The Shifty Laffer Curve

ZSOLT BECSI

The author is an economist in the regional section of the Atlanta Fed's research department.

It has been said that the virtue of the Laffer curve is that you can explain it to a congressman in half an hour and he can talk about it for six months.

—Hal Varian, *Intermediate Microeconomics*

WITHOUT TAXES THERE ARE NO GOVERNMENT SERVICES. PEOPLE UNDERSTAND THIS REALITY BUT ALSO PREFER TO GET THE MOST FROM THEIR GOVERNMENTS AT THE LEAST COST. IN THE UNITED STATES, ANY NUMBER OF POLITICIANS AT THE LOCAL, STATE, AND FEDERAL LEVELS OWE THEIR SUCCESS TO EMPHASIZING TAX CUTTING.

According to logic, this voter response means that people are opting for fewer government services across-the-board or are voting for changes in the mix of services rendered. It is at this point that things become complicated because what happens to expenditures influences how much revenue a government needs to collect. In other words, tax policy cannot be made in isolation from expenditure policy because the mix of expenditures affects economic activity and thus the revenue yield from tax policy.

To understand the impacts of tax policy, one needs to know what determines tax revenues. A good place to start is with what is popularly known as the Laffer curve, which shows how tax rates and tax revenues are related.[1] Essentially, the Laffer curve posits that as tax rates rise continuously from zero, tax revenues rise up to some maximum after which tax revenues fall. This curve became famous early in the 1980s when supply-side theorists argued that lower tax rates would mean higher revenues because existing rates were too high to maximize tax revenues—that is, tax rates were so high that fewer taxed goods were being produced and the overall effect was lower tax revenues. While conceptually simple, the Laffer curve came under increasing scrutiny after tax cuts based on supply-side arguments apparently failed to "deliver the goods." Tax rates fell but tax revenues did not rise accordingly, and the United States resorted to deficit spending. In part, the expected outcome did not occur because there are important theoretical limitations that produce the deceptive simplicity of the Laffer curve. This article examines the macroeconomic and conceptual issues that may have made a difference.[2] Understanding these considerations may shed more light on why the 1980s supply-side experiment did not produce the desired results. It should also help frame future budget discussions.

Because most analyses of the Laffer curve occur in a static framework that has proved inadequate, this analysis presents a simple dynamic model that resembles the discussion in Baxter and King (1995). This framework is useful for analyzing the long-run effects of tax policies.[3] In addition, the model can easily be extended to analyze the disposition of government revenues and the consequent effects on national income. It turns out that how the government spends its tax revenues—on consumption, investment, or transfers—is important for understanding the Laffer curve. In fact, a different Laffer curve is associated with the different ways revenues are spent, and it is important to know which curve one is operating on when designing tax policies. Otherwise, one might be riding the wrong curve, so to speak, and thus miscalculating revenue effects.

Background

Perhaps one of the first things one learns in studying the economics of taxation is that taxes alter equilibrium prices and quantities of taxed goods. A tax on any good x introduces a tax wedge between the price demanders pay and the price suppliers receive. Thus, the equilibrium quantity of good x will fall unless demand or supply is perfectly inelastic. When the tax rate is adjusted upward, tax revenues will rise as long as the percentage rise in the tax rate exceeds the percentage fall in quantity. However, as one lets the tax rate rise at a given percentage rate, the quantity of x falls, implying that the percentage change of quantity will rise. At some point the percentage fall in quantity dominates the percentage rise in tax rates so that further tax rate increases cause tax revenues to fall. At the point at which tax revenues begin to fall, tax revenues are at a maximum.[4] This revenue-maximizing point is a sort of Holy Grail for policymakers interested in defending the impact of various budgetary reforms.

Tax policy cannot be made in isolation from expenditure policy because the mix of expenditures affects economic activity and thus the revenue yield from tax policy.

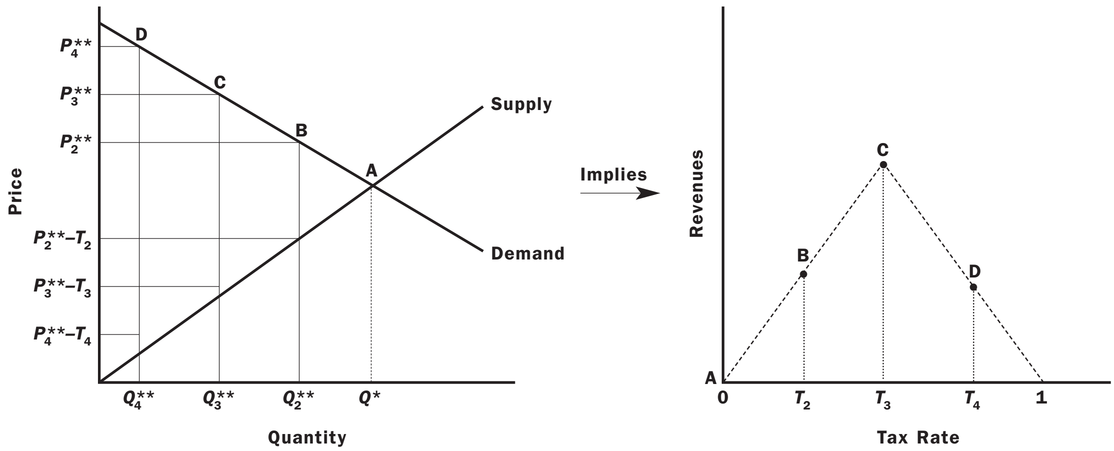
One can easily see these points in a simple demand-and-supply graph (see Chart 1). The intersection of supply and demand gives the before-tax equilibrium quantity, Q^*, and price, P^*. Introducing a tax drives a wedge between the price demanders pay and the price suppliers receive. Thus, a tax causes equilibrium quantity to fall to Q^{**} and the before-tax price to rise to P^{**}. The after-tax price is the before-tax unit price after taxes have been subtracted, or $P^{**} - T$. At Q^{**} the amount of tax revenues collected is given by the rectangle $Q^{**} \times T$. As can be easily verified by comparing rectangles for different tax rates, tax revenues first rise as tax rates are raised from small levels because the tax rate effect on revenues tends to dominate. But after a while tax revenues start to shrink because the quantity effect dominates the tax rate effect.

