

CAN TAX REVENUES GO UP WHEN TAX RATES  
GO DOWN?

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## ABSTRACT

When Arthur Laffer and other "supply side advocates" plot the "Laffer Curve," a relationship between tax revenue and a particular tax rate, they draw an upward-sloping segment of the curve called the normal range, followed by a downward-sloping segment called the prohibitive range. The prohibitive range is said to exist because high tax rates stifle economic activity and encourage leisure pursuits. Since a given revenue can be obtained with either of two tax rates, government would act rationally by choosing the lower rate of the normal range.

This paper introduces a new curve which summarizes the combinations of tax rates and the responsiveness of the amount of labor supplied to tax rates that result in maximum revenues, thus separating the "normal area" from the "prohibitive area." Looking at labor tax rates and total revenue, for example, the tax rate that maximizes revenue will depend on the assumed labor supply response to taxes. A general-purpose empirical model of the U.S. economy is used to plot the Laffer curve for several response rates, and to plot the newly introduced curve using the labor tax example. Results indicate that the United States could conceivably be operating in the prohibitive area, but that the tax rate on U.S. labor income and/or labor supply response would have to be much higher than most economists have estimated.

# CAN TAX REVENUES GO UP WHEN TAX RATES GO DOWN?\*

Don Fullerton\*\*

## 1. INTRODUCTION

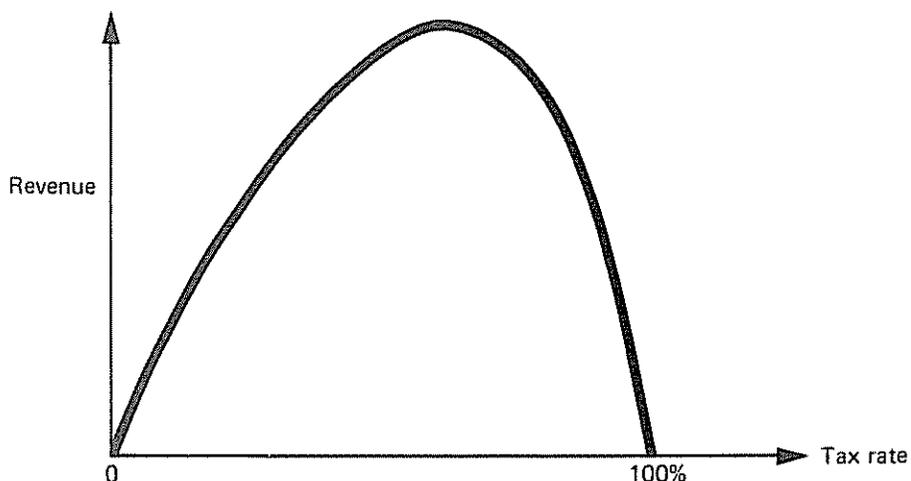
Ever since Arthur B. Laffer first drew his famous curve on a napkin in a Washington restaurant six years ago, there has been considerable public debate about the possibility of an inverse relationship between tax rates and government revenue. As drawn in Figure 1, the curve plots total revenue against the tax rate and indicates that there are two rates at which a given revenue can be collected. The upward sloping portion of the curve is called the "normal" range and the downward sloping segment is the "prohibitive" range. The prohibitive range is said to exist because the high tax rates stifle economic activity, force consumers and businesses to barter, and encourage leisure pursuits. 1/ No rational government would knowingly operate on this range in the long run.

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\* Some results in this paper also appeared in National Bureau of Economic Research (N.B.E.R.) working paper no. 467 in April 1980 entitled "On the Possibility of an Inverse Relationship Between Tax Rates and Government Revenues."

\*\* I am indebted to my colleagues A. Thomas King, John B. Shoven, and John Whalley with whom I developed the general equilibrium model used in this study. I am also grateful to the Treasury Department's Office of Tax Analysis for financial assistance. This revised version of the N.B.E.R. paper incorporates changes suggested by David Bradford, Shantayanan Devarajan, Ronald E. Grieson, Michael Kaufman, James E. Rauch, Harvey Rosen, and Nicholas Stern. I wish to thank Carole Garland of the Office of Tax Policy for coordinating the clerical efforts and assisting with production. I retain full responsibility for errors and for the views expressed.

Figure 1



Debate about the validity of the Laffer curve has been conducted mostly in the spheres of politics and journalism, and has included a wide variety of unsupported claims and opinions. These range all the way from the assertion that the prohibitive range does not exist to Laffer's claim that "we are well within this range at present." 2/ Simple theoretical models can show that the prohibitive range does indeed exist, but the U.S. position on the curve is clearly an empirical matter. Despite the obvious importance of this issue for fiscal policy, there has been no serious estimation of the curve using an economic model. 3/ This paper attempts to correct this deficiency by using a general equilibrium 4/ taxation model to address two

questions. First, what is the position of the United States on the curve today? Second, what is the relationship between the location of the curve itself and critical numbers such as the appropriate factor (production input) supply elasticity? 5/ 6/

The next section offers a brief review of some salient points from the debate. A common aspect of previous studies is that a prohibitive range for some local or non-U.S. economy is always associated with particularly high tax rates, high factor supply elasticities, or both. The third section sets out the conditions under which, in the long run, a lower tax rate could result in higher revenues. These conditions are summarized in a new curve, plotting the appropriate factor supply elasticity against the tax rate. The fourth section describes the general equilibrium model used to simulate the effects of various tax rates. The estimations of these effects are in section five, and both the Laffer curve and the new curve are plotted for an example with a labor tax and labor supply elasticity. Section six provides some evidence on the value of the critical labor supply elasticity, and the last section concludes that to operate in the prohibitive range, the tax rate on labor income and/or the factor supply elasticity must be very high.

## 2. A BRIEF LITERATURE REVIEW

The idea of an inverse relationship between tax rates and revenue is not entirely new. Adam Smith, in The Wealth of Nations (1776) could hardly be more explicit:

High taxes, sometimes by diminishing the consumption of the taxed commodities, and sometimes by encouraging smuggling, frequently afford a smaller revenue to government than what might be drawn from more moderate taxes. (Book V, Chapter II)

The international trade literature, as exemplified by Caves and Jones (1973), has reflected an understanding of the existence of a revenue-maximizing tariff. This pre-Laffer edition contains a hump-shaped tariff revenue curve which looks just like Figure 1. With respect to internal taxes, Jules Dupuit in 1844 states:

By thus gradually increasing the tax it will reach a level at which the yield is at a maximum . . . Beyond, the yield of tax diminishes . . . Lastly a tax [which is prohibitive] will yield nothing.

