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Can Tax Cuts Pay for Themselves? An Examination of Dynamic Scoring with Public Capital

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Abstract

Can a decrease in tax rates increase tax revenues? If so, to what extent? This paper builds upon recent work by Mankiw and Weinzierl (2006) on the issue by incorporating public capital into a dynamic scoring. The significant components of growth effects and transition paths, along with the conditions under which a tax cut can "pay for itself" are illustrated using the familiar Laffer curve. It is shown that the productivity of public capital and the amount of revenue allocated to public capital investment have important impacts on the growth effects, transition paths and Laffer curves. Using standard labor and capital tax rates, the growth effects are shown to offset only 1 percent of the potential revenue loss from a labor tax cut and 46 percent of the potential revenue loss from a capital tax cut. A broader measure of tax rates from Feldstein (2006) shows that growth effects can offset approximately 30 percent of the potential revenue loss from a labor tax cut and approximately 157 percent from a capital tax cut. The latter result indicates that capital tax cuts may be more than just self-financing; they may actually increase tax revenues by 57 percent.

JEL Classification: E1, H2, H3, H6

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1 Introduction

"The results are in, and they are clear: Economic growth has lead to a surge of tax revenues and shrinking deficits. Despite the cries from our critics, it cannot be denied that low taxes truly are consistent with rising federal revenues . . ."

> U.S. Treasury Secretary John Snow, "Their Income Up, U.S. Rich Yield a Tax Windfall" *Wall Street Journal*, May 20-21, 2006

Can a permanent decrease in tax rates increase tax revenues and if so, to what extent? These questions have received renewed interest from politicians and economists alike since the 2001 and 2003 Bush tax cuts. Supply-side economists answer with an emphatic "yes" claiming that current U.S. tax rates are so high that the growth effects from tax cuts to national output will result in tax cuts paying for themselves. These effects include higher saving, investment and labor supply caused by changes in tax policy. Conventional measures of tax policies on revenues, however, yield the opposite result in which tax cuts necessarily lead to lower tax revenues. These conventional measures, such as those used by the Congressional Budget Office (CBO) and the Congressional Joint Committee on Taxation (JCT), incorporate a variety of behavioral effects but miss the macroeconomic feedback effects. A relatively new modeling technique known as *dynamic scoring* provides an analytical framework that helps elucidate some of the salient issues in the debate and can show the conditions under which a tax cut might be self-financing. As opposed to *static scoring* (the measures most associated with the JCT and CBO methodology), dynamic scoring incorporates all of the macroeconomic feedback effects from tax cuts to national income.[1] This paper builds upon recent work on the issue by incorporating public capital into a dynamic scoring model presented in Mankiw and Weinzierl (2006), hereinafter referred to as "M-W". The significant components of growth effects and the conditions under which a tax cut can "pay for itself" are derived from the model and illustrated using the familiar Laffer curve. The transition paths to different tax-cut steady states are also derived. It is shown that the productivity of public capital and the amount of revenues allocated to it have important impacts on the growth effects, Laffer curves and transition paths. Using the standard tax rates from M-W, the growth effects of labor tax cut are shown to offset only 1 percent of the potential revenue loss while capital tax cuts have growth effects that offset approximately 46 percent of the potential revenue loss. A broader measure of tax rates from Feldstein (2006) shows that growth effects can offset approximately 30 percent of the potential revenue loss from a labor tax cut and

[1] Details on how microeconomic, but not macroeconomic, behavior is incorporated into JCT and CBO estimates can be found in Joint Committee on Taxation (2005) and Auerbach (2005).

approximately 157 percent from a capital tax cut. The latter result indicates that capital tax cuts may be more than just self-financing; they may actually increase tax revenues by 57 percent.

Using variants of the Ramsey (1928) optimal growth models, M-W separates static from dynamic effects of tax cuts to measure the degree to which a tax cut may be self-financing. They find that neither labor nor capital tax cuts are entirely self-financing and that static scoring always overstates the revenue loss of tax cuts. This paper augments their model by adding public capital to examine how the expenditure side of the government affects their results. Utilizing Laffer curve diagrams provides additional insight into the nature and causes of the feedback effects.

The paper is organized as follows. Section 2 provides a background on the economic and political controversies surrounding dynamic scoring. Section 3 presents the basic model with inelastic labor supply and previews the analytical and numerical results. Section 4 extends the basic model to include labor-leisure choice. Section 5 develops and examines the transition path for tax cuts. Section 6 concludes.

2 Background

The importance of dynamic scoring rose dramatically with the 2001 and 2003 tax reforms under President George W. Bush. The Economic Growth and Tax Relief Reconciliation Act of 2001 (EGTRRA) was designed to significantly reduce income tax rates over a multi-year period and produced a cumulative income tax rate reduction of 3 percent for the 29, 31 and 36 percent tax brackets while lowering the highest bracket at the time, 39.6 percent, to 35 percent. The Jobs and Growth Tax Relief Reconciliation Act of 2003 (JGTRRA) reduced tax rates on realized capital gains from 10 to 5 percent (in brackets where ordinary income tax was 15 percent or less) and from 20 to 15 percent (for brackets above) through 2007 and then zero and 15 percent, respectively, in 2008. Dividend tax rates were reduced from the rates that apply to ordinary income to the rates that apply on capital gains.[2] Proponents of the tax cuts, from economists such as Thomas Sowell to US Treasury Secretary John Snow, claim that recent increases in government revenues were the direct result of the 2001 and 2003 tax cuts.[3] Opponents attribute the tax revenue increase to myriad other factors affecting taxable income and note various counterexamples in which tax rate increases were accompanied by large increases in tax revenues.