The rate at which the revenue-maximizing point occurs determines whether tax rates for a given product should be raised or lowered from current levels. The answer depends in part on the relative demand-and-supply elasticities, or how sensitive quantity demanded or supplied is to price changes. Generally, the more inelastic and the steeper the curves are, the higher the revenue-maximizing tax rate is. This relationship holds because the percentage reduction in quantities tends to be small and less likely to dominate a given tax rate change than if curves were more elastic. This pattern can be easily verified by drawing steeper demand or supply curves in Chart 1 and comparing rectangles for a given tax rate. As a rule, demand or supply curves tend to be more inelastic the more broadly the tax is defined or the fewer substitution possibilities there are (either on the supply or demand side). For example, the revenue-maximizing tax rate on chocolate bars will tend to be lower than the revenue-maximizing tax rate on food, both of which in turn are likely to be lower than the revenue-maximizing rate on cigarettes. Similarly, the revenue-maximizing state sales tax rate should be lower than for federal sales taxes given that people can avoid state taxes by moving.

The theoretical Laffer experiment deals only with the effects on revenues from changing tax rates. However, in the real world tax rates are usually not changed in isolation. What the government does with the revenues it receives will also determine where revenues are maximized. So far it has been assumed that the government did nothing with its revenues so that expenditures had no effects. This scenario is essentially like assuming that the government wastes its revenues, no better than throwing them into the ocean. If instead tax revenues were returned lump-sum to taxpayers, or in a way that would not affect taxpayers' behavior, the negative wealth effects of the tax would be offset. This approach would increase tax revenues relative to throwing the money away. However, because the taxed activity has become more expensive relative to untaxed activities, a substitution effect remains whereby the quantity of the taxed activity falls relative to all other activities.

But what if the government actively spends its revenues, as it invariably does? If the government uses revenues to buy more of the taxed good, it will increase the demand for the good. This move will tend to offset the decline in quantity caused by the tax increase, and both tax revenues and the revenue-maximizing tax rate will tend to rise. Finally, if the revenues are used to add to the public capital stock,

CHART 1 Derivation of Laffer Curve



the supply of good x may increase and, again, the quantity decline will be offset and the revenue-maximizing tax will tend to be higher.[5]

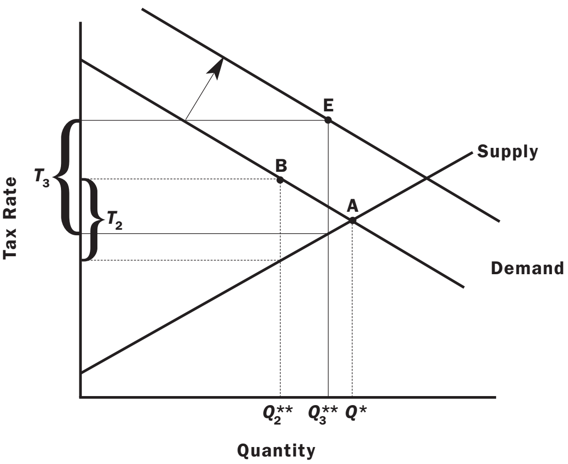
Graphically, when revenues are used by the government to increase demand, an outward shift occurs at the same time the tax is imposed. As seen in Chart 2, the shift in demand counteracts the quantity reduction when taxes are raised in isolation. Thus, equilibrium quantity falls by a lesser amount than before. Also, as can be seen by comparing revenue rectangles, tax revenues rise by a larger amount than if no taxes are raised. This observation suggests that the revenue-maximizing tax rate under a balanced-budget policy is higher than if expenditures do not keep pace with tax revenues.[6] Alternatively, when revenues are used to increase the supply of the good, the supply curve shifts to the right instead of the demand curve. However, the qualitative result is the same.

Fullerton (1982) summarizes the Laffer curve literature. For the most part, this literature was comfortable with the assumption that tax revenues adjust smoothly to tax rate changes.[7] Strong assumptions about the shape of individual preferences and firm-production functions were employed by theorists and empiricists alike. This literature also tended to use mostly static frameworks. Thus, the focus of the research was to empirically investigate the shape of the Laffer curve and determine where current tax rates were on this curve. The majority of the papers found that for U.S. income taxes, tax rates were on the upward-sloping portion of the Laffer curve. Thus, it was assumed, a reduction of income tax rates would lower tax revenues.