After the introduction of the Laffer curve (or perhaps the reintroduction of the Smith-Dupuit curve) in 1974, the quality of debate deteriorates significantly. Jude Wanniski (1978) chronicles various fiscal catastrophes from the fall of the Roman Empire to the Great Depression and attributes each of them to some tax hike occurring within a few years in either direction.

At various points in his analysis Wanniski suggests that the peak of the curve is at a 25 percent tax rate (page 260), and that the peak of the curve "is the point at which the electorate desires to be taxed" (page 98). 7/ He states that the welfare maximizing government would operate somewhere on the normal range with the size of its budget determined by standard cost-benefit analysis.

For the opposition, Kiefer (1978) asserts that there is no tax rate for the overall economy which can be measured on the horizontal axis, and that "the Laffer Curve represents a gross simplification of a major portion of macro-economics into a single curved line" (page 15). These arguments are not compelling either in view of the large number of economic models which oversimplify in order to comprehend and convey economic phenomena. Kiefer also reminds us that income and substitution effects tend to be offsetting. For example, though a reduction in his personal income tax rate gives the individual an incentive to work more and consume less leisure, this tax reduction also allows him to work less and consume more leisure while maintaining the same after-tax income. The tendency to work more is the substitution effect and the tendency to work less is the income effect.

Kiefer argues against overemphasis on the supply side, claiming that "by concentrating primarily on incentive and supply-side effects, the Laffer Curve largely ignores the actual

mechanism by which fiscal policy exerts its biggest and most immediate impact--demand side effects." These antagonists appear to be using different models that are not comparable. 8/

Canto, Joines, and Laffer (1978) build a simple equilibrium model with one output, two factors of production, and a labor/leisure choice on the part of consumers. The utility function 9/ of individuals in their model includes the discounted values of consumption and leisure of each future period, 10/ a formulation which is very similar to the larger empirical general equilibrium model used later in this paper. Another similarity is that the capital stock is fixed in any one period, but can grow over time. Labor taxes in these models decrease the net-of-tax wage received by workers. Each individual reacts to this decrease with an income effect and a substitution effect. In their model, however, government revenues are returned to workers through transfers or used to buy goods which are perfect substitutes for private goods. This modelling cancels out the income effect and therefore leaves the economy with a labor supply that unambiguously decreases as the labor tax rate increases.

There are three objections raised by this modelling. The first objection, recognized by these authors, is that if transfers are given to individuals other than those who pay taxes, and if individuals have different preferences for income versus

leisure, then income effects do not necessarily cancel. The second objection is that if a government does nothing other than tax labor and rebate the revenue to the laborers, then overall economic welfare will decrease. Clearly government will make people worse off if it taxes them into working less and then spends the tax revenue on something they could have provided just as well themselves. Thus these authors' model does not account for the inherent efficiency gain that occurs when government corrects market failure by providing a "public good." The benefits of consuming such goods spill over to other individuals who have not paid for them, so that private persons will not buy as much of them as their social benefits would justify. Police protection and street lighting are good examples. Since the private market for such goods does not allocate resources efficiently, government can increase consumer welfare by providing them. Thirdly, it is clear that some public goods like police protection may actually act to encourage private production. The labor taxes that reduce workers' desire to supply labor at a given wage may be spent by the government on public goods that cause producers to willingly increase wages in their attempt to hire more labor and increase output. Therefore, the "balanced budget" labor supply does not have to decrease with labor tax rate increases as these authors insist. Econometric estimates of how it responds will be surveyed in a later section. 11/

In empirical work, Grieson et al (1977) find the possibility of an inverse relationship between tax rates and revenue for local government in New York. "The inclusion of state taxes lost when economic activity leaves both the city and state would . . . raise the possibility of a net revenue loss as a result of an increase in business income taxes." They find that the nonmanufacturing sector has fewer alternatives to the New York City location and should be taxed more heavily relative to the manufacturing sector whose response to tax is more elastic. Grieson (1979) finds the two sectors reversed for Philadelphia, where nonmanufacturing is under greater competitive pressure. Still, "Philadelphia may have been at or very close to the revenue maximizing point . . . before the recent income tax increase, which raises the possibility of it having been in excess of the socially optimal one."

Finally, Charles Stuart (1979) uses a fairly simple two-sector model to find that the current 80 percent marginal tax wedge in Sweden exceeds their revenue-maximizing rate by 10 percent. According to Stuart's analysis, Sweden's high tax rates encourage barter and non-market activity, placing its economy on the prohibitive range.

3. ANOTHER SIMPLE CURVE

A common feature of arguments from both sides of the debate is an implicit or explicit reference to factor supply elasticities. The offsetting income and substitution effects pointed out by Kiefer merely imply that the relevant supply elasticity might be low or negative, i.e., that the relevant factor supply may increase very little or even decrease in response to an increase in the net-of-tax wage. The emphasis on large incentives in the supply-side argument implies a large elasticity. The "open" nature of a local economy, i.e., the fact that labor and capital can move in and out of it more easily than they can move in and out of a national economy, implies a more elastic response to a local tax. Indeed, the entire debate reduces to the empirical matter of the size of the relevant factor supply elasticities. If they are high enough, people would reduce their work effort or investment so much in response to increased taxes that the economy could be on the prohibitive range.