The dynamic scoring debate surfaced in the U.S. legislature in 2002 when members of Congress asked the Joint Tax Committee to augment its current methods of estimating revenues to include the long-

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[2] Gale and Orszag (2004)

[3] Sowell claims:

> More than 40 years ago, President John F. Kennedy got Congress to cut tax rates, with the ideas that this would provide incentives to change economic behavior in a way that would increase economic growth and individual incomes, and therefore lead to more tax revenue coming into the Treasury than had been the case under the higher tax rates. That is exactly what happened.
>
> Years later, Ronald Reagan made the same argument and . . . [t]ax receipts during every year of the 1980s were higher than they had ever been in any year before.

Sowell, Thomas “Liberals cling to economic myths to maintain political power”. *The Colorado Springs Gazette*, May 28, 2006.

term dynamic effects of tax policy. The topic gained further political prominence when discussions of dynamic scoring were included in the 2003 CBO report and the 2004 *Economic Report of the President*. Support within the Bush administration has culminated in the establishment of the Division on Dynamic Analysis Office in the U.S. Treasury. The politically controversial aspects of dynamic scoring are easy to see. Relative to dynamic scoring, static scoring systematically overestimates revenues losses from tax cuts and overestimates revenue gains from tax increases. Estimates from dynamic scoring make it more difficult politically to raise taxes and easier to cut them. Economic controversy exists because there are reasonable arguments both for and against dynamic scoring (see Auerbach (2005)). Given the political and economic importance of dynamic scoring, understanding the affects of tax rate changes on economic growth is of crucial importance to the debate. The simple dynamic framework herein elucidates some of the key issues in this debate.

3 The Basic Model

Mankiw and Weinzierl (2006), use the Ramsey (1928) neoclassical growth model to construct a framework for dynamic scoring. The model, which has become a workhorse in macroeconomic dynamics and public finance, is appealing due to its tractability that provides closed-form and economically-interpretable results. The M-W version assumes the government provides lump-sum transfer payments while maintaining a balanced budget. In this paper, the government spends on both lump-sum transfer payment and production-enhancing public capital while maintaining a balanced budget.[4] It will be shown that the composition of government expenditures has important impacts on the feedback effects of tax cuts. How revenues are spent may impact the economy just as significantly as how those revenues are generated.

We begin with a simple neoclassical growth model for an infinitely-lived representative household in a decentralized closed economy. Like the M-W model, households produce output, Y, using private capital, K, public capital per-effective-worker, g_I, and effective labor, AN where A represents labor-augmenting technology. Public capital is complementary to private factors in that increases in public capital raise the productivity of both private capital and labor. Public capital is assumed to be non-excludable and proportionally congestible in AN, meaning the more effective workers are, the more intensively they use public capital.[5] The production function has constant returns to scale in private capital and effective labor of the form

$$Y = F(K, g_I) = K^{\beta}(AN)^{1-\beta}g_I^{\alpha} \tag{1}$$

[4] The importance of public capital to economic growth is cited throughout the theoretical and empirical literature. See Glomm and Ravikumar (1997) for a review of the empirical literature.

[5] One can think of per capita g_I, as equal to $\frac{G_I}{(AN)^{\varphi}}$ where φ measures the congestibility of public capital. If $\varphi = 0$, public capital is non-rival and therefore a public good in the Samuelsonian sense. If $\varphi = 1$, as assumed herein, public capital is perfectly rival. This modeling specification provides a conservative bias for the estimate of the productivity. Similar setups are employed in Alogoskoufis, Klayvitis (1996), Glomm, Ravikumar (1994 and 1997) and others.

Labor-augmenting technology, A, grows exponentially at rate z so that $A = A_0e^{zt}$. The model is simplified by rewriting variables in per-effective-worker terms: $y = \frac{Y}{AN}$, $c = \frac{C}{AN}$, $i = \frac{I}{AN}$, and $k = \frac{K}{AN}$. The production function in per-effective-worker terms is

$$y = f(k, g_I) = k^{\beta} g_I^{\alpha} \tag{2}$$

Given constant returns to scale, profits are exhausted by payments to capital and labor.

The production function satisfies the familiar Inada conditions: $f_i \rightarrow \infty$ as i approaches zero, and $f_i \rightarrow 0$ as i approaches infinity for $i = k$, g_I. Firms take government action as exogenous and under competitive input and output markets have the familiar input demands

$$r = \beta k^{\beta-1} g_I^{\alpha} \tag{3}$$

$$w = (1 - \beta) k^{\beta} g_I^{\alpha} \tag{4}$$

Given $\alpha + \beta < 1$, the aggregate production function produces steady state growth in which the per-effective-worker growth rate is equal to zero.