With Malcomson (1986), studies began probing the strong assumptions leading to a simple Laffer curve using static general equilibrium models.[8] Guesnerie and Jerison (1991) show for general demand functions and technologies that Laffer curves can have many shapes. Their argument is consistent with the idea that when the Laffer curve exhibits several peaks, moving to one peak may not maximize revenues

1. The idea behind the Laffer curve has been around for a long time, as long as 200 years by some accounts. See Fullerton (1982) and Blinder (1981) for historical references.
2. There are also empirical limitations, but the focus of the article is on the macro and conceptual issues.
3. The model is also simple enough to allow an explicit solution. It is related to simple models found in Becsi (1993) and Koenig and Huffman (1998). While supply-side arguments for lowering tax rates rely heavily on the growth effects of fiscal policies, the model can easily be extended along the lines of Ireland (1994).
4. The existence of a revenue-maximizing point can be proved using elementary calculus. All that is needed is the assumption that tax revenues are a continuous and differentiable function of tax rates. Also, tax revenues must be zero when tax rates are zero or when tax rates are at some very high rate. With these assumptions, Rolle's Theorem states that there exists a tax rate such that tax revenues are maximized.
5. Of course, raising public capital may also affect demand inasmuch as it affects the utility derived from good x. Symmetrically, public consumption may affect the supply side. Thus, public consumption and investment will be treated symmetrically in utility and production in this article.
6. In the case of very high tax rates, where higher rates in isolation mean lower revenues, a balanced-budget approach might cause an offset to the reduction in tax revenues.
7. In other words, the mathematical assumptions of Rolle's Theorem (see Blinder 1981) were respected.
8. See also Malcomson (1988), who shows that the tax function could be discontinuous at some tax rates.

CHART 2
Tax Revenues with and without Government Spending



globally unless it is the highest one. Finally, Gahvari (1989) shows that how the budget is balanced when tax rates are changed will affect the shape of the Laffer curve. In particular, a lump-sum transfer leads to a normally shaped Laffer curve while government consumption may eliminate the downward-sloping portion. Essentially, the positive effects on production of an increase of government spending may dominate the contractionary quantity effects of rising tax rates. If the expansionary effects are strong enough, an increase in tax rates will always be associated with an increase in total revenues. This article elaborates on this last view.

Description of the Model

This section develops a simple dynamic macroeconomic model consisting of household, production, and government sectors. To study the long-run effects of taxes, attention is turned to the steady-state equilibrium of the model where all variables are constant through time. Despite its simplicity, the model is a useful starting point for analyzing the steady-state effects of various fiscal policies. In particular, it allows one to explore the Laffer curve in a long-run context and also illustrates how the Laffer curve depends on the disposition of tax revenues.

To start the analysis of how public expenditures affect household and firm decisions, it is useful to look at broad measures of consumption and output. First, composite consumption is defined as private consumption, c, plus the services derived from public consumption, c^g, and public capital, k^g.[9] In short, composite consumption, x, is given by

$$x \equiv c + \mu_c c^g + \mu_k k^g.$$

This formulation says that as the μ_i parameters rise, public services substitute more closely for a unit of private consumption. Similarly, total output is defined as the sum of private output produced for profit, y, and output produced as a direct by-product of government activities:

$$y + A_c c^g + A_k k^g.$$

This formulation says that a unit of government expenditures will increase total output by A_i. In other words, A_c is the marginal product of public consumption, and A_k is the marginal product of public capital. While this specification is very simple, it has the drawback that private and public output are substitutes.

It is assumed that households would like to maximize composite consumption and leisure obtained in each period of their lives.[10] However, they are constrained by their budgets. In other words, purchases of consumption goods and savings can never exceed after-tax earnings from working and past savings. The solution of this problem leads to well-known optimality conditions for constrained utility maximization: the marginal rate of substitution (*MRS*), which equals the ratio of the marginal utilities of two goods, is equated to the price ratio of the two goods. In other words, the *MRS* is the rate at which the individual is willing to sacrifice one good in return for another to keep lifetime utility constant. The price ratio is the rate at which the two goods can be substituted and still satisfy the budget constraint. The difference between the *MRS* and the price ratio is that the former is determined by individuals' tastes and the later is determined by the marketplace. Optimality means simply that tastes and market realities are in harmony.[11]

Optimality forces households to adjust consumption and labor until the marginal rate of substitution of composite consumption and leisure is equal to the after-tax wage rate:

$$MRSh = (1 - t_y)w, \tag{1}$$

where h is the fraction of time a person spends working. Alternatively, $1 - h$ is the fraction of time devoted to leisure. To understand this equation, consider what happens when an individual works more. Suppose the increase in work time is Δh. In this case utility will fall with the reduction in leisure time unless consumption rises sufficiently. Consumption must rise by $MRSh \times \Delta h$ to keep utility constant. Thus, $MRSh$ gives the desired increase in consumption for a unit increase of labor (or unit loss of leisure). Alternatively, the budget constraint indicates that if labor rises by Δh, after-tax labor earnings will rise by $(1 - t_y)w\Delta h$ units. Thus, consumption can rise only as much as labor income.

To see that individuals will adjust their consumption and labor until the *MRS* equals the price ratio, suppose that the *MRS* is smaller than the price ratio. In this case, a given reduction of leisure will be rewarded with more consumption (from additional wages) than individuals require to keep utility constant. Thus, they will work more because overall utility rises when work effort and consumption are increased. As labor and consumption are increased, the *MRS* rises because leisure is scarcer and further sacrifice requires more consumption in order to keep utility constant. Finally, the *MRS* will rise until condition (1) is satisfied.

