slope coefficients in the inverse primary input supply and final demand functions (including cross price effects),

S = (m + n) × (m + 2n) matrix of production function coefficients,

O = (m + 2n)-element column vector of zeros,

X = n-element column vector of total output,

M_X = n-element column vector of sector manufacturing capacities,

R_λ = demand for labor services in the economy, and

M_λ = total available labor services.

Equation 2 represents the fixed proportion production functions in the Leontief formulation, while equation 3 requires a non-negative solution for each sector's output. Finally, equation 4 limits the output of each production sector to its manufacturing capacity, while equation 5 limits total employment in the economy to the "full employment" labor force. Solving equation 1 subject to equations 2 through 5 is equivalent to maximizing total producer and consumer surplus provided the integrability conditions hold and the D matrix is negative definite or negative semi-definite.

Sectoring the Model

The eight-sector model of the U.S. economy developed in this study represents an aggregated version of the 85-sector input-output table published by the U.S. Department of Commerce. The eight production sectors include: (1) agriculture, (2) mining and quarrying, (3) construction, (4) manufacturing, (5) processed food and tobacco, (6) energy, (7) services, and (8) trade and transportation. This aggregated eight-sector table was then used to calculate the technical coefficients in the S matrix in equation 2.

Estimating the D Matrix

The next step in developing a quadratic input-output model is to estimate the slope coefficients for the final demand and primary input supply functions appearing in the D matrix in equation 1. Final demand in an aggregated input-output table includes gross private capital formation, changes in business inventories, government demand (all levels), and net export demand in addition to the traditional consumer demand by the household sector. Given the dominant nature of personal consumption expenditures in total final demand, however, consumer theory should play a large part in conceptualizing the estimating equations. Data aggregated across production sectors also cause difficulties when conceptualizing the final demand for the aggregated sector's product. Having acknowledged these difficulties, the final demand equations for the products emanating from the first seven sectors take the general form:

$$(6)\quad Y_i = b_{i0} + \sum_{j=1}^{n} b_{ij} P_j + \sum_{j=n+1}^{m} b_{ij} Z_{ij} \qquad (i = 1, 2, \ldots, 7)$$

where Y_i is the quantity of final demand for goods and services from the ith sector, P_j is the real price of the good or service produced by the jth sector, and Z_{ij} is the jth exogenous variable hypothesized to affect the final demand for the ith sector's product. The exogenous variables include expected personal disposable income as well as those variables like the exchange rate thought to influence non-household final demand.

The final demand equation for the trade and transportation sector is specified to be a linear function of the final demand for each of the other sector's products except construction and services, which have zero margins. This equation for the jth year takes the form:

$$(7)\quad Y_{8j} = \sum_{i=1}^{6} \xi_{ij} Y_{ij} \qquad (i = 1, 2, 4, 5, 6)$$

in which the ξ_{ij} weight representing the ith sector in the jth year is given by

$$(8)\quad \xi_{ij} = (T_{i,72}/Y_{i,72}) \times (Y_{8,72}/Y_{8,j})$$

where $T_{i,72}$ represents the transportation and trade margin for the products emanating from the ith sector in 1972, $Y_{i,72}$ is the final demand for the ith sector's products (excluding imports) in 1972, $Y_{8,72}$ is the final demand for transportation and trade services in 1972, and $Y_{8,j}$ represents the final demand for transportation and trade services in the jth year if the first term in equation 8 was left unadjusted.

Data on final demand used in estimating equation 10 was obtained from the 85-sector input-output tables published by the U.S. Department of Commerce for 1958, 1961, 1963, 1966, 1967, 1968, 1969, 1970 and 1971. These values were first aggregated up to the eight sectors adopted in this study and then deflated by an appropriate price deflator to arrive at a measure of quantity. Sector 1 (agriculture) includes sectors 1-4 in the 85-sector model; sector 2 (mining and quarrying) includes sectors 5-10; sector 3 (construction) includes sectors 11 and 12; sector 4 (manufacturing) includes sectors 13, 16-30, 32-64, 82, and 83; sector 5 (food processing and tobacco) includes sectors 14 and 15; sector 6 (energy) includes sectors 31 and 68; sector 7 (services) includes sectors 66, 67, 70-79, 81, and 84-87; and sector 8 (transportation and trade) includes sectors 65 and 69. The individual price indices for the products sold by each sector and the GNP price deflator used to express prices in real terms were also obtained from U.S. Department of Commerce publications.