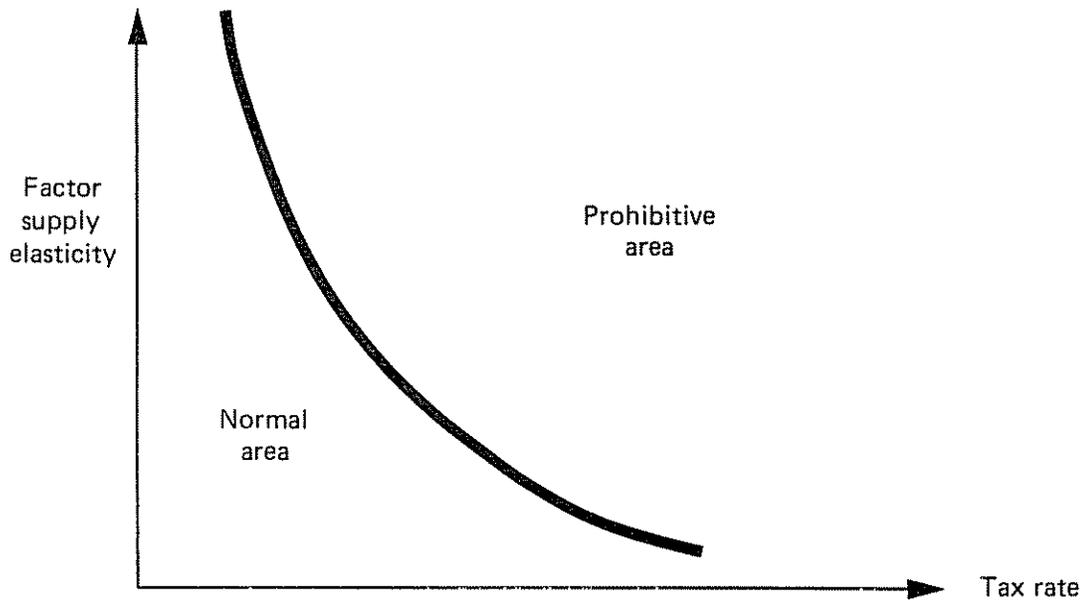
The very location of Laffer's curve in Figure 1 depends on the supply elasticity of the factor being taxed. 12/ If that elasticity were fairly low, the total revenue maximizing point would be at a higher tax rate for that factor, and conversely. One can imagine a third dimension on that diagram giving different elasticity values. If one made the total revenue axis perpendicular to the page, the diagram's hill would be converted

into a mountain range, with the total revenue peaks occurring at points running from a low tax rate and high elasticity combination to a high rate and low elasticity pair. This series of peaks is plotted in Figure 2. Everything to the southwest of that curve signifies the "normal area", where raising rates gain revenue, and northeast of the curve is the "prohibitive area," where no rational government would knowingly operate. Each point on the curve shows the tax rate that maximizes total revenue for a given elasticity. 13/

At an infinite supply elasticity, the owners of a factor such as labor or capital will respond to a tax by refusing to supply it at all. The government cannot acquire additional revenue by taxing that factor, and the maximum total revenue would be obtained elsewhere (a zero tax rate for that factor is best). For a large finite elasticity, the tax rate would have to be very low to remain in the normal range. As this elasticity decreases, higher tax rates will maximize revenues. Finally, at a zero elasticity, factor supply is unaffected, and the only bound on revenue is given by total product of the factor.

From this description, we can place all the advocates on a single spectrum. Those who say we are in the prohibitive area believe that the relevant elasticity and/or tax rate are higher,

Figure 2



those who say we are in the normal area believe they are lower, and those who deny the existence of the inverse relationship must believe that the supply elasticity is zero or negative.

#### 4. THE GENERAL EQUILIBRIUM MODEL

To simulate the effects of different tax rates for a variety of factor supply elasticities, a previously developed general equilibrium taxation model is used. This model is still evolving after several years of work, and it has already been used for other purposes including the evaluation of various tax reform

proposals. However, it was built as a general purpose model, and its features are surprisingly well suited for this application. No adjustments were required to obtain the following estimates. Since more thorough descriptions of the model are available elsewhere, only an outline of its features is presented here. 14/

The model's economy is divided into 19 profit maximizing producing sectors, 15 consumption commodities and 12 consumers differentiated by income class. Each industry has a Cobb-Douglas or Constant Elasticity of Substitution (CES) production function, where the elasticity of substitution between capital and labor 15/ is chosen as a "best-guess" value from evidence in the literature. Each output can be used as an intermediate input. Outputs can be purchased by the government, used for investment, or converted into consumer goods. There is also a simple foreign trade sector, though factors of production cannot move across national boundaries.

Each consumer has initial endowments of labor and capital services which can be sold for use in production. Because of the assumptions of perfect factor mobility and competition, the net-of-tax return to each factor is equal across industries. 16/ A consumer can also choose to withhold some of his labor endowment, consuming leisure instead of working. The capital stock is fixed in any one period, but the dynamic version of the model

allows savings to augment the stock in later periods. The elasticity of substitution between present and future consumption is based on an estimate of the savings elasticity with respect to the net-of-tax of return on savings. This elasticity is used because the after-tax rate of return on savings tells the individual how much extra future consumption he can get by sacrificing present consumption. For this value the 0.4 percent change in savings per 1 percent change in the rate of return as found by Boskin (1978) is used. The elasticity of substitution between consumption and leisure is based on an estimate of the labor supply elasticity with respect to the net-of-tax wage. For this value a 0.15 percent change in labor supply per 1 percent change in the wage is typically used, but relationships for different labor elasticity values will be derived below when the curve in Figure 2 is plotted.

The various Federal, state, and local taxes are typically modelled as tax rates on the value of purchases of appropriate products or factors. Corporate income taxes and property taxes are modelled as taxes on the use of capital that differ by industry because, for example, different proportions of industries are incorporated. Social security, workmen's compensation and unemployment insurance appear as taxes on use of labor. These rates differ by industry partly because different proportions of workers are subject to the social security maximum, but in 1973

they averaged 9.1 percent of gross payments to labor. Personal income taxes operate as different schedules for each consumer group, with tax rates on the last dollar of income earned (so-called marginal tax rates) increasing from an average of 1 percent for the lowest income group to an average of 40 percent for the highest income group.

The numerical coefficients of the model have been estimated for 1973 using data from the National Income and Product Accounts, the Bureau of Labor Statistics' Consumer Expenditure Survey, and the Treasury Department's Merged Tax File. These data are adjusted for known inaccuracies in government data collection procedures, e.g., the fact that depreciation of plant and equipment for tax purposes is different from their economic depreciation, and for general equilibrium consistency requirements.

The model does not include involuntary unemployment or inflation per se. It expresses all prices in relative terms -- there is no money in the model. Voluntary unemployment is captured through the labor/leisure choice, however, and the interaction of inflation with progressive tax rates is simulated by, for example, moving individuals into higher tax brackets. <sup>17/</sup> The model thus concentrates on long-run, microeconomic behavior and is therefore consistent with the models of the supply-side advocates.