Households adjust consumption and savings across time until the *MRS* of consumption in adjacent periods equals the after-tax interest rate:

$$MRSx = r(1 - t_y). \tag{2}$$

The logic behind this condition is similar to that of condition (1). When current consumption is reduced by Δx, the next period's consumption must rise by $-MRSx \times \Delta x$ to keep utility constant. In steady state, the $MRSx$ reflects an individual's impatience to consume early. An impatient household requires a higher return for a sacrifice of current consumption. From the budget constraint, decreasing current consumption by Δx allows the household to increase savings by $\Delta k = -\Delta x$. An increase in savings will cause next period's earnings to rise by $r(1 - t_y)\Delta k$, which is the increase in capital earnings from additional savings. Thus, the price ratio in equation (2) measures how much additional future consumption one can have if current consumption is reduced by one unit. If condition (2) does not hold with equality, then households will adjust their savings. For instance, if the *MRS* exceeds the price ratio, then the individual requires more future consumption to keep utility constant for the unit sacrifice of current consumption than the budget constraint allows. Thus, current consumption will be raised relative to future consumption.

In the production sector firms use labor and private capital to produce their output. Competitive firms vary their labor and capital mix until profits are maximized. Profit maximization by the firm implies that the firm adjusts inputs until its marginal products equal its factor costs. These conditions can be succinctly represented with a small amount of notation. The marginal product of labor is denoted *MPh* and is the additional output from varying labor by one unit. Similarly, *MPk* is the marginal product of physical capital. Also, the unit cost of labor is the wage rate, w, and the cost of capital is the rental rate, r. With this notation, firms maximize profits when

$$MPh = w \tag{3}$$

and

$$MPk = r. \tag{4}$$

Intuitively, when the firm is in a situation in which the marginal product of an input exceeds the unit cost of the input, profits can be raised by hiring more of the input in question. As more of the input is employed, the marginal product tends to fall because of diminishing returns. Hiring of the input will proceed until the marginal products again equal marginal costs.

Finally, the public sector pursues a balanced-budget strategy and purchases consumption and investment goods and makes lump-sum transfers, l^g, from the proceeds of its income tax collections. The government's budget constraint is described by

$$c^g + k^g + l^g = t_y(wh + rk), \tag{5}$$

where the right-hand side of the equation depicts the source of tax revenues from labor and capital income and the left-hand side shows uses of funds.

9. The public good aspects of public consumption such as spending on health care, housing, education and defense will affect individual utility. Some of these expenditures will be closer substitutes for private spending than others. The services from public capital such as highways and streets, educational structures, and public utilities could also enter private utility.
10. Literally, it is assumed that lifetimes are infinite, an assumption that can be viewed as a useful abstraction of long lives. In addition, technically oriented readers will find it useful to know that the model assumes that lifetime preferences are intertemporally separable and that preferences over consumption and leisure are logarithmic. Furthermore, production is Cobb-Douglas (see the appendix), and capital depreciates fully in each period. As is well known, these popular assumptions yield an explicit solution and can be a useful starting point for dynamic analyses. However, it must be noted that the strong assumptions on the form of the utility and production functions may limit the shape of the associated Laffer curves.
11. Again note that long-run optimality conditions are derived by assuming that a steady state exists. A household is in steady state when asset holdings do not change across time; thus, consumption, labor, and savings are time invariant and time subscripts can be dropped.

All markets are assumed to equilibrate in all periods. Thus, aggregate demand equals aggregate supply, or

$$c + k + c^g + k^g = y + A_c c^g + A_k k^g. \qquad (6)$$

Here total output supplied by firms is given on the right-hand side. The left-hand side shows private and government demand. This equation is just another way of writing the gross domestic product (GDP) identity with the government sector broken out.

Description of Steady-State Equilibrium

The six equations introduced above are enough to describe a simple economy in steady state and deduce the effects of income taxes and the effects of public spending.[12] Equations (2) and (4) together determine the marginal product of private capital and also the private capital-labor ratio. Thus, raising the income tax rate reduces the after-tax marginal product of private capital below its equilibrium level. To restore the steady-state marginal product of capital, the firms cut back on capital, thus causing the capital-labor ratio to rise and the productivity of capital to rise. While the income tax has a large effect on the productivity of capital, government consumption and investment do not have any effect. The effect of these variables on the model economy is through the GDP identity, which is considered next.

The Laffer curve became famous early in the 1980s when supply-side theorists argued that lower tax rates would mean higher revenues because existing rates were too high to maximize tax revenues.

Once the productivity of capital is determined, equation (6) determines the share of output that goes to consumption. Thus, anything that enhances the productivity of capital will raise the consumption-output ratio. Furthermore, an increase in the fraction of output devoted to public consumption or public investment will lower the fraction of output that goes to consumption. However, care must be taken to distinguish between demand and supply effects of government spending. If the marginal product from public input is zero so that there are no supply effects, then crowding out of consumption is one-for-one. To include supply effects one must also keep track of the productivity of government spending. If the marginal product of public services is greater than zero, the share of consumption remaining for output will fall by less than one-for-one. Because it is likely that the marginal product for public capital exceeds the marginal product of public consumption, public consumption will have a greater crowding-out effect than public capital.

Given the consumption-output ratio, equations (1) and (3) pinpoint the steady-state level of labor. The focus is on three ways that labor in this economy is altered. First, anything that causes the consumption-output ratio to rise raises *MRSh* in equation (1). Because *MRSh* exceeds the price ratio, individuals adjust consumption and leisure to reduce *MRSh* and bring equation (1) back to equality. As discussed previously, households work and consume less and increase the time devoted to leisure. Second, given the ratio of consumption to output, a rise in the income tax rate lowers the after-tax marginal product of labor in equation (3). To restore the equilibrium marginal product, work effort must fall because of diminishing returns. At the same time, this falling work effort lowers *MRSh* in equation (1) until households are happy with a lower after-tax marginal product of labor. Finally, given the consumption-output share, increasing the output share of public consumption or capital tends to raise *MRSh*. This effect induces households to substitute away from consumption toward leisure and to reduce aggregate labor. However, the substitution effect on labor is offset more when there is a greater decline in the consumption share.