Data and statistical problems necessitated some changes to the final specifications for the estimating equations. Because of the limited number of observations available to estimate the coefficients in equation 6 for each sector and the potential problems caused by multicollinearity among the price variables, the total number of independent variables used in each equation was restricted. Missing years within the data series also precluded the use of lagged endogenous variables in the model.

All equations achieved an F-ratio statistically significant from zero, and all equations have coefficients with the signs suggested by theoretical considerations. Since the coefficients on the exogenous variables in these equations (Z_{ij}) are folded into the intercept term in the objective function of the model, our interest here is in the coefficient estimates associated with P_i. All but three of these coefficients estimates are greater than their corresponding standard errors. Furthermore, all the own price coefficients along the diagonal in this table have the expected negative sign. The signs for the coefficients off the diagonal of course can be either positive or negative (i.e., complements or substitutes). The model developed in this study also contains three primary input supply functions: labor, noncomparable imports, and all other primary inputs.

Estimating the C Vector

Given the slopes of the inverse final demand and primary input supply functions and the observed price-quantity coordinates for these products and inputs, the next step is to substitute this information into the D matrix in equation 1 and then calculate the intercepts for each function. The intercepts in the C vector in equation 1 are given by the point of intersection between the price axis and linear segments with the slopes recorded in the D matrix passing through the equilibrium price-quantity coordinates.

A more detailed explanation of this model is provided by John B. Penson, Jr., Hovav Talpaz, and Henry S. Foster, "Estimation and Validation of Quadratic Input-Output Models," Research Working Paper 81-2, Research Department, Federal Reserve Bank of Kansas City, 1981.

Monitoring Lease-Financing in Agriculture

By Ann Laing Adair, John B. Penson, Jr., and Marvin Duncan

Lease-financing is a common method of acquiring the use of an asset in many sectors of the U.S. economy. The American Association of Equipment Lessors estimates the value of equipment currently under lease in the United States at $100 billion, an increase of 150 per cent from the 1974 estimate of $40 billion. Businesses currently lease such items as construction equipment, office machinery, and medical equipment.

In recent years, agricultural producers have begun viewing financial leases as an alternative method of financing the acquisition of specific types of machinery and equipment such as irrigation equipment, tractors, and harvesting equipment. In fact, some producers are using lease-financing to acquire livestock. Interest in lease-financing is growing partly because of specific advantages not available if debt-financing is used.

A financial lease is defined as a noncancellable contractual commitment for the lessee to make a series of payments to the lessor for the use of an asset, although the lessor retains title to the asset. The length of the lease period of a financial lease usually corresponds to the economic life of that asset. Thus, financial leases differ from operating leases, which are short-term rental agreements covering one production period or less.

Because of the expected growth in lease-financing, analysts should be able to examine the impact of lease-financing on the structure and performance of the farm sector. Specific information pertaining to financial leases should be reflected in the aggregate balance sheet, income statement, and cash flow statement maintained for the farm sector. However, such data currently are not collected at an aggregate level. For example, data on lease-financing do not appear in the aggregate sector financial statements compiled by the U.S. Department of Agriculture.

Lack of data on lease-financing in these sector financial statements overstates the financial position and performance of farm operators and biases many of the standard analytical ratios calculated from these statements to the extent that lease-financing represents a significant source of capital in the farm sector. This lack of data also means that models of the farm sector attempting to reflect the portfolio decisions of producers may suffer from specifica-

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Ann Laing Adair is a research associate with the Federal Reserve Bank of Kansas City, John B. Penson, Jr., is a visiting scholar at the Federal Reserve Bank of Kansas City on leave from Texas A&M University, and Marvin Duncan is an assistant vice president and economist at the Bank.

tion and measurement bias.

The first section of this article gives a brief overview of the factors which influence the decision to lease an asset rather than to purchase it. Next, the specific impacts that exclusion of data on lease-financing have on the farm sector financial statements are discussed. The biases introduced into standard analytical ratios calculated from these financial statements, and the impact a continued lack of data will have upon research, are then identified. Finally, to provide a better understanding of the magnitude of the existing data gaps, the results from a survey of 131 leasing companies are presented. These results indicate that while the current use of lease-financing by agricultural producers is small, lessors expect substantial future growth of financial leases in agriculture. The results of the survey also shed some light on the characteristics of lessors active in agricultural leasing and the types of assets being leased.