3. 1 Household Utility and the Budget Constraint

The economy is populated by an infinitely-lived household that derives utility from consumption, C, in the isoelastic form,

$$U(C) = \frac{C^{1-\gamma}}{1-\gamma}$$

where the parameter γ is the inverse of the intertemporal elasticity of substitution. Converting to per-effective-worker terms, household utility is given by $U(c) = \frac{(ce^{zt})^{1-\gamma}}{1-\gamma}$. The goal of the household is to maximize the summation of discounted utility over an infinite time period given by

$$\int_0^{\infty} e^{-\rho t} \frac{(ce^{zt})^{1-\gamma}}{1-\gamma} dt \tag{5}$$

The discount factor, $e^{-\rho t}$, accounts for the rate of time preference, ρ. To finance consumption, the household faces a budget constraint that incorporates the existing fiscal regime. Per-effective-worker disposable income is divided among consumption and investment in capital, I_K.

$$(1 - t_n)w + (1 - t_k)rk + g_T = c + I_K \quad (6)$$

Disposable income is derived from after-tax wages, $(1 - t_n)w$, after-tax returns on private investments, $(1 - t_k)rk$, and a transfer from the government, g_T.[6] Input prices w and r are taken as given along with government expenditures. The stock of private capital (in per-effective-worker terms) grows at rate

$$I_K = \dot{k} + (z + \delta)k \quad (7)$$

Substituting equations (7) into (6) gives the law of motion for private capital $\dot{k}$ in per-effective-worker terms

$$\dot{k} = (1 - t_n)w + (1 - t_k)rk + g_T - (z + \delta)k - c \quad (8)$$

3.2 Government Budget Constraint

The government provides investment in public capital, I_G, and transfers, G_T, with revenues from taxes on labor income, t_n and capital income, t_k. The government budget constraint states that government expenditures, G_T and I_G, must equal tax revenues, R.

$$G_T + I_G = R \quad (9)$$

Total revenues are derived from a labor tax, t_n, and a capital tax, t_k

$$R = t_n w + t_k rk \quad (10)$$

Like private investment, pubic investment is a function of the growth rate of the economy, z and is assumed to depreciate at rate δ, i.e., $I_G = \dot{g}_I + (z + \delta)g_I$. The percentage of tax revenues devoted to investment in public capital is given by the parameter, s, so that $I_G = sR$. The remainder of tax revenues goes to government transfers, $g_T = (1 - s)R$. Fiscal policy is completely characterized by the terms is s, t_k and t_n. In this framework, the government directly chooses the *proportion* of its expenditures and only indirectly chooses the actual *level* of expenditures by the fiscal parameters. Budget balance is maintained through adjustments in government transfers and investment.

[6] The results are greatly simplified by assuming the capital tax only applies to gross returns, r, rather than the net-of-depreciation returns, $r - \delta$.

3.4 The Steady States

The representative household maximizes utility by maximizing discounted consumption, equation (5), subject to the resource constraint, equation (8), and the standard transversality condition for capital.

$$Max_c \int_0^\infty e^{-\rho t} U(c)dt$$

$$subject\ to\ \dot{k} = (1 - t_n)w + (1 - t_k)rk + g_T - (z + \delta)k - c$$

$$Limit_{t \to \infty} e^{-\rho t} \lambda k = 0 \qquad (11)$$

where λ represents the shadow price of private capital. The steady state for the economy occurs where per-effective-worker consumption, private capital, public capital and output are constant and is described by the following five equations.

$$\frac{\dot{c}}{c} = \frac{1}{\gamma}[(1 - t_k)r - (\delta + \rho + z\gamma)]$$

$$\dot{k} = w(1 - t_n) + rk(1 - t_k) + g_T - (z + \delta)k - c$$

$$g_T = (1 - s)R$$

$$I_g = sR$$

$$R = t_n w + t_k rk \qquad (12)$$

The first two equations are derived from the first-order conditions in the maximization problem. The remaining three equations come from the government budget constraint and the government's rule of allocation. These equations constitute a simultaneous system that can be solved for optimal values of per-effective worker private capital, k^*, and public capital, g_I^* in terms of the fiscal, production and preference parameters. The steady state values are

$$k^* = [\frac{\beta(1 - t_k)}{z\gamma + \delta + \rho}]^{(1-\alpha)/(1 - \beta - \alpha)} [\frac{sF}{z + \delta}]^{\alpha/(1 - \beta - \alpha)} \qquad (13)$$

$$g_I^* = [\frac{\beta(1 - t_k)}{z\gamma + \delta + \rho}]^{\beta/(1 - \beta - \alpha)} [\frac{sF}{z + \delta}]^{(1 - \beta)/(1 - \beta - \alpha)} \qquad (14)$$

where $F = (1 - \beta)t_n + \beta t_k$ and sF represents the proportion of tax revenues to investment in public capital. The first term in the steady state equations, $\frac{\beta(1 - t_k)}{z\gamma + \delta + \rho}$, is related to the steady state after-tax return on private capital while the second term in the steady state equations, $\frac{sF}{z + \delta}$, represents the effect of public capital investment on output. Private and public capital are shown as positively related to labor taxes. This occurs in the inelastic labor supply case because an increase in labor tax rates has no effect on labor supply and the additional revenues support increases in public capital. Private capital increases because increases in public capital increase the marginal product of capital. This result differs significantly from the M-W model which is replicated by setting α equal to zero in equation (13). In that case, labor taxes do not affect steady state k. The relationship of private and public steady-state capital with respect to capital taxes is ambiguous. Increases in capital taxes raise private and public capital as long as the increase in investment in public capital (the second term) outweighs the negative effect of capital taxes on the return to private capital (the first term).