So far, the equilibrium capital-labor ratio (or productivity of private capital), the equilibrium level of labor, and the consumption-output ratio have been determined. Because private output is produced with private capital and labor, it is easy to find, given that equilibrium labor and capital and the form of aggregate production are known. Qualitatively, output changes will reflect input changes, and the effects of the various policy changes on output will be traced out below. It is also possible to calculate the effect on consumption and capital of a policy change because it is known how the consumption-output ratio and the capital-output ratio (or productivity of private capital) respond as well as how output responds. Finally, it should be noted that although the productivity of capital is not observed, the real (inflation-adjusted) interest rate, which in equilibrium reflects the marginal product of capital, is observed.

Theoretical Effects of Balanced-Budget Income Tax Changes

As discussed above, a simple income tax will cause private inputs to fall. Increasing the income tax causes the ratio of private capital to private output to fall and the private capital-labor ratio to rise because it lowers the after-tax marginal product of private capital. Because the marginal product of labor is also lowered and the capital-labor ratio has already been determined, labor must fall. Thus, output and the private capital stock fall in the long run. Because the productivity of private capital falls, the consumption-output ratio rises. The total effect on consumption seems uncertain because the share of consumption rises at the same time private output falls. Normally, these two factors combine to raise consumption (at the expense of savings and output). Finally, notice that tax revenues rise or fall depending on whether output falls proportionately less than the tax rate rises.

To keep its budget balanced, the government has to do something with the revenue change. Thus, the effects of different expenditure strategies must be weighed against the effects of the tax rate changes. A lump-sum transfer or tax has only wealth effects and does not affect the long-run equilibrium at the margin. On the other hand, increasing public consumption or capital will affect the steady state of the economy much as it was shown to do in the simple demand-and-supply analysis at the outset of this paper.

Suppose public consumption adjusts with income tax rates to balance the budget. While the capital-output ratio is unaffected because the after-tax marginal product of capital is unchanged, the consumption-output ratio falls since fewer resources are left over. The share of consumption falls less than one-for-one if the marginal product of the government expenditures is positive.[13] It can be shown that the increase in the share of public services and the fall of the consumption-output ratio together cause the marginal rate of substitution of leisure and consumption to fall below the market wage. Bringing the marginal rate of substitution back into equilibrium requires increasing consumption, but doing so is only possible by working more. However, since more labor implies that the productivity of capital rises, private capital rises to keep the capital-labor ratio constant. The rise in private inputs increases income tax revenues and raises private (and total) output. Thus, an income tax with budget-balancing public consumption causes a smaller reduction in GDP than if expenditures did not change.

How do the effects of public consumption differ from the effects of public investment? The difference depends on the relative marginal products of consumption and investment and on their relative substitutability with private consumption. It seems reasonable that the marginal product of public capital is greater than the marginal product of public consumption. Assume that $A_c < A_k$ and for simplicity that $\mu_c = \mu_k$, and let the share of public consumption and the share of public investment increase equally. In this case, the consumption-output ratio is crowded out to a greater extent by a rise in the share of public consumption than by public investment. This relationship exists because increasing public capital raises total production more, leaving more resources for consumption. However, since the consumption-output ratio falls more with public consumption, the marginal utility of consumption rises more. Thus, to reequilibrate the optimal marginal rate of substitution, households increase their work effort more with public consumption than with public investment. Thus, private capital, labor, output, and consumption rise more when public consumption is increased than when the share of public capital rises by an equal amount. In essence, since increasing the share of public capital causes total output to increase more, private inputs (and output) are required to rise less than with an equal increase in the share of public consumption. Since factor incomes rise less with an increase in public investment than with an increase in public consumption, tax revenues rise less, too.

A different Laffer curve is associated with the different ways revenues are spent, and it is important to know which curve one is operating on when designing tax policies.

Just as reasonable is the supposition that public consumption is a closer substitute for private consumption than for public investment. Assume that $\mu_c > \mu_k$ and for simplicity that $A_c = A_k$. Thus, increasing the share of public consumption or investment reduces the share of consumption equally. However, the marginal utility of consumption rises by a greater amount with public capital because for a given increase in public capital composite consumption will

12. The discussion focuses on an illustrative case that allows a closed-form solution (see the appendix). The solution is simplified by assuming that all forms of government expenditure can be written as linear functions, $\varepsilon_i y$, of "private" output, y. In this case, it is possible to write all endogenous variables as linear functions of y and then solve for y itself.
13. Since increasing the share of public consumption (or investment) also tends to lower the marginal utility of consumption, the negative effect on consumption is reinforced.

fall more than with a decrease in public consumption. Thus, increasing the share of public capital will increase labor, private capital, and output more than an equal increase in the share of public consumption will. In summary, the expansionary effect of an increase in public consumption or investment is positively related to the substitutability with private consumption and with the size of the marginal product. While it is easy to imagine that $\mu_c > \mu_k$ or that $A_c < A_k$, it is more difficult to see what the overall effect might be. This issue is analyzed in the next section.