There is a potential difference, however. The model used in this paper assumes government transfers are made to consumer groups in proportion to their observed 1973 receipts from social security, unemployment compensation, food stamps, and other welfare programs. Supply-side advocates may believe that these payments reduce the incentives of the people who receive them to work. The degree to which the supply-side advocates are correct depends on the program's ability to isolate important characteristics such as age, disability, and number of dependents which make the recipient unable to work. If the program successfully isolates those characteristics, its payments will have little or no disincentive effect. Our model does in fact treat them as having no disincentive effect. To the extent that larger disincentive effects exist due to transfer payments, higher tax rates should be used in describing the current U.S. economy. 18/

##### 5. ESTIMATION

Supply-side advocates refer to several different types of taxes when they claim that an inverse relationship exists between a particular tax rate and government tax revenue. The curve in Figure 2 could be plotted by varying a product tax rate against the price elasticity of demand for that product, or by plotting capital tax rates against the elasticity of savings with respect to the net-of-tax return to capital. The latter example was

attempted with the empirical model, but no prohibitive area was discovered. 19/ For this reason, the example used here is the labor tax against the labor supply elasticity.

In our model the tax on labor used by industry averages 9.1 percent of gross payments to laborers. The personal income tax takes another 1 percent to 40 percent of marginal (or last dollar at) labor income, depending on the consumer's marginal tax bracket. The total tax rate thus ranges from about 10 percent to over 40 percent of labor income. 20/ One problem with interpreting a general formulation like the Laffer curve is that the tax rate on the horizontal axis in figure 1 may be either average or marginal. The distinction is necessary because marginal rates are more important for incentive effects. If the tax is steeply progressive so that marginal rates are very high, it will take a significantly lower average rate to get onto the prohibitive range than if the tax is not at all progressive. A solution is to vary the industrial labor tax rate of 9.1 percent since this rate is both average and marginal, i.e., it takes 9.1 percent of all labor income and 9.1 percent of the last dollar earned. Variations in this rate alone are reported below, but the reader should remember that the additional personal income tax and other taxes always remain. The tax rates reported are thus understatements of the model's true rate. 21/

Table 1

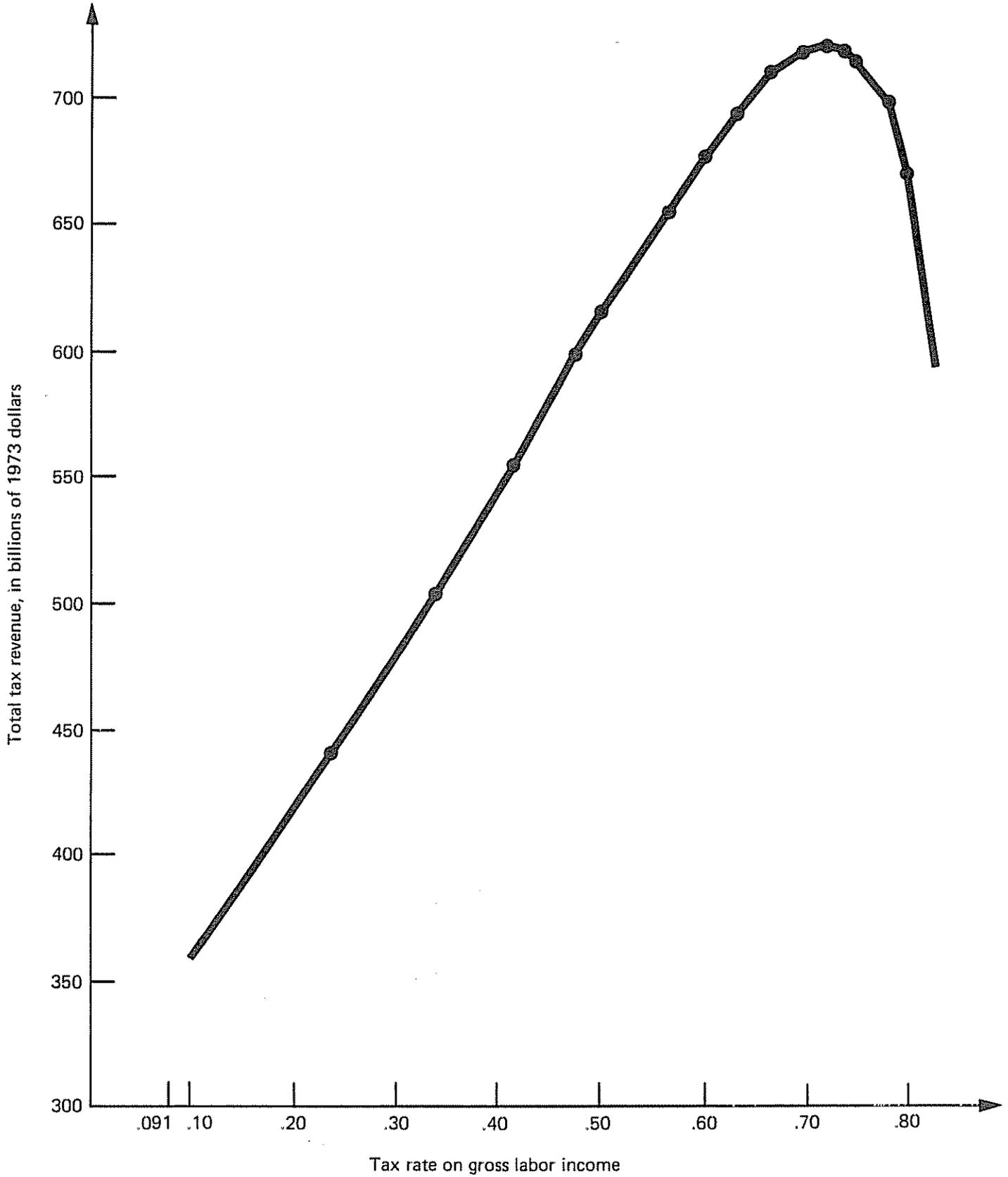
Total Revenue Associated with Each Labor Tax Rate,  
in Billions of 1973 Dollars

Tax Rate on Gross Income	Labor Supply Elasticity with Respect to Net-of-Tax Wage									
	.15	.50	1.00	1.50	1.75	2.00	2.50	3.00	4.00	
-.111										341.79
.000										365.57
.048										365.93
.091	360.00	360.00	360.00	360.00	360.00	360.00	360.00	360.00	360.00	360.00
.130						364.00	361.98	358.23		349.18
.167				369.80	365.17	360.85				
.200				370.82	363.62	356.91				
.231	439.48		391.82	369.60		350.57				295.40
.286			396.49	361.52						
.310			396.60							
.333	503.71		395.43							
.375			389.75							
.412	555.56	474.13	380.36							
.474	597.41	481.65								
.487		481.98								
.500	615.16	481.78	336.60							
.565	657.84	476.01								
.600	678.84									
.630	694.90									
.667	711.16									
.697	719.58									
.706	720.89									
.714	721.53									
.718	721.60									
.722	721.52									
.730	720.92									
.750	715.79									
.778	697.79									
.800	670.19									
.833	593.30									