Steady state revenues are given by substituting steady state values into the revenue function, $R = t_n w^* + t_k r^* k^*$. Substituting (3), (4), (9), (13) and (14), into the revenue function gives

$$R = t_n(1-\beta)k^{*\beta}g_I^{*\alpha} + t_k\beta k^{*\beta}g_I^{*\alpha}. \qquad (15)$$

This equation serves as the basis for measuring the dynamic effect of capital and labor tax cuts on revenue.

3.5 The Feedback Effect for the Basic Model

The dynamic effect of a marginal cut in capital and labor tax rates on tax revenues is examined by taking derivatives of equation (15) with respect to t_k and t_n, respectively. The results from each derivative can be dissected into a static effect, dynamic effect, feedback effect and growth effect. The *static effect* represents the conventional scoring method in which national income and other macroeconomic variables are unaffected by changes in tax rates. The static effect on revenues from a capital tax cut and labor tax cut are

$$\frac{dR}{dt_k}\Big|_{\text{Static}} = rk = \beta y \quad \text{and} \qquad \frac{dR}{dt_n}\Big|_{\text{Static}} = wn = (1-\beta)y.$$

These equations indicate that the static effect is unambiguously positive: when tax rates decrease, tax revenues decrease by an amount equal to the tax base of the respective tax. Using the standard measure of capital's share of $\beta = ⅓$, these results indicate that a one percent decrease in capital taxes will decrease revenues by 0.33 percent. The *dynamic effect*, on the other hand, takes the same derivatives but with respect to the steady state revenue function, R^*. That derivative with respect to the capital tax is

$$\frac{dR}{dt_k}\Big|_{\text{Dynamic}} = \left[\frac{(1-\beta)(1-t_n)-t_k}{(1-\beta-\alpha)(1-t_k)}\right]\beta y = \left[\frac{(1-\beta)(1-t_n)-t_k}{(1-\beta-\alpha)(1-t_k)}\right]\frac{dR}{dt_k}\Big|_{\text{Static}} \qquad (16)$$

The term preceding βy and $\frac{dR}{dt_k}|_{\text{Static}}$ represents the *feedback effect* from tax cuts to economic growth in the dynamic setting.[7] The feedback effect measures the amount of the static revenue effect that is actually incurred. For example, a feedback effect of one implies that tax cuts produce no additional economic growth to offset the decline in tax revenues and the dynamic revenue loss equals the static revenue loss. A feedback effect of zero implies tax cuts induce enough growth to keep tax revenues constant. This is the case in which tax cuts "pay for themselves" and can be shown to occur for capital tax cuts if $t_k \geq (1 - \beta)(1 - t_n)$. Notice that neither the growth rate of labor-augmenting technology, z, nor the expenditure allocation parameter, s, appears in the result. The feedback effect is only affected by the tax rates, t_k and t_n, and output elasticities, β and α.

To quantify these effects, a private capital output elasticity of $\beta = 1/3$ and a public capital output elasticity of $\alpha = 0.10$ are assumed.[8] Measurements of the marginal tax rates on capital and labor fall within a wide range based on multiple factors. In the interest of providing a broad but relevant range of results, two groups of tax rate estimates are used. The first rates lie within a range commonly given in the literature (and are those used by M-W), $t_k = t_n = ¼$. The second group comes from Feldstein (2006) and consists of rates significantly higher than M-W as will be discussed later in the paper.

To quantify the feedback effect, the first group of parameter values is substituted into (16) which give

$$\frac{dR}{dt_k}\Big|_{\text{Dynamic}} = 0.588\,\frac{dR}{dt_k}\Big|_{\text{Static.}}$$

The feedback effect on revenue of a capital tax cut is only 58.8% of its static impact. The *growth effect* of a tax cut shows how much of the static revenue decrease is mitigated over time by the positive growth impact of the tax cut and is measured by one minus the feedback effect.[9] The growth effect for capital tax cuts is 41.2%.

Note that higher α raises the feedback effect and, conversely, diminishes the growth effect. The economic rationale is straightforward: decreases in tax rates decrease public capital and less public capital implies a lower marginal product of private capital. The lower marginal product decreases private investment and hence output. By implicitly setting $\alpha = 0$, the M-W model generates a lower feedback effect of 0.50 implying that 50% of a capital tax cut pays for itself.

Feldstein's (2006) estimates of capital and labor tax rates are much larger than those are given in the M-W model. The marginal labor tax rate provided by M-W exclude the combined employee-employer

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[7] The feedback effect is positive if $t_n > -\frac{\beta}{1-\beta}$, which holds by definition.

[8] Estimates of β are typically between 0.25 and 0.36 while those for α are between 0.05 and 0.15. For a survey of the latter see Glomm and Ravikumar (1997).