FACTORS INFLUENCING THE GROWTH OF LEASE-FINANCING

By using a financial lease, lessees can gain certain advantages that are not available if the asset is debt-financed. Debt-financing usually requires a down payment of at least one-fourth of the total cost of the asset. Lease-financing, on the other hand, is often compared with 100 per cent debt-financing. This comparison is not entirely valid, however, because the annual lease payments must usually be paid at the beginning of each year. A financial lease also allows the sales tax to be spread over the term of the lease rather than being paid in a lump sum at the time of purchase.

The length of a financial lease is also usually longer than the length of a comparable loan. This allows the total cost of the asset to be spread over a longer time period, which generally means the annual lease payments are smaller than the annual loan payments. This advantage is partially offset, however, because the total cost associated with lease-financing is usually higher than the total cost associated with debt-financing.

A lessee may also derive some tax advantages from lease-financing. For example, the lessee may deduct the total annual lease payment from his tax return as a business expense, similar to other business expenses such as fuel and hired labor. Although the lessee cannot deduct depreciation on the equipment, the terms of the lease may permit him to receive all or some portion of the investment tax credit on the asset. Lease-financing may also reduce the lessee's risk exposure by reducing the risk of machinery obsolescence, if a shorter lease period is used. A financial lease can also protect the producer against unexpected increases in interest costs resulting from rising interest rates on variable rate loans.

Lease-financing would not be available to lessees unless it was also advantageous to lessors. Lessors benefit from financial leases because they can shelter business income through the depreciation deduction on the leased asset and—if the lease permits—through the investment tax credit. The actual sale price of the asset at the end of the lease period may be greater than the residual value estimated by the lessor at the initiation of a lease. If so, the lessor may realize a capital gain when selling the asset. In short, lessors can often realize higher rates of return on their equity by providing lease-financing services than they can by making loans to agricultural producers. Thus, because of the potential advantages to both lessees and lessors, lease-financing is expected to grow in the future.[1]

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[1] Further discussion of the relative advantages available to the lessee and lessor from lease-financing, and of the criteria for evaluating whether lease-financing or debt-financing is the better alternative on an individual basis, is presented in a proposed working paper by the authors.

IMPORTANT GAPS IN FARM SECTOR FINANCIAL STATEMENTS

In spite of the potential growth in lease-financing by agricultural producers, data on lease-financing do not appear in the farm sector financial statements compiled by the U.S. Department of Agriculture (USDA). The farm sector financial statements, however, are not the only places from which data on lease-financing have been excluded. Until recently, data on lease-financing were excluded from nonfarm sector financial statements as well. In 1980, the Bureau of Economic Analysis revised its published series on plant and equipment expenditures to include, among other things, expenditures by commercial banks and others for plant and equipment leased to other businesses.[2]

The current USDA statistical series on farm income and the farm sector's balance sheet do not reflect the services provided by, or obligations associated with, lease-financing by agricultural producers. This data gap will bias analyses of the sector's structure and performance based on these financial statements to the extent that lease-financing is used in the farm sector. The financial statements and potential biases related to each are discussed in the following sections.

Gaps in the Balance Sheet

The balance sheet reports information on the structure of the assets and liabilities attributable to farming (Table 1). The current stock of machinery and motor vehicles reflected in the balance sheet, for example, is equal to the stock of machinery and motor vehicles in the previous year, minus capital consumption during the year, plus annual farm expenditures given by survey data on farmers' purchases of machinery and equipment during the year. The farm expenditures survey, however, does not collect information on leased assets. Therefore, the asset category for machinery and motor vehicles excludes leased equipment currently being used in agricultural production.[3]

Nor do financial lease obligations appear in the liabilities section of the balance sheet. Since financial leases are long-term contractual commitments to make a series of payments to the lessor, they should be reported in the balance sheet as liabilities, along with other long-term financial obligations.[4] If financial leases are omitted, the balance sheet would understate the total long-term financial commitments of the farm sector.

The understatement of total liabilities resulting from the exclusion of financial leases also affects financial ratios calculated using information contained in the balance sheet. For example, the debt-to-equity ratio would be understated to the extent that lease-financing is used to acquire depreciable farm assets. Thus,

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[2] As a result of the BEA revisions, reported business investment was 10 per cent higher than previously estimated, up from $254.9 billion to $279.9 billion. U.S. Department of Commerce, Bureau of Economic Analysis, *Survey of Current Business,* Vol. 60:10, October 1980, pp. 24-39.