Evaluating Laffer Curve Experiments

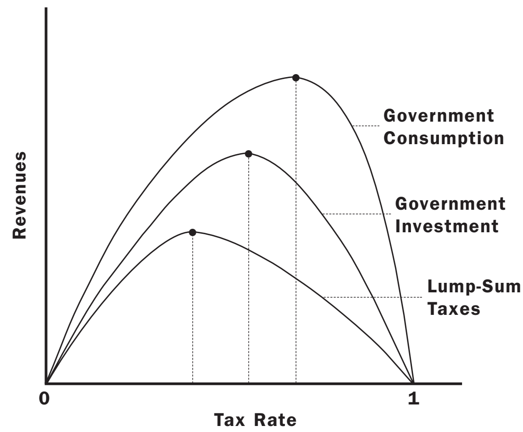
Which of these competing influences on labor, private capital, and output tends to dominate? It turns out that the net effect of an increase in the share of public expenditures ε_i can be described very simply. It can be shown that in this simple model the effect of ε_i on labor, private capital, and private output is proportional to $(1 - A_i - \mu_i)$ for $i = c, k$.[14] In other words, the effect of any government expenditure adjusts the pure demand effect by subtracting a supply effect A_i and a demand substitution effect μ_i.

A few studies have tried to quantify $(1 - A_i - \mu_i)$. Overall, the evidence seems to suggest that $A_c + \mu_c \leq A_k + \mu_k$.[15] Thus, it seems likely that public consumption will have a stronger positive effect on labor, private capital, and private output while public capital will have a stronger positive effect on total output.[16] In particular, increasing public consumption at the expense of public capital will raise private inputs and tax revenues but lower total output.

This finding has strong implications for the Laffer curve since the response of total revenues to a change in the income tax depends on changes in income from private inputs. Increasing the income tax rate tends to raise the average tax rate and to reduce private inputs. As tax rates continue to rise, the percentage fall in private-factor income eventually dominates a given percentage rise in the income tax rate. At this point, total revenues will begin to fall if tax rates rise any further. Since lump-sum transfers have no long-run macroeconomic effects, balancing the budget with lump-sum transfers will not affect the Laffer curve.

In contrast to lump-sum transfers, increasing the share of public capital will cause private-factor incomes to rise, offsetting the tax-induced contractionary effect. Thus, with budget-balancing increases of public capital, tax revenues will be higher than if lump-sum transfers were used. As indicated in Chart 3, the Laffer curve with public capital expenditures will be above the Laffer curve for lump-sum transfers. It also can be shown that the revenue-maximizing income tax rate will be greater when public capital is used than when it is not. The downward-sloping part of the Laffer curve occurs at higher tax rates on the higher curve than on the lower curve. In other words, it is less likely that tax revenues increase when income tax rates and public capital are reduced simultaneously than when lump-sum transfers have been reduced.

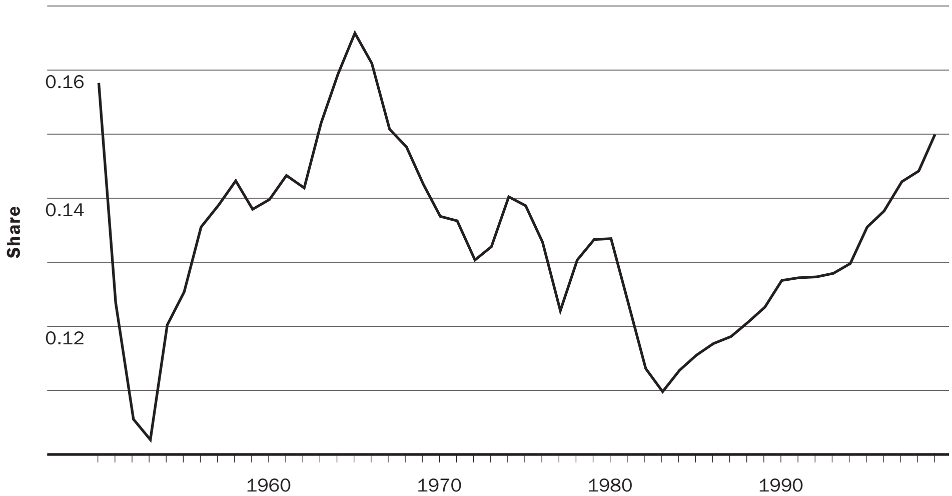
CHART 3
Laffer Curves under Alternative Spending Arrangements



Lastly, increasing the share of public consumption is likely to cause income from private inputs to rise more than if public capital were increased. Thus, tax revenues will be higher if government consumption is used to balance the budget. Equivalently, the Laffer curve for public consumption lies above the Laffer curve of public investment (and it can be shown that the revenue-maximizing tax rate will be higher, too). This possibility is also depicted in Chart 3 along with the other two possibilities.

Which of the three Laffer curves in Chart 3 is the correct one for the 1980s under the Reagan administration? Answering this question requires a quick look at the data, which reveals three important features of the times. The two well-publicized features are the federal marginal tax cuts and the deficit-financed spending (on transfers and government consumption).[17] Another important feature of the data for the period is that public capital investment dropped relative to public consumption, continuing a trend started in the mid-1960s (see Chart 4).[18] Thus, to some extent higher government consumption was paid for by lower government investment. When government consumption is increased at the expense of government investment, the total effect on tax revenues equals the effect on GDP that is proportional to $A_c + \mu_c - A_k - \mu_k$. Because GDP falls, less revenue is collected than before at prevailing tax rates. In essence such a policy shifts all existing Laffer curves down.