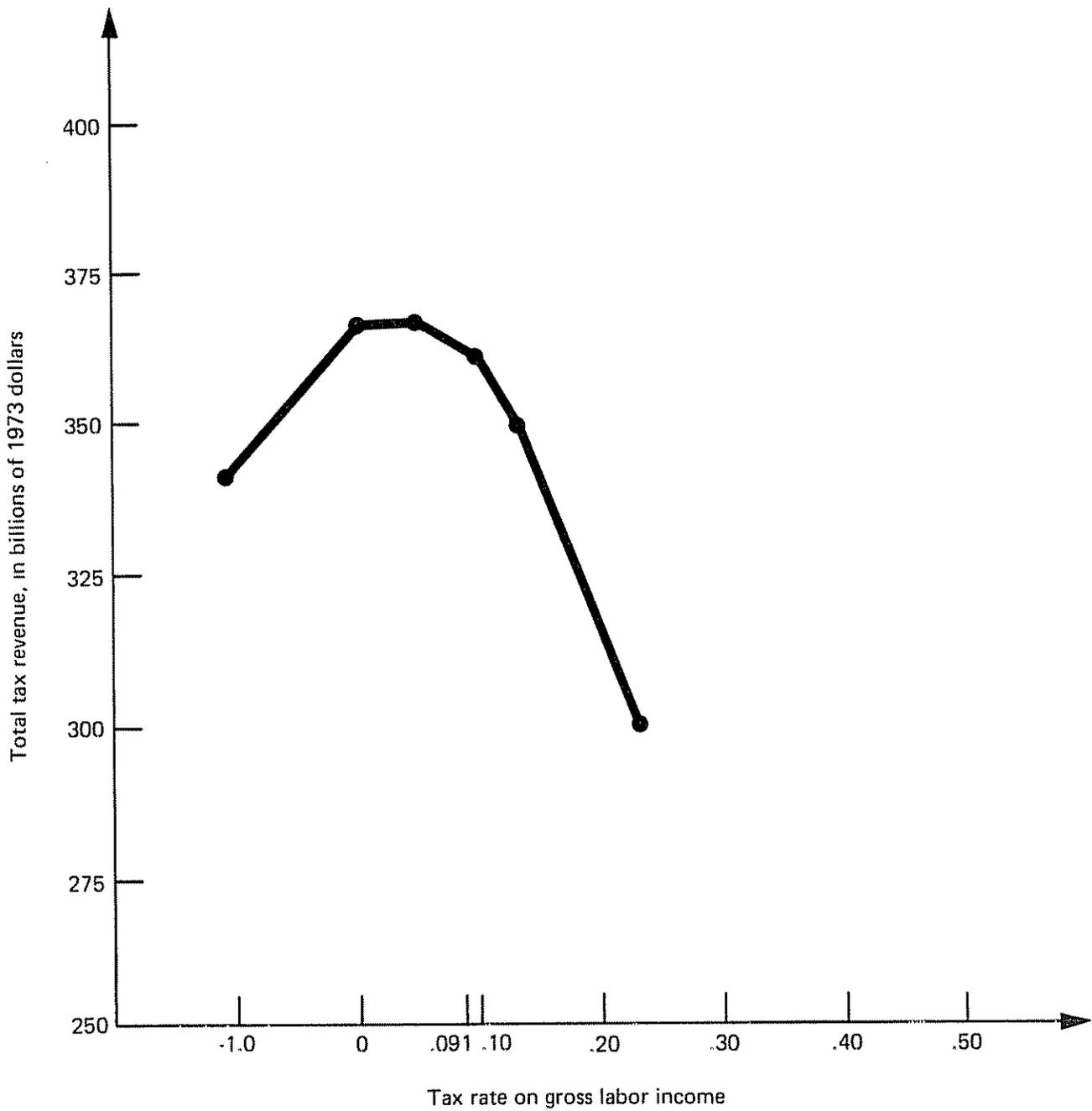
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Simulations were made selectively to save computational expense. Not all possible rates are reported.