[3] The lessee should record a financial lease as an asset at an amount equal to the present value of the future lease payments. This value serves as a proxy for the present value of the services provided by the asset over the term of the lease. The rate of interest implicit in the lease agreement should be used to determine the present value. If this rate is not known, the lessee should use the current interest rate on a similar term loan. For further clarification, see: Financial Accounting Standards Board, *Accounting for Leases,* Statement #13 as amended and interpreted through May 1980, Stamford, Connecticut, May 1980.

[4] The discounted future lease payments should be shown as a long-term liability, while the current lease payment should be shown as a current liability. By discounting future lease payments, the lessee is accounting for the income generated by the funds that would have been used if the asset had been purchased rather than leased. For further discussion, see Financial Accounting Standards Board, *Accounting for Leases.*

the farm sector's leverage position and its exposure to financial risk would be understated. Such an understatement would suggest the presence of credit reserves that may not exist.

Gaps in the Income Statement

Omission of data on lease-financing can also affect the financial ratios calculated from the income statement, which displays information

Table 1
BALANCE SHEET OF THE U.S. FARMING SECTOR, SELECTED YEARS

Item	Billions of Dollars in Year: 1970	1975	1980*
ASSETS			
Physical Assets:			
Real estate	215.8	368.5	671.3
Non-real estate			
Livestock†	23.5	24.6	61.2
Machinery and motor vehicles	32.3	55.7	94.3
Crops stored on and off farms‡	10.9	23.3	33.1
Household equipment and furnishings	9.6	14.0	20.5
Financial Assets:			
Deposits and currency	11.9	15.1	15.9
U.S. savings bonds	3.7	4.3	4.0
Investments in cooperatives	7.2	10.5	18.6
Total	314.9	516.0	918.9
CLAIMS			
Liabilities:			
Real estate debt	29.2	46.3	82.1
Non-real estate debt to:			
CCC§	2.7	0.3	4.5
Other reporting institutions//	15.8	29.2	59.0
Nonreporting creditors#	5.3	6.0	11.7
Total liabilities	53.0	81.8	157.3
Proprietors' equities	261.9	434.2	761.6
Total	314.9	516.0	918.9

SOURCE: *Balance Sheet of the Farming Sector,* Agricultural Information Bulletin No. 416, Economic Statistics, and Cooperatives Service, U.S. Department of Agriculture.
*Preliminary.
†Beginning with 1961, horses and mules are excluded.
‡Includes all crops held on farms and crops held off farms as security for CCC loans. On January 1, 1978, the latter totaled $1,827 million.
§Nonrecourse CCC loans secured by crops owned by farmers. These crops are included as assets in this balance sheet.
//Loans of all operating banks, Production Credit Associations, the Farmers Home Administration, and discounts of the Federal Intermediate Credit Banks for agricultural credit corporations and livestock loan companies.
#Loans and credit extended by dealers, merchants, finance companies, individuals, and others.

pertaining to income and expense flows in the farm sector (Table 2). While this income statement currently reflects the obligations associated with leases on farm land, it does not include financial leases on machinery and equipment. But the current financial lease payment should be reported as an expense in the income statement. The omission of current financial lease payments for farm machinery and equipment would understate total farm production expenses and hence overstate net farm income.

These omissions introduce biases into analytical ratios normally calculated using in-

Table 2
U.S. FARM INCOME AND EXPENSES, SELECTED YEARS

Item	Billions of Dollars in Year: 1970	1975	1979
Cash Receipts:			
Marketings of crops	21.0	45.2	62.8
Marketing of livestock and livestock products	29.6	43.1	68.6
Government payments	3.7	0.8	1.4
Other cash income	0.5	1.2	2.1
Nonmoney Income:			
Value of farm products consumed	0.8	1.3	1.5
Rental value of farm dwellings	3.0	5.4	9.1
Net change in inventories	0.0	3.4	4.1
Gross income	58.6	100.4	149.6
Cash Expenses:			
Feed purchased	8.0	12.6	17.0
Livestock purchased	4.3	5.0	12.7
Seed purchase	0.9	2.3	3.4
Fertilizer and lime	2.4	6.4	6.7
Repairs and operation	4.5	7.8	13.7
Hired labor	4.3	6.4	9.2
Interest on non-real estate debt	1.6	3.0	6.6
Miscellaneous	5.0	8.6	14.4
Taxes on farm property	2.6	3.3	4.3
Interest on farm mortgage debt	1.8	3.4	6.3
Net rent to nonoperator landlords	2.1	4.6	5.3
Noncash Expenses:			
Depreciation and capital consumption	6.8	12.6	19.0
Total expenses	44.3	76.0	118.6
Net income from farming	14.3	24.4	31.0