CHART 4
Nondefense Government Investment as a Share of Total Government Expenditures, 1950–99



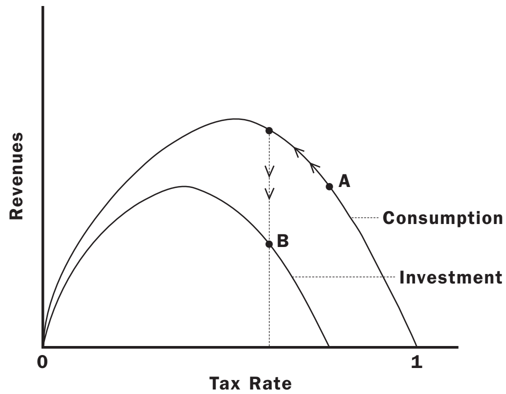
Note: This series takes a ratio of nondefense government investment and total government expenditures. Both series include local, state, and federal expenditures.

Now suppose that the preexisting income tax rate was higher than it ought to be to maximize revenues. In other words, suppose that the prevailing tax rate was on the downward-sloping portion of the Laffer curve as indicated by point A in Chart 5. Under these circumstances, lowering the tax rate would tend to increase revenues. However, if government consumption rises at the expense of government investment, the Laffer curve shifts down. Thus, rather than rising on the original curve, tax revenues fall from point A in Chart 5 to point B. At this point, lowering of tax rates would still increase revenues. However, the additional revenues from lowering tax rates would be insufficient to offset the decline in revenues brought about by the expenditure switch. Thus, it seems that supply-siders may have overlooked an important determinant of the position of the Laffer curve.[19]

Under the Clinton administration there have been two developments with implications that can be explained using the current analysis: tax rates have risen, and government investment has risen relative to government consumption.[20] If one

14. This relationship can be shown by totally differentiating the closed-form solution in the appendix.
15. Aschauer (1989a, 1989b, 1990) cites evidence that the marginal product of public consumption, A_c, is close to zero and that the marginal rate of substitution between private and public consumption, μ_c, is in the range (0.2, 0.4). However, Kuehlwein (1992) finds no evidence for the substitutability of public and private consumption. Thus, μ_c is more likely in the range (0, 0.4). To date there exists no empirical evidence on the size and sign of μ_k. Aschauer (1990) finds that the marginal product of public capital, A_k, may be close to four. Tatom (1991a, 1991b), however, argues that these estimates may be overstated by 40 percent, if not more.
16. Notice that when $A_k + \mu_k < (>) 1$ an increase in public investment will crowd private capital in (out). Aschauer (1989a) argues that public capital may have two effects. First, if public capital raises the marginal productivity of private capital, it will crowd private capital in. Second, if public capital rises, it will raise output creating a positive wealth effect for households, which will raise consumption and lower savings. Thus, private capital is crowded out. Aschauer finds that the first effect comes to dominate over time. While this article does not consider this effect, assuming a small enough $A_k + \mu_k$ is a rough approximation. For the second effect Aschauer seems to assume that $A_k + \mu_k > 1$.
17. The calculation abstracts from the deficit-financed increase in government spending because ultimately it must be paid for with future tax increases, future spending reductions, or higher growth of incomes. Ireland (1994) shows that deficit-financed increases in government spending will eventually pay for themselves through higher growth. However, it may take a long time.
18. Note that the chart compares nondefense government investment to total expenditures. Both investment and expenditure numbers include outlays at the local, state, and federal levels. Also see, for instance, Baxter and King (1995).
19. One implication of this analysis is that empirical studies of the Laffer curve must carefully control for the effects of all types of government expenditures.
20. This statement refers to Chart 4. Government investment and consumption numbers include expenditures at the local, state, and federal levels.

CHART 5
Laffer Curve Depicting the Switch from Government Investment to Consumption as Tax Rates Are Reduced



believes that the downward-sloping portion of the Laffer curve is relevant, then such a policy would be a move from point B to point A in Chart 5. However, many economists would argue that the United States is on the upward portion of the Laffer curve. In this case, the positive effect on tax revenues from an increase in tax rates would be reinforced by the shift in government expenditures. In either case, the analysis suggests higher tax revenues, an outcome the data bear out.

Conclusion

Nature and tax policy abhor a vacuum. If tax policy is designed without reference to expenditure policy, it is possible that the effects on tax revenues may be miscalculated. To make this case, a simple neoclassical growth model was developed and the long-run effects of government expenditures and income taxes were analyzed. It was shown that a reduction of tax rates would increase income from labor and private capital and would increase output. Reducing public capital at the same time will tend to lower private inputs and production and thus lower income tax revenues, in turn reducing the tax revenues derived from a cut in income tax rates. The larger the productivity of public capital is or the more precipitous its decline, the likelier it is that tax revenues will fall. By this argument, cutting income taxes at the same time that public investment falls and government consumption rises, as occurred in the 1980s, increases the likelihood that the government loses tax revenues. In this case, a revenue-increasing strategy would have been to lower income tax rates but increase public investment at the expense of government consumption. As a general rule, raising public investment relative to public consumption will tend to add to tax revenues. More importantly, realizing that the Laffer curve is shifty (in the sense that it moves with external shocks) should lead to better tax-policy design.

A Closer Look at the Model

Households maximize the utility function

$$\Sigma_{s\geq 1}(1/\rho)^{s-1}[\ln(c_s+\mu_c c_g+\mu_k k_{s-1}^g)+\alpha\ln(1-h_s)]$$

subject to a budget constraint that is summarized by

$$c_s+k_s=(1-t_y)(w_s h_s+r_s k_{s-1})+l_s^g,$$

where l_s^g is the lump-sum transfer (or tax), k_{s-1} is physical capital accumulated up to period s, and k_s is the additional holdings of capital. This equation implies the following first-order conditions that correspond with equations (1) and (2) in the text:

$$MRSh\equiv\frac{\alpha/(1-h)}{1/(c+\mu_c c^g+\mu_k k^g)}=(1-t_y)w, \quad \text{(A1)}$$

and

$$MRSx\equiv\rho=r(1-t_y), \quad \text{(A2)}$$

respectively, with subscripts dropped to indicate that variables are in steady state.