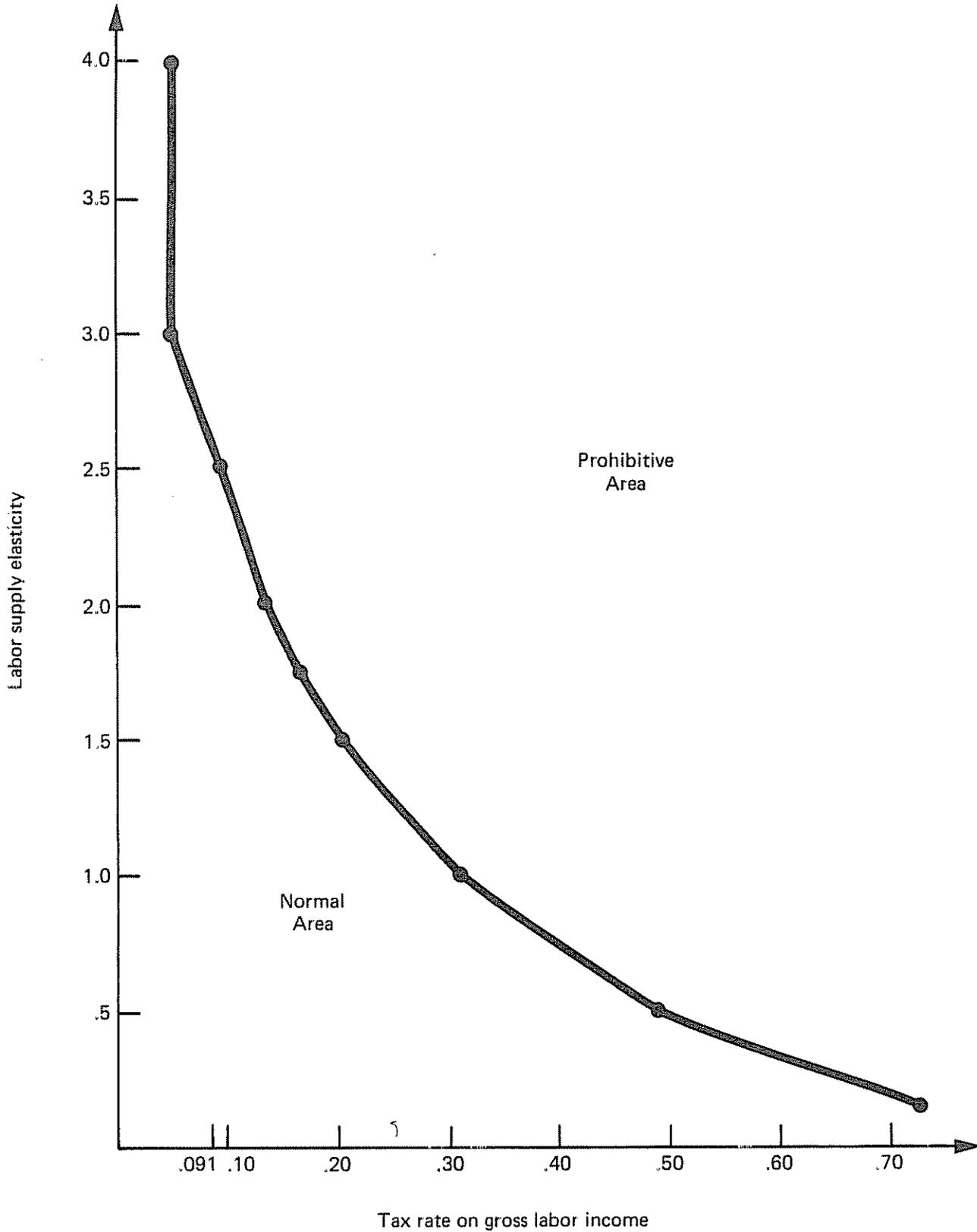
**Figure 3**  
**Laffer Curve with a .15 Labor Elasticity**



**Figure 4**  
**Laffer Curve with a 4.0 Labor Elasticity**



**Figure 5**  
**Elasticity and Tax Rate Combinations**



The consistent 1973 data set, with adjustments described in section 4, shows a total tax revenue of \$360 billion compared to a national income of \$1,252 billion. 22/ These values are replicated in Table 1 for any possible labor supply elasticity, holding tax rates constant. Estimated revenues resulting from labor tax rates other than 9.1 percent will depend on the labor supply elasticity. Revenues in excess of \$360 billion are rebated to consumers in proportion to their original after-tax income. These rebates are necessary because general equilibrium conditions require a balanced government budget, and increases in government purchases would influence the equilibrium solution. 23/

The results from over 60 experiments with different elasticities and tax rates are summarized in Table 1. 24/ The first column shows the total revenue resulting from different labor tax rates using the model's base value of .15 for the labor supply elasticity with respect to the net-of-tax wage. The "observed" total revenue of \$360 billion corresponds to the base tax rate of 9.1 percent, and total revenues increase with tax rates up to a tax which is 71.8 percent of gross labor income. Beyond that rate, revenues start to fall. 25/

Any column of data from Table 1 can be used to plot an example of Figure 1, as is done in Figure 3 for the .15 elasticity. In any of these Laffer curve diagrams, the modelled U.S.

economy is represented by .091 on the labor tax rate axis. If the various tax rate, transfer, and elasticity assumptions employed in this paper are reasonably accurate, then the U.S. economy is well down the normal range of the curve. For those who prefer a high elasticity, Figure 4 plots another Laffer curve. The 4.0 labor supply elasticity and current tax rates place the United States well onto the prohibitive range. 26/

Underlined in each column of Table 1 is the maximum revenue point for that elasticity. These tax rate and elasticity combinations correspond to points on a curve like Figure 2. The curve plotted for this example is shown in Figure 5. On this curve, with the basic tax rate of 9.1 percent (recall that the personal income tax rates of 1 percent to 40 percent have been in effect throughout), the labor supply elasticity would have to be at least 2.5 to put the U.S. economy over the peak and onto the prohibitive range. Alternatively, if the supply elasticity is at least 1.0 percent and the tax rate is at least 30 percent then the U.S. economy would again be operating on the prohibitive range. Figure 5 allows the reader to select a plausible tax rate and elasticity combination to determine whether the United States is now in the prohibitive area.

6. WHAT IS THE TRUE LABOR SUPPLY ELASTICITY?

The basic tax rates, including the .091 labor tax rate, were carefully calculated when the model was developed. However, estimates of the aggregate labor supply elasticity are harder to establish. The econometric literature gives many estimates for population subgroups, since different individuals will typically have different rates of response to a new net-of-tax wage. Finegan's (1962) occupational study found managers, craftsmen, and clerical workers varying from a  $-.29$  to a  $+.42$  percent change in labor supply per 1 percent increase in the net-of-tax wage, while Boskin's (1973) division by sex, race, and age found estimates from  $-.07$  (for prime-age white males) to a  $+1.60$  (for elderly black women). Since taxes generally do not vary with these characteristics, the relevant labor supply elasticity is an aggregate one. Table 2 summarizes a number of econometric studies and is based mostly on discussion in Killingsworth (1976).

There is a certain injustice to these authors in reporting their results in such a summary fashion. Each study has its own measure of the wage, its own data-year or time-period, and its own methods of estimation. The studies differ as to how they account for labor participation rates and as to whether they account for the "balanced budget" effects of government spending

as discussed on page 7. The numbers in Table 2 are only presented to provide the reader with a basis for choosing a plausible aggregate labor supply elasticity. Since few aggregate studies are available, male and female estimates can be roughly combined.

Elasticity estimates for males are mostly small and negative, ranging from  $-.40$  to zero. Borjas and Heckman (1978) review the econometrics of these studies and reduce the bounds to  $-.19$  and  $-.07$ . The estimates for females are more often positive, and can be large in absolute value. Killingsworth finds that females' elasticity estimates are mostly between  $.20$  and  $.90$  in cross-section studies. One can obtain the model's  $.15$  aggregate labor supply elasticity by performing a rough numerical calculation. The Statistical Abstract of the United States shows that the median money income of male employed civilians has consistently been twice that of the females. It also shows about a 1.7 ratio of males to females in the labor force, a ratio which is decreasing with time. In any case, the ratio of male to female income should be at least 3.0. Taking a relatively high male elasticity of  $-.10$  and a relatively high female elasticity of  $+.90$ , the three-to-one weighted average is a  $.15$  aggregate elasticity ( $.75 \times -.10 + .25 \times .90 = .15$ ).