[9] The growth effect also measures the dead-weight loss created by a tax increase as seen in Feldstein (2006).

payroll tax of 15.3 percent and an average state income tax of 5 percent. Feldstein includes these values to give a total labor tax rate of approximately 45 percent. For the marginal capital tax rate, Feldstein incorporates the notion of double taxation on capital income in which firm profits are taxed at 35 percent at the corporate level and approximately 15 percent at the individual level. Combining these tax rates produces a total capital tax rate of 50 percent. Unlike M-W, the tax rates of $t_n = 0.45$ and $t_k = 0.50$ satisfy the condition $t_k \geq (1 - \beta)(1 - t_n)$ implying capital tax cuts can pay for themselves. Substituting these values into (16) yields

$$\frac{dR}{dt_k}\Big|_{\text{Dynamic}} = -0.471\,\frac{dR}{dt_k}\Big|_{\text{Static.}}$$

The negative feedback effect of -0.471 implies a positive growth effect of 1.471. Not only does a tax cut pay for itself at these rates, it actually raises government revenue by nearly 50 percent of the static revenue loss.

The effects of a labor tax cut on government revenue is given by the derivative of R is taken with respect to t_n at the steady state.

$$\frac{dR}{dt_n}\Big|_{\text{Dynamic}} = \frac{(1-\beta)}{(1-\alpha-\beta)}\,(1-\beta)y = \frac{(1-\beta)}{(1-\alpha-\beta)}\,\frac{dR}{dt_n}\Big|_{\text{Static}} \qquad (17)$$

This result has two interesting features. First, neither tax rate affects the feedback effect. Second, the feedback effect is greater than one and the corresponding growth effect is negative. Thus the dynamic effect of a cut in labor tax rates amplifies, rather than mitigates, the negative static effect. The economic rationale is that lower labor taxes leads to lower public capital without inducing more labor. Lower public capital leads to lower marginal productivity of private capital, decreasing private investment and contributing to the amplification of the negative impact of the tax cut. Substituting the parameter values into (17) gives

$$\frac{dR}{dt_n}\Big|_{\text{Dynamic}} = 1.1765\,\frac{dR}{dt_k}\Big|_{\text{Static}}$$

Because tax rates do not enter into the feedback equation, the long-run impact on revenue of a labor tax cut for both the M-W and Feldstein tax rates is the same, 117.65% of its static impact. The dynamic effect lowers tax revenues by an additional 17.65% of the static effect. This result is significantly different from the M-W result in which the dynamic effect of labor tax cuts equals the static effect again because of the assumption $\alpha = 0$.

Up to this point, the analysis has focused on changes in marginal tax rates on *total* government revenues. Reports on tax collections, however, often focus on a particular tax and the revenues that it alone has generated. The dynamic scoring framework extends itself easily to derive feedback effects for individual tax revenues. For example, the revenue derived from capital taxes, call it R_{tk}, comes from $t_k rk$ alone and excludes $t_n w$. The static effects and feedback effects for capital taxes are found by taking the derivative of capital tax revenues with respect t_k

$$\frac{dR_{tk}}{dt_k}\Big|_{\text{Dynamic}} = \left[\frac{(1-t_k)[\beta t_k + (1-\beta)t_n(1-\alpha)] - \beta F}{F(1-t_k)(1-\alpha-\beta)}\right] \frac{dR_{tk}}{dt_k}\Big|_{\text{Static}} \tag{18}$$

The feedback effects with M-W and Feldstein parameter values are 0.863 and 0.475, respectively. These are significantly larger than the feedback effects for the total revenue case which implies the growth effects are smaller. The difference between the feedback effects for the total revenue and for the individual revenue case is the feedback that occurs from capital tax cuts to changes in labor tax revenue. That difference is equal to $-\frac{t_n(1-\beta)[sF - \alpha(1-t_k)]}{sF(1-t_k)(1-\alpha-\beta)}$. To calculate the feedback effects for the labor tax revenue, take the derivative of t_n with respect to labor tax revenues ($t_n w$), call it R_{tn}

$$\frac{dR_{tn}}{dt_n}\Big|_{\text{Dynamic}} = \left[1 + \frac{\beta(1-\alpha)t_n}{(1-\alpha-\beta)[(1-\beta)t_n + \beta t_k]}\right] \frac{dR}{dt_n}\Big|_{\text{Static.}} \tag{19}$$

The feedback effects with M-W and Feldstein parameter values are 1.118 and 1.113, respectively. Like the capital tax case, these feedback effects are larger (and the growth affects, smaller) than in the total revenue model. This occurs because the important feedback from labor tax cuts to investment behavior and its positive affect on capital tax revenue is excluded.

3.6 Illustration of Feedback Effects: The Laffer Curve

The graphical analogue to the feedback equations above is the eponymous Laffer curve shown in Figure 1. With tax revenues on the vertical axis and tax rates on the horizontal, the Laffer curve is graphed as a (skewed) inverted hyperbola with three distinct and significant points. Two of these points consist of intercepts along the horizontal axis at tax rates of zero and 100 percent. These points illustrate the common-sense notion that tax revenues will be zero if the government imposes a tax rate of either zero or one-hundred percent. The third significant point of the Laffer curve is its peak where $\frac{dR}{dt_k}\big|_{\text{Dynamic}} = 0$. Tax rates to the left of the peak, where $\frac{dR}{dt_k}\big|_{\text{Dynamic}} > 0$, are optimal to tax rates on the right of the peak where $\frac{dR}{dt_k}\big|_{\text{Dynamic}} < 0$ because any amount of revenue generated from a tax rate to the right of the peak could be generated at a lower tax rate to the left of the peak. In addition, a decrease in tax rates on the left of the peak will generate lower revenues; a decrease on the right of the peak will generate *higher* revenues. In other words, tax cuts from a point on the right of the peak pay for themselves.