Firms produce according to a Cobb-Douglas production function, $y=k^{\theta}h^{1-\theta}$. Under these circumstances the first-order conditions corresponding to equations (3) and (4) in the text are

$$MPh\equiv(1-\theta)(y/h)=w, \quad \text{(A3)}$$

and

$$MPk\equiv\theta(y/k)=r, \quad \text{(A4)}$$

respectively.

Combining household and firm-optimality conditions and imposing a steady state yields

$$\alpha\,\frac{(c/y+\mu_c\varepsilon_c+\mu_k\varepsilon_k)\,y}{1-h}=(1-t_y)(1-\theta)(y/h) \quad \text{(A5)}$$

and

$$\rho=(1-t_y)\theta(y/k), \quad \text{(A6)}$$

where total output in steady state is

$$y+y^g=(1+A_c\varepsilon_c+A_k\varepsilon_k)y. \quad \text{(A7)}$$

Furthermore, dividing both sides of the government's revenue constraint by y implies

$$\varepsilon_c+\varepsilon_k+\varepsilon_l=t_y. \quad \text{(A8)}$$

Finally, the market clearing conditions now look like

$$c+k+\varepsilon_c y+\varepsilon_k y=(1+A_c\varepsilon_c+A_k\varepsilon_k)y. \quad \text{(A9)}$$

As long as the marginal products of the public inputs are less than unity, the demand effects of public expenditures dominate the supply effects.

Using the last five equations, a closed-form solution to the model is easily found. The solution proceeds much like the exposition in the text. From (A6), steady-state capital is a linear function of equilibrium output. Thus, the average productivity of capital is given by

$$\frac{k}{y}=\frac{(1-t_y)\theta}{\rho}. \quad \text{(A10)}$$

Substituting (A10) into (A9) yields

$$c/y=1-(1-A_c)\varepsilon_c-(1-A_k)\varepsilon_k-(k/y), \quad \text{(A11)}$$

which in turn, after substitution into (A5), yields

$$h=\frac{(1-t_y)(1-\theta)}{(1-t_y)(1-\theta)+\alpha\,[(c/y)+\mu_c\varepsilon_c+\mu_k\varepsilon_k]}. \quad \text{(A12)}$$

Then, output can be found by rewriting the production relationship as

$$y=(k/y)^{\frac{\theta}{1-\theta}}h \quad \text{(A13)}$$

and inserting (A10) and (A12). Finally, consumption and capital are found by multiplying (A10) and (A11) with (A13).

REFERENCES

Aschauer, David A. 1989a. "Does Public Capital Crowd Out Private Capital?" *Journal of Monetary Economics* 24 (September): 171–88.

———. 1989b. "Is Public Expenditure Productive?" *Journal of Monetary Economics* 23 (March): 177–200.

———. 1990. "Is Government Spending Stimulative?" *Contemporary Policy Issues* 8 (October): 30–46.

Baxter, Marianne, and Robert G. King. 1995. "Fiscal Policy in General Equilibrium." *American Economic Review* 83 (June): 315–34.

Becsi, Zsolt. 1993. "The Long (and Short) of Taxation and Expenditure Policies." Federal Reserve Bank of Dallas *Economic Review* (Third Quarter): 51–64.

Blinder, Alan S. 1981. "Some Thoughts on the Laffer Curve." In *The Supply-Side Effects of Economic Policy,* edited by Laurence H. Meyer. St. Louis: Center for the Study of American Business at Washington University and Federal Reserve Bank of St. Louis.

Fullerton, Don. 1982. "On the Possibility of an Inverse Relationship between Tax Rates and Government Revenues." *Journal of Public Economics* 19 (October): 3–22.

Gahvari, Firouz. 1989. "The Nature of Government Expenditures and the Shape of the Laffer Curve." *Journal of Public Economics* 40 (November): 251–60.

Guesnerie, Roger, and Michael Jerison. 1991. "Taxation As a Social Choice Problem: The Scope of the Laffer Curve Argument." *Journal of Public Economics* 44 (February): 37–63.

Ireland, Peter N. 1994. "Supply-Side Economics and Endogenous Growth." *Journal of Monetary Economics* 33 (June): 559–71.

Koenig, Evan F., and Gregory W. Huffman. 1998. "The Dynamic Impact of Fundamental Tax Reform—Part 1: The Basic Model." Federal Reserve Bank of Dallas *Economic Review* (First Quarter): 24–37.

Kuehlwein, Michael A. 1992. "Disaggregate Evidence on the Substitutability between Public and Private Spending." Hoover Institution Working Paper E92-16, June.

Malcomson, James M. 1986. "Some Analytics of the Laffer Curve." *Journal of Public Economics* 29 (April): 263–79.

———. 1988. "Some Analytics of the Laffer Curve: Reply," *Journal of Public Economics* 35 (February): 131–32.

Tatom, John A. 1991a. "Public Capital and Private Sector Performance." Federal Reserve Bank of St. Louis *Review* 73 (May–June): 3–15.

———. 1991b. "Should Government Spending on Capital Goods Be Raised?" Federal Reserve Bank of St. Louis *Review* 73 (March–April): 3–15.

Varian, Hal R. 1990. *Intermediate Microeconomics*. 2d ed. New York: W.W. Norton Company.