Table 2

Estimates of the Labor Supply Elasticity

Authors	Data subset	Type of data	Range of Estimates
----- For males -----			
Finegan (1962)	Male family heads	Inter-occupational	-.35 to -.25
Rosen (1969)	Male family heads	Inter-industrial	-.30 to -.07
Kalachek-Raines (1970)	Male family heads	U.S. cross-section	+ .05 to +.30
Owen (1971)	Male family heads	U.S. time series	-.24 to -.11
Greenburg-Kosters (1973)	Poor male family heads	U.S. cross-section	-.16 to -.05
Boskin (1973)	Different male subgroups	U.S. cross-section	-.07 to +.18
Hill (173)	Poor male family heads	U.S. cross-section	-.32 to -.07
Ashenfelter-Heckman (1973)	Male family heads	U.S. cross-section	-.15
Fleisher-Parsons-Porter (1973)	Males ages 45-59	U.S. cross-section	-.25 to -.10
Ashenfelter-Heckman (1974)	Married males	U.S. cross-section	Zero
----- For females -----			
Finegan (1962)	Females	Inter-occupational	-.095
Leuthold (1968)	Females	U.S. cross-section	-.067
Kalachek-Raines (1970)	Females	U.S. cross-section	+ .20 to +.90
Boskin (1973)	Different female subgroups	U.S. cross-section	-.04 to +1.60
Ashenfelter-Heckman (1974)	Married females	U.S. cross-section	.87
----- Aggregate -----			
Winston (1966)	Aggregate	International cross-section	-.11 to -.05
Lucas-Rapping (1970)	Short run aggregate	Time-series	1.35 to 1.58
Lucas-Rapping (1970)	Long run aggregate	Time-series	Zero to 1.12

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7. CONCLUSION

This paper investigates a number of analytical and empirical arguments about the relationship between tax rates and government revenues. A general equilibrium tax model was used to examine this relationship. Another curve was developed that shows the combinations of tax rates and factor supply elasticities at which tax revenue is maximized. This new curve indicates that the U.S. economy could conceivably be operating in the "prohibitive range" of tax on labor income, but that labor supply elasticities would have to be very high for this possibility to be realized, or labor taxes would have to be much higher than those calculated in this paper. Available evidence about the value of the labor supply elasticity does not support the view that our government is currently behaving irrationally with respect to that tax.

The model could be applied to find circumstances where the tax rates, for example, on capital income of secondary earners, and the income of welfare recipients are in the prohibitive range. This should be the agenda of future research.

The model may also be used to determine when state and local taxes are in the prohibitive range. McGuire and Rapping (1968, 1970) find labor supply elasticities of 20 to 100 for particular

states or industries. These elasticities imply that one jurisdiction cannot charge higher tax rates than its neighbors, and they are perhaps becoming more and more applicable to nations because factor mobility across national boundaries is itself increasing. These latter considerations do not confirm the existence of a tax on the prohibitive range, but they make one much more plausible.

Finally, though the results of this paper tend to reject the notion of an inverse relationship between major U.S. taxes and government revenues, they do not necessarily invalidate the claim that these taxes should be lowered. Even on the normal range, taxes may be higher than desired by voters. Preferences can change over time, voters may now demand fewer public goods, and they can legitimately request a tax decrease. Though incentive effects can be important even if they do not have perverse effects on revenue, the point is that the "economics of the tax revolt" are less the economics of incentive effects and more the economics of public choice.

FOOTNOTES

1. The tax rate of Figure 1 generally refers to any particular tax instrument, while revenues generally refer to total tax receipts. Thus we must account for the effect of one tax on all other tax bases. An increase in the payroll tax rate, for example, could affect not only its own revenue, but work effort and therefore income tax revenues.
2. Michael Kinsley (1978) correctly claims that there is no logical necessity for revenues to be zero at 100 percent tax rates, due to nonmonetary incentives for work effort, but he incorrectly infers that "there's no logical reason to assume without proof that the Laffer curve ever reverses direction at all." Laffer (1978) points out that there must be some higher rate where economic activity goes to zero. "If every time a person goes to the office he receives a bill from the government instead of receiving a check from his employer, sooner or later even the wealthiest and most highly motivated will stop going to the office. There won't be any earnings, and total government revenue will equal zero. For the sake of argument, imagine the government collects zero revenue at 100 percent tax rates." The quotation in the text is from Laffer's "Statement Prepared for the Joint Economic Committee Hearings on the Macroeconomic Impact of the Administration's National Energy Plan," May 20, 1977, reprinted in Laffer and Seymour (1979).
3. Several papers have described models in which there exists the possibility of a prohibitive range. See Canto, Laffer and Odogwu (1977) and Canto, Joines and Laffer (1978). Other empirical papers have found examples of local governments operating in this range. See Grieson et al (1977) and Ronald E. Grieson (1979). Estimates from DRI, Wharton, and Chase Econometric models are also provided in Kiefer (1978). None of these papers plot out the Laffer curve however, or estimate its relationship to various elasticities. As shown below (page 9), an "open" economy like a local government is more likely to be burdened with a ceiling on revenues.
4. An equilibrium model is one in which there is no excess demand for or excess supply of any consumption good or production input (such as labor) at prevailing prices. For example, involuntary unemployment cannot exist in an equilibrium model because it implies an excess supply of labor (though an equilibrium model could include a minimum wage in which case those people who would be willing to work for a lower wage would be involuntarily unemployed). An equilibrium model is general when it contains all markets, none of which can have excess demand or supply.