[Insert Figure 1 here]

The peaks of the Laffer curves for total revenue are derived by setting the feedback terms equal to zero and solving for the relevant tax rate. For example, setting the feedback equation in (16) equal to zero and solving for t_k reveals that total revenue with respect to the capital tax rate peaks at $t_k^{peak} = (1 - \beta)(1 - t_n)$. The capital tax peaks with M-W and Feldstein parameter values are 0.863 and 0.475, respectively. Using (18), the peak for capital taxes revenues is found for the individual tax revenue case. The peak occurs at 0.652 for the M-W parameter values and at 0.646 for the Feldstein parameter values.[10] Unlike capital taxes, labor taxes do not have peaks in the simple elastic labor supply model. Equation (17) reveals that total revenue with respect to the labor tax rate is an upward-sloping line without a peak. The same result obtains in the individual revenue case derived from equation (19). The assumption of an inelastic labor supply means that a change in labor tax rates will not alter the feedback effect and there is no point at which a labor tax cut can pay for itself. Thus, the basic model of the inelastic labor supply is useful in elucidating the mechanisms by which feedbacks from cuts in tax rates affect macroeconomic aggregates and tax revenues but its results are counter to empirical evidence and economic intuition. This discrepancy is resolved for the model in the case of elastic labor supply.

4 Elastic Labor Supply

A common argument for the growth effects of tax cuts is that they stimulate labor supply. A decrease in labor taxes increases the after-tax wage received by workers and thus induces greater work effort if the substitution effect of a wage increase outweighs the income effect. To analyze this important potential effect, labor effort is incorporated into the utility function in a form that leads to a constant steady state value for leisure. The utility function takes a form proposed by King, Plosser, and Rebelo (1988) in which the uncompensated elasticity of labor supply is zero. Preferences over consumption and labor are given by

$$U(c,n) = \frac{(ce^{zt})^{1-\gamma} e^{-v(n)(1-\gamma)} - 1}{1 - \gamma}$$

where γ represents the inverse of the intertemporal elasticity of consumption. The utility function is appealing in that it generates hours worked are constant in the steady state but may grow or decrease along

[10] Numerical values are used because the analytical solution for the peak tax rate in this case is extremely complex.

transition paths from one steady state to the next. The maximization problem for labor-leisure choice follows the same setup as the inelastic labor case.

$$Max_{c,n} \int_{t=0}^{\infty} e^{-\rho t} U(c,n)dt$$

$$\text{Subject to } \dot{k} = y + g_T - (z + \delta)k - c$$

$$Limit_{t\to\infty} e^{-\rho t}\lambda k = 0 \qquad (20)$$

The steady state equations are the same as in the inelastic case but with the addition of an equation representing steady state labor and a modification of the equation for consumption growth which include labor supply.

$$\frac{\dot{c}}{c} = \frac{1}{\gamma}[(1-\gamma)v(n)\,\dot{n} + (1-t_k)r - (\delta + \rho + z\gamma)] \qquad (21)$$

$$v'(n) = \frac{(1-t_n)w}{c} \qquad (22)$$

To simplify, we set $\gamma = 1$ and use L'Hôpital's Rule to put the utility function in log-linear form and we assume $v(n) = \psi n^{(1+\sigma)/\sigma}$ where ψ is a scalar. In the numerical estimates, ψ is set equal to 3 as used in the business cycle literature to constrain labor time to the empirically relevant value of about 1/3 of the total time available. The parameter σ represents the compensated (constant-consumption) elasticity of labor supply whose value has an important impact on the feedback effect and corresponding Laffer curves. The steady state results for g_I, n and k are

$$n^* = [(\frac{\sigma}{1+\sigma})\frac{(1-t_n)(1-\beta)X}{\psi(X(1-sF) - Z\beta(1-t_k))}]^{\sigma/(1+\sigma)}$$

$$k^* = (\frac{Fs}{Z})^{\alpha/(1-\alpha-\beta)}(\frac{\sigma(1-t_n)(1-t_k)(1-\beta)\beta}{(1+\sigma)\psi[X(1-sF) - Z\beta(1-t_k)]})^{(1-\alpha)/(1-\beta-\alpha)}(n^*)^{(-1+\sigma\beta-\alpha(1+\sigma))/(\sigma(1-\alpha-\beta))}$$

$$g_I^* = \frac{sFX}{Z\beta(1-t_k)}k^*$$

where $X = (\rho + \delta + z)$ and, as in the inelastic model, $F = (1-\beta)t_n + \beta t_k$. As with the inelastic labor model, the static effect on revenues from a capital tax cut and labor tax cut are

$$\frac{dR}{dt_k}\Big|_{\text{Static}} = rk = \beta y \quad \text{and} \quad \frac{dR}{dt_n}\Big|_{\text{Static}} = wn = (1-\beta)y.$$