SOURCE: *Economic Indicators of the Farm Sector: Income and Balance Sheet Statistics, 1979,* Statistical Bulletin No. 650, U.S. Department of Agriculture, 1979.

formation from the income statement. For example, an overstatement of net farm income would cause the rate of return on equity capital to be overstated. As a result, the profitability of farm investment—as measured by the rate of return on equity capital—would be overstated in comparison to nonfarm investment alternatives.

Efficiency ratios, which measure how farmers use their resources, are also calculated based on information from the income statement. The turnover ratio, for example, measures the gross farm income generated per dollar of farm business assets controlled by the farmer. To compute the ratio properly, gross farm income should be divided by all farm business assets. Because equipment and machinery acquired by lease-financing are not included in the balance sheet, the turnover ratio is overstated. The magnitude of this bias will depend, of course, upon the current amount of lease-financing in agriculture.

Gaps in the Cash Flow Statement

The exclusion of information on financial lease obligations will also affect the cash flow statement (Table 3). Current financial lease payments should either be subtracted from net cash income or listed separately as a use of funds. This would prevent the current lease payment from being reflected in "personal consumption and other cash uses," which is calculated residually, and which is typically reserved for funds used for nonfarm purposes.

Several of the standard ratios used to analyze this financial statement are listed at the bottom of Table 3. The ratio of total purchased capital to total net cash income, for example, would be understated if current lease payments are not reflected in net cash income. Net cash income divided by total cash uses would also be biased because the current lease payment is omitted from both items. Finally, the ratio of debt outstanding to net cash income would be biased for the same reason. As the importance of lease-financing grows, the biases introduced into these ratios will affect an analyst's assessment of financing outcomes in the farm sector.

Other Considerations

Measures of the productivity of inputs in farming are also affected by the omission of machinery and equipment acquired by lease-financing from the sector's financial statements. The productivity of the farm sector is estimated by dividing the index of farm output by the index of farm inputs. But this ratio is overstated to the extent that producers use assets acquired through financial leases, which are not included in the index of farm inputs. The input shares for capital will also be understated when the ratios of machinery, equipment, and building expenses to gross farm income are calculated from data that exclude assets acquired via lease-financing.

Finally, the lack of data on lease-financing in the farm sector financial statements could hamper future research, including the development of models used in policy analysis. For example, the absence of lease-financing data could bias future investigations of the investment and borrowing behavior of agricultural producers, as well as projections of future capital and credit flows in the farm sector.

SURVEY OF EQUIPMENT LESSORS

Because of the potential importance of lease-financing activity in agriculture, and because of the current sparsity of data on financial leases, a national survey of equipment lessors was conducted by the Federal Reserve Bank of Kansas City. A total of 131 leasing companies were surveyed and asked to indicate (1) the current magnitude of lease-financing by agricultural producers, (2) the expected future growth of lease-financing in this sector, and (3) the