5. In general, the location of the curve depends on consumption behavior, production technology, and other circumstances in the economy. In wartime, for example, individuals might be willing to work harder at higher tax rates to generate larger tax revenues. Later sections estimate the curve with a model of the 1973 U.S. economy.
6. The elasticity of factor supply is the percentage change in the quantity of the factor supplied in response to a percentage change in the price of that factor. For example, the elasticity of labor supply is the percentage change in the quantity of labor supplied in response to a one percent change in the net-of-tax wage.
7. Other interesting claims of Wanniski include "if the tax rate is zero . . . production is maximized," (page 97) and "revenues plus production are maximized at [the peak of the curve]" (page 98). Walter Heller (1978) has his own complaints about Wanniski's evidence: "At a time when only a few million Americans paid income taxes and Federal spending was less than 5 percent of GNP (it was 3 percent in 1929), we are asked to believe that federal income tax cuts alone powered the growth of GNP from \$70 billion in 1921 to \$103 billion in 1929." Arthur Laffer, on the other hand, calls Wanniski's book "the best book on economics ever written."
8. Kiefer would seem to have in mind the Keynesian model of an economy suffering from insufficient aggregate demand, resulting in substantial involuntary unemployment of labor and other resources. The Keynesian model is not comparable to the model Laffer and his supporters are using because the former assumes the existence of substantial price inflexibility, while the latter uses an equilibrium model in which prices move to eliminate all excess demands and supplies. Nowadays economists resolve the conflicts between the two types of models by saying that price inflexibility can occur only in the "short run" and must disappear in the "long run," so that Keynesian models are more relevant in the former case and equilibrium models are more relevant in the latter case. For the rest of this paper we implicitly take the long-run point of view.
9. The utility function contains information relevant for determining the satisfaction an individual derives from consumption and leisure.
10. If one receives income  $P$  in the present period, one can invest it at the prevailing interest rate  $r$ , and  $n$  periods later one will have  $P(1+r)^n$ . Income received in the present period is worth  $(1+r)^n$  times the same dollar amount received  $n$  periods later, so the future income must be discounted by  $(1+r)^n$ .

11. These three shortcomings of the Canto, Joines, and Laffer (1978) theoretical model are not explicitly corrected in the empirical model used below, but they are implicitly corrected through the possibility of positive or negative labor supply elasticities.
12. Product taxes such as tariffs are equally relevant. One can convert general product taxes to equivalent taxes on the factors that produce them. One can also consider specific product taxes by plotting them against demand elasticities, thus defining the boundary of the prohibitive area where buying is reduced so much in response to the tax that total tax revenue decreases.
13. This analysis over-simplified by using a given elasticity for all tax rates to find the revenue-maximizing point. As the tax rate varies, so would equilibrium prices, incomes, and preference numbers like the factor supply elasticity. Also the curves in both Figure 1 and Figure 2 are intentionally vague about the particular tax rate and elasticity involved because they have a general significance which requires specific application. Both curves will be estimated for a particular factor tax and factor supply elasticity.
14. See Fullerton, Shoven, and Whalley (1978, 1979) and Fullerton, King, Shoven and Whalley (1980a, 1980b).
15. That is, the percentage change in the ratio of the amount of capital to the amount of labor employed in production that occurs in response to a percentage change in the ratio of the prices of capital and labor.
16. This is true since if any industry paid factors (e.g., labor and capital) less than the others paid, the factors would migrate to other industries, causing them to be scarce in the low-paying industry and forcing it to bid up before-tax factor payments until after-tax returns in the industry were equal to those in other industries. If any industry paid factors more than the others paid, factors would migrate to that industry, causing them to be abundant in the high-paying industry and allowing it to bid down factor payments until after-tax returns in the industry were equal to those in other industries.
17. Effective capital tax rates are calculated by measuring each industry's real use of capital with replacement cost depreciation. The simulated effects of inflation on capital gains account for the largely nominal gains that are subject to tax.

18. The difference between paying people who don't work and paying people not to work is the difference between a lump-sum payment and a marginal payment with incentive effects. Legally, an employee must be laid off to be eligible for unemployment compensation. A worker can ask to be laid off, but employers may be reluctant to circumvent the intent of the law. These transfers are not automatically and fully available to non-workers. Similarly, Aid to Families with Dependent Children (AFDC) payments are designed to select recipients by particular characteristics that minimize disincentive effects. Social security payments are higher for the blind or disabled. Finally, note that these transfers, to the extent that they are disincentives, do not apply to most labor supply decisions. If a person has been working 40 hours per week and decides to work 39 hours instead, he usually does not become eligible for transfers at all. Laffer (1978) states correctly, however, that "if transfer payments included 'means', 'needs', or 'income' tests they too should be included [as disincentives]." Another more thorough study could undertake to measure incentive effects of transfers.
19. Over 40 simulations were performed in seeking a prohibitive area for capital taxes. Using the dynamic version of the model, rates were increased to 83 percent of gross capital income, savings elasticities were increased to 4.0, and equilibria were calculated out to fifty years in the future. There was not a single case discovered where total revenues were less than the revenues associated with a lower tax rate for the same period. Inverse relationships between tax rates and revenues may exist for high effective rates of tax on certain types of real capital income for certain individuals. No overall inverse relationship was discovered in this model, however, because the tax applies to the savings decision, while savings are only an increment to the capital base. More than fifty years would be required for the tax base reduction to offset a tax rate increase and result in lower revenues.
20. The model measures labor income after the industries' factor tax but before the individual's personal income tax. Since the factor tax is 9.1 percent of labor income, and personal tax is another 1 percent to 40 percent of marginal labor income, the tax rate can be expressed as 10 percent to 45.5 percent of labor income gross of all taxes.
21. For those who wanted a higher tax rate to account for the disincentive effect of welfare programs, the personal income tax could roughly compensate for the ignored potential disincentive of the transfer payments.

22. An expanded notion of welfare that includes leisure valued at the net-of-tax wage equals \$1,690 billion.
23. A decrease in revenue is corrected by a similar lump-sum charge on consumers in proportion to their original after-tax income, so that government purchases still remain constant. In this sense, the model is much like Laffer's since a change in the tax rate is accompanied by a positive or negative lump-sum redistribution.
24. These simulations are static in the sense that total amounts of labor and capital are fixed. Labor can be sold to industry or retained for leisure in the simulation, while both factors can be reallocated among industries.
25. The computer model provides much other information about the simulated equilibrium. With the .15 elasticity and 71.8 percent tax rate, labor supply falls off by almost half. The gross-of-tax wage rises, but the net-of-tax wage falls by 40 percent in the new equilibrium. Because labor is made more expensive and leisure cheaper than their social costs, national income falls by more than the increase in the value of leisure. Our expanded notion of welfare thus shows a net loss of \$269 billion in real terms.
26. In the 4.0 elasticity case, even the small jump from a 9.1 percent to 13 percent tax rate causes a 9 percent fall in labor supply and a net welfare loss of \$26 billion in real terms.

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