The significant difference between the inelastic and elastic labor cases appears in the feedback effects. These effects are smaller than in the case of inelastic labor for cuts in both capital and labor tax rates. The derivative of the steady state dynamic effect from the capital tax cut is found to be

$$\frac{dR}{dt_k}|_{\text{Dynamic}} = [1 - \frac{[\beta t_k + (1-\beta)t_n]}{(1-\alpha-\beta)(1-t_k)} - \frac{z(1-\beta)[\beta t_k + (1-\beta)t_n]}{(1-\alpha-\beta)((z\gamma+\rho)(1-sF) - z\beta(1-t_k))}\frac{\sigma}{(1-\sigma)}]\frac{dR}{dt_k}|_{\text{Static}}$$

Unlike the inelastic labor supply result, the percentage of tax revenues allocated to public capital, s appears in the feedback effect. As would be expected, the higher the allocation parameter, the higher the feedback effect. The higher feedback effect is mirrored by a lower growth effect. The higher feedback effect/lower growth effect is reflected in both an increase in the height of the Laffer curve and a rightward skewing of it as shown in Figure 2. The Laffer curve rises because higher public capital stimulates output in the economy and generates greater tax revenues. The rightward skewing occurs because higher public capital diminishes the ability of tax cuts to be self-financing. Similarly, increases in the output elasticity of public capital, α, cause the same increase and rightward skew in the Laffer curve. Thus an increase in either the amount or effectiveness of public capital leads to larger tax revenues for any given tax rate and decreases the ability of tax cuts to "pay for themselves".

Another significant term in the feedback effect is the consumption-compensated elasticity of labor supply elasticity, σ. A value of zero, for example, implies hours worked are insensitive to changes in after-tax wages and thus, mimics the inelastic labor supply case. There exists substantial uncertainty and debate about the value of the elasticity. While labor economists often find values near 0.18 for men and 0.43 for women, the real business cycle literature typically uses much larger values (see Prescott (2004) who suggests a value around 3). Higher values of σ lead to lower values for both the height of the Laffer curve and skew so that for any given value of σ, as tax rates rise the amount of revenue generated is lower and the rate at which tax cuts pay for themselves is lower. In other words, the larger the elasticity of labor supply, the higher the growth effects of tax cuts. Higher tax rates imply lower after-tax wages which decrease labor supply and cause a smaller impact on GDP and therefore, tax revenues. Figure 2 illustrates.

[Insert Figure 2 here]

The feedback effects with M-W and Feldstein parameter values are 0.536 and –0.565, respectively. Thus, allowing the labor supply to respond to changes in capital tax rates induces a 0.052 percentage point increase in the growth effect for the M-W parameters and a 0.094 percentage point increase for the Feldstein parameters. As with the inelastic case, capital tax cuts pay for themselves assuming the Feldstein parameter values. The quantitative effect is much larger in the case of a labor tax cut.

The dynamic effect of a labor tax cut is found to be

$$\frac{dR}{dt_n}\Big|_{\text{Dynamic}} = [1 - \frac{[t_k\beta + t_n(1-\beta)]}{(1-\alpha-\beta)(1-t_n)}\frac{\sigma}{(1+\sigma)}]\frac{dR}{dt_n}\Big|_{\text{Static}}$$

Unlike the inelastic case, the feedback effect from a labor tax cut may be less than one. In fact, the feedback effects with M-W and Feldstein parameter values are 0.992 and 0.699, respectively. The growth effects are positive for both parameter values but much smaller than in the elastic labor model without public capital. In particular, whereas the M-W model had a feedback effect of approximately 84 percent (a growth effect of 16%), the addition of public capital raises the feedback effect to 99 percent (a growth effect of 1%). Only the higher Feldstein numbers imply significant economic growth from labor tax cuts; in that case, growth pays for 31 percent of the static loss from a labor tax cut in the public capital model.

Like the feedback effects for tax cuts with respect to total revenues, the feedback effects for the individual tax revenues, R_{tk} and R_{tn}, are smaller with elastic labor supply. Because the equations for the feedback effect are exceedingly long and complex, only numerical results are provided. The feedback effect on individual revenue for a labor tax is 0.994 and 0.806 using the M-W and Feldstein parameter values, respectively. The feedback effect on individual revenue for a capital tax is 0.856 and 0.461 using the M-W and Feldstein parameter values, respectively.

The Laffer curve peaks experience a similar decrease from the inelastic to the elastic labor supply case. For total revenues, the labor tax rate peaks at 0.723 for the M-W parameter values and 0.693 for those of Feldstein. The capital tax rate peaks at 0.493 percent and 0.354 for the M-W and Feldstein parameter values. For the individual revenue case, the Laffer peaks are 0.648 percent and 0.642 for capital taxes with respect to the M-W and Feldstein parameter values, and 0.75 and 0.746 for labor taxes. Table 1 summarizes these results.

[Insert Table 1 here]

5 Transitional Dynamics

The steady state results derived in the previous sections describe two points along the economy's path from one steady state to the next. The time it takes to reach the new steady state is crucial to a policy's political feasibility. For instance, a policy that leads to a new Pareto optimal steady state may be politically infeasible if the positive effects are not felt until many years after the tax cut is implemented. This section addresses the transition path from one steady state to another using a log-linearization of the elastic labor supply model.