Table 3

CASH SOURCES AND USES OF FUNDS FOR THE U.S. FARM SECTOR, SELECTED YEARS

	1970	1975	1979
		Billions of Dollars	
Cash Sources of Funds*			
1. Net cash income from farm and nonfarm sources	37.6	60.0	87.5
2. Net flow of real estate loans	1.1	4.8	11.3
3. Net flow of non-real estate loans†	1.2	4.2	10.7
4. Total cash sources of funds‡	39.9	69.0	109.5
Cash Uses of Funds:			
5. Purchases of machinery and motor vehicles	4.9	8.7	10.5
6. Capital improvement to real estate assets	2.4	4.7	5.6
7. Other capital purchases§	1.5	1.0	5.5
8. Annual capital formation	8.8	14.4	21.6
9. Purchases of real estate from discounting proprietors	4.1	9.8	13.2
10. Total purchased capital	12.9	24.2	34.8
11. Personal comsumption and other cash uses	27.0	44.8	74.7
12. Total cash uses of funds	39.9	69.0	109.5
Capital Flows:			
13. Total purchased capital	12.9	24.2	34.8
14. Change in inventories	0.0	3.4	4.1
15. Total capital flow	12.9	27.6	38.9
Real Dollar Flows:			
Total net cash income/GNP deflator (1958 = 100)	27.8	32.3	40.2
Personal consumption and other uses/GNP deflator (1958 = 100)	20.0	24.1	34.4
Analytical Ratios:		Per Cent	
Total purchased capital/total net cash income (line 10 ÷ line 1)	34	40	39.8
Total net flow of loans/total purchased capital ((2 + 3) ÷ 10)	18	37	63.2
Total net flow of loans/total capital flow ((2 + 3) ÷ 15)	18	33	56.6
Net flow of real estate loans/total cash uses (2 ÷ 12)	3	7	10.3
Net flow of non-real estate loans/total cash uses (3 ÷ 12)	3	6	9.8
Cash income/total cash uses (1 ÷ 12)	94	87	79.9
Debt outstanding/total net cash income	141	136	179.8

SOURCE: *Agricultural Finance Outlook,* U.S. Department of Agriculture, November 1979.

*Cash sources of funds from sale of real estate to the nonfarm sector are not included due to the lack of data.

†Does not include CCC loans.

‡Gross cash farm operating expenses have been deducted from gross cash farm income.

§Includes net additions to household furnishings, commercial bank deposits and currency, and purchases of breeding livestock. Purchases of breeding livestock are estimated as a percentage of total expenditures for the purchase of livestock. Census data are used to estimate the percentage values.

characteristics of agricultural lessors and the leases offered to farmers.[5] The survey results are discussed in this section, and summary statistics are presented in Table 4.

Net agricultural lease receivables—which represent the total amount of agricultural leases outstanding at a particular time—were $628 million in 1980 for the firms responding to the survey, an increase of 141 per cent over the 1979 level of $261 million. Although the increase in net agricultural lease receivables noted by survey respondents was only about 3 per cent as large as total farm gross capital expenditures in 1979, lease-financing by agricultural producers is expected to increase substantially in the near future. The lessors responding to the survey expect their net agricultural lease receivables to reach $874 million by the end of 1981, and $2.1 billion by the end of 1985. These figures represent increases above 1980 levels of 39 per cent and 234 per cent, respectively (Table 4).

Characteristics of Agricultural Lessors

Lessors involved in agricultural lease-financing generally fall into three categories: (1) captive lessors, (2) independent lessors, and (3) bank lessors.[6] Table 5 summarizes the information obtained in the survey of these three types of lessors.

Captive lessors are wholly owned leasing subsidiaries of agricultural machinery and equipment manufacturers. Financial leases are often used as a marketing device by machinery and equipment manufacturers to increase their market penetration, and as an alternative method of financing equipment during periods of tight credit. Captive lessors currently account for approximately 54 per cent of the total lease-financing by agricultural producers. In 1980, this type of lessor held net agricultural lease receivables of $336 million. Investment in lease-financing by individual captive lessor firms ranged from a low of $80,000 to a high of $133 million. Growth expectations held by these lessors reflect more optimism than those held by other lessors. Captive lessors project their net agricultural lease receivables to reach $579 million by the end of 1981, and $1.4 billion by the end of 1985. These figures represent increases above 1980 levels of 73 and 330 per cent, respectively.

Captive lessors currently lease many types of machinery and equipment. Tractors, harvesting equipment (including combines, forage harvesters, balers, etc.) and other implements (such as plows, grain drills, and cultivators) are the primary types of equipment leased. Leasing of livestock, typically dairy cattle, is another area of considerable involvement by captive lessors. Items not directly used in agricultural production are also leased. Captive lessors, as a whole, have little involvement in lease-financing of livestock equipment (hog confinement faciltities and feedlot buildings and equipment) and grain storage and handling equipment.

The second category, independent lessors,

[5] The survey included leasing companies identified as having an interest in agricultural lease-financing. However, since all lessors involved in lease-financing to agriculture cannot readily be identified, this survey should not be interpreted as a random sample of the total population of agricultural lessors. The survey results likely represent a significant proportion of the total current involvement in agricultural lease-financing, but it would be inappropriate to use these results to calculate the magnitude of biases that currently exist in the financial ratios. Rather, the survey results give an indication of the potential growth in this activity and of the primary types of assets being leased by the responding lessors.

[6] Other companies such as large insurance companies have recently become involved in lease-financing to agriculture. These companies were not included in the survey. Therefore, the results reported based on survey responses understate agricultural lease-financing.

Table 4

CHARACTERISTICS OF THE AGRICULTURAL LEASING INDUSTRY

(Based on Survey Results*)

	Involvement in Leases by All Responding Lessors	Involvement by Any Individual Lessor	
		Minimum	Maximum
Total Net Lease Receivables in 1980 (Millions $)	2459.9	.015	523.2
Net Agricultural Lease Receivables in 1980 (Millions $)	627.7	.015	133.2
Percentage Net Agricultural Lease Receivables are of Total Net Lease Receivables in 1980	25.5%	——†	——
Net Agricultural Lease Receivables in 1979 (Millions $)	260.6	.036	58.1
Percentage Increase in Net Agricultural Lease Receivables From 1979 to 1980	140.9%	——	——

	All Responding Lessors	Minimum	Maximum
Estimated Level of Net Agricultural Lease Receivables (Millions $)			
In 1 Year	874.3	.054	337.1
In 5 Years	2097.8	.057	830.1
Percentage Increase Expected From 1980 in the Value of Net Agricultural Lease Receivables			
In 1 Year	39.3%	——	——
In 5 Years	234.2%	——	——

	Average	Minimum	Maximum
Length of Leases (Years) (Mean Value)	5.6	3.5	7.6
Estimated Residual Value (Per Cent of Original Purchase Price) (Mean Value)	14.2%	5.0%	36.1%

	Percentage of Leases Accounted For by Type of Equipment	Highest Percentage of Total Lease Business by Type of Equipment for an Individual Lessor
Types of Equipment Leased (%)		
Tractors	14.3	85.0
Autos	0.8	31.0
Trucks	4.3	100.0
Irrigation Equipment	26.8	100.0
Grain Storage and Handling Equipment	9.1	80.0
Harvesting Equipment	11.6	100.0
Livestock Buildings and Equipment	5.3	40.0
Livestock	14.4	100.0
Implements and Other Machinery	7.9	100.0
Non-Production Items	5.6	100.0
	100%	

*The figures presented in this table are a summary of survey responses, which are not a randomly distributed sample.
†Not applicable.

Table 5
CHARACTERISTICS OF LESSORS INVOLVED IN AGRICULTURAL LEASE-FINANCING
(Based on Survey Results*)

	Types of Lessors		
	Banks	Captive	Independent
1980			
Total Net Lease Receivables (Millions $)	804.4	1004.2	651.2
1980			
Net Agricultural Lease Receivables (Millions $)	105.3	335.7	186.8
Minimum	.056	.080	.015
Maximum	41.9	133.2	57.5
1979			
Net Agricultural Lease Receivables (Millions $)	56.5	88.1	116.0
Minimum	.036	.416	.186
Maximum	15.7	40.4	58.1
Estimated Level of Net Agricultural Lease Receivables (Millions $)			
In 1 Year	120.9	579.4	174.0
In 5 Years	166.4	1444.1	487.4
Length of Lease (Years) (Mean Value)			
Minimum	4.2	2.8	3.4
Average	6.6	4.5	5.4
Maximum	8.1	7.6	7.2
Estimated Residual Value (Per Cent of Original Purchase Price) (Mean Value)	9.39	24.16	13.97
Percentage of Leases Accounted For by Type of Equipment			
Tractors	5.04	24.69	17.11
Autos	2.13	0.0	0.05
Trucks	2.47	0.25	7.26
Irrigation Equipment	44.17	3.25	23.15
Grain Storage and Handling Equipment	11.78	1.25	10.25
Harvesting Equipment	14.94	19.33	6.05
Livestock Buildings and Equipment	1.30	1.25	10.03
Livestock	0.0	25.00	20.90
Implements and Other Machinery	9.73	12.49	4.60
Non-Production Items	8.61	12.50	0.62
	100%	100%	100%

*The figures presented in this table are a summary of survey responses, which are not a randomly distributed sample.

have as their primary business the leasing of assets. Although most leases made by independent lessors are made directly to lessees, some do participate in lease-financing arrangements with equipment dealers and with banks. In 1980, independent lessors accounted for 30 per cent of the total net agricultural receivables, totalling $187 million. Independent lessors surveyed expect their net agricultural lease receivables to remain about the same in 1981 as they were in 1980. By 1985, however, their agricultural receivables are expected to total $487 million, an increase of 161 per cent over 1980.

Leases of irrigation equipment and livestock currently account for approximately 44 per cent of agricultural leases held by independent lessors. Tractors, grain storage and handling equipment, and livestock equipment comprise the other major categories of equipment leased by these lessors.

A third category is composed of banks and bank-affiliated lessors. Bank lessors currently have the smallest involvement in agricultural lease-financing of the three types of lessors examined, although their involvement has almost doubled since 1979. They held $105 million in net agricultural lease receivables in 1980. Although these lessors anticipate growth in this activity, their estimates are more conservative than those of other lessors. Bank lessors expect net agricultural lease receivables to increase 15 per cent in the next year, and 58 per cent by the end of 1985. This type of lessor usually has a smaller average net agricultural lease receivable value than do the other lessors.

Bank lessors, as a whole, have almost 44 per cent of their leases in irrigation equipment, with harvesting equipment and grain storage and handling equipment also being important. They also lease-finance other implements and non-production items to a greater extent than do the other lessors. However, bank lessors have little involvement in lease-financing of tractors and trucks, and almost no involvement in livestock leasing.

Characteristics of Financial Leases to Agriculture

The terms of a financial lease are important in analyzing the nature of a lessee's liability associated with lease-financing. The length of the lease period is also important in determining the future cash inflow to the lessor.

The leasing firms responding to the survey indicated an average lease period of 5.6 years. The minimum period was 3.5 years, and the maximum period was 7.6 years. Captive lessors appear to structure slightly shorter lease periods than do lessors in general. The average lease period for a captive lessor was 4.5 years, with a minimum length of 2.8 years and a maximum length of 7.6 years. Independent lessors reported an average lease period of 5.4 years, only slightly different from the industry average. The minimum lease period for independent lessors was 3.4 years, and the maximum length was 7.2 years. Both are slightly less than the industry average. Longer lease periods are structured by bank lessors, possibly because the items they lease, such as irrigation equipment, have on average a longer useful life. The average lease period offered by bank lessors was 6.6 years, the minimum was 4.2 years, and the maximum was 8.1 years.

Lessors, at initiation of a financial lease, must estimate what the residual value of the asset leased will be when the lease period expires. Payments are then amortized to cover the cost of the asset, less the estimated residual value. The lessor normally receives the residual value when the asset is sold at the end of the lease period. The actual residual value received for the asset, however, may differ substantially from the lessor's original estimate. In recent years, with rising prices for new and used machinery, the value at the end of the lease

period has usually exceeded the estimated residual value.

Lessors as a whole estimated the residual value of the assets they leased to be approximately 14.2 per cent of their original value. Captive lessors estimate a higher residual value, 24.2 per cent of the asset's original value, although this may be due to the shorter lease periods used by captive lessors. Independent lessors estimate the residual value to be 14.0 per cent of the asset's original value. Finally, bank lessors typically estimate a 9.4 per cent residual value, which reflects in part their somewhat longer lease periods.

SUMMARY

Financial leases are increasingly viewed by agricultural producers as an alternative to debt-financing the acquisition of assets. As the average size of farms increases, producers will require even greater amounts of capital equipment for production. Lease-financing provides the producer with some advantages not available if debt-financing is used. For these and other reasons, lease-financing is expected to continue to grow in the future.

Financial leases are presently not reflected in the financial statements of the farm sector. While lease-financing is shown to be relatively small at present, efforts should be undertaken now to collect information that would enable analysts to monitor the future growth of lease-financing. Without such efforts, the standard financial ratios based upon data from these financial statements could become biased. Research conducted using data from these financial statements would also be affected. The farm sector's financial statements should begin now to account for the services provided by financial leases, and the obligations associated with them, if its financial structure and performance are to be accurately measured.

While the results of the survey reported in this article suggest that the magnitude of lease-financing to agriculture currently is not large, the amount of net agricultural lease receivables reported here understates total involvement in agricultural lease-financing. Furthermore, firms in the industry predict that lease-financing will grow rapidly in the near future. The survey results thus reinforce the importance of beginning efforts now to include information on lease-financing in the financial statements for the farm sector.

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