The transition path for the economy can be characterized by differential equations for c, k, g_I and n. These equations are used to determine the value of a variable at any point in time after a tax cut is implemented. Once a tax cut occurs, labor supply, public capital and consumption immediately jump to their respective transition paths and then move along it towards their new steady state values. Private capital, on the other hand, is initially fixed and so gradually increases toward its new steady state value following the tax cut. The derivations of these equations are contained in the Appendix. A dynamic tax revenue equation is created by substituting the individual variable paths into the revenue equation, $R = t_w wn + t_k rk$. Because k, n and g_I transition at the same speed, R is given by

$$R = [\beta t_k + (1 - \beta)t_n]k_t^{\beta} n_t^{1-\beta} g_{I,t}^{\alpha}.$$

Tax cut simulations show that the addition of public capital to the Mankiw-Weinzierl model increases the speed at which the feedback effects occur. For example, a capital tax cut in the M-W model leads to steady state growth effect of 53 percent, with an immediate effect of 10.6 percent, 21.3 percent by the fifth year and a 41.9 percent effect by the twenty-fifth year. For the public capital model, the steady state growth effect of a capital tax cut is 49 percent with an immediate growth effect of 12.5 percent. The impact after one year is 20.2 percent, 31 percent after three years and 47.67 by the 20th year. Thus, the revenue impacts are larger with public capital for each period along the transition path. For a labor tax cut, the steady state growth effect is 16.7 percent in the M-W model. The immediate effect is 12.3 percent. The impact after 5 years is 13.5 percent, 14.3 percent by year 10 and 15.7 percent by year 25. For the public capital model, the steady state growth effect of a labor tax cut is less than 1 percent. The immediate growth effect is -99.28 percent (the decrease in initial revenues is nearly doubled). In this case, the benefits of increased work effort and saving from lower tax rates is greatly outweighed by the lower productivity of labor and capital caused by the decrease in public capital. After the first year, the supply side effect is still negative at -99.19 percent but is effectively zero by period 3. By the tenth year, the steady state value has approximately been reached. From that point on, yearly tax revenue losses are approximately equal to the static result. These effects are summarized in Table 2.

[Insert Table 2 here]

Public capital parameters, s and α, along with the compensated labor elasticity, σ, have important effects on the transition paths. Increases in s increase investment in public capital which decreases the steady state growth effects in each period and decelerates the transition to the steady state for both capital and labor tax cuts. Increases in α increase the productivity of public capital which decreases the steady state growth effects but accelerates the transition to the steady state for both capital and labor tax cuts. In other words, tax cuts are less able to generate economic growth for higher levels of public capital, whether the higher levels come from more allocation of tax revenues or greater productivity. Increases in σ increase the steady state growth effects and accelerate the transition to the steady state for both capital and labor tax cuts. Figure 3 shows the paths of revenue over time, R_t, as they approach their steady state values, R_{ss}.

[Insert Figure 3 here]

6 Conclusions

Determining the conditions under which tax cuts can pay for themselves depends to a large extent upon the types of government expenditures funded by tax revenues. Mankiw and Weinzierl (2006) use a simple neoclassical growth model to illuminate some of the private-sector mechanisms by which tax cuts can spur economic growth, expand the tax base and offset part of the revenue losses. Their sanguine conclusions are that the growth effects of capital tax cuts and labor tax cuts can offset of revenue losses by 52 and 17 percent, respectively. This paper has built upon their model by introducing a more realistic government that provides both transfers and investment in public capital. It was shown that the addition of public capital tempers the M-W conclusions in various ways. First, the addition of public capital significantly lowers the growth effects from both capital and labor tax cuts. Specifically, the growth effects from capital tax cuts cover only 46 percent of lost revenue while labor tax cuts cover only one percent of lost revenue for the typical tax rate estimates of 25 percent for labor and capital. Second, the addition of public capital significantly alters the time it takes to reach a steady state. Specifically, increases in the productivity of public capital accelerate the movement toward the steady state while increases in public capital investment cause a deceleration to the steady state. Third, public capital affects the peak and shape of the Laffer curve. Increases in both public capital investment and public capital productivity skew the Laffer curve to the right and raises the peak tax rate. Because this peak indicates the point at which taxes can become self-financing, the rightward skew implies a lower likelihood that a tax cut can "pay for itself". The idea that the United States may be on the "right side" of the Laffer curve is controversial. Only under the Feldstein (2006) parameter values does this situation arise and only for capital tax cuts.

Directions for future research include two modeling extensions to come closer to actual U.S. tax policy. Because deficit spending has again become the norm for the federal government, the public capital model should be expanded to include debt financing. The second is to allow for temporary, rather than permanent, tax cuts to account for so-called "sunset" clauses in the current tax code. These modifications are likely to generate different growth effects and transition speeds than the model herein.

Appendix

The log-linearized differential equations used for the transition path of section 5 are derived in this appendix. The steady state equations from (13), (22) and (23) provide the dynamic system that is comprised of the following four differential equations.

$$\frac{\dot{c}}{c} = (1 - t_k)\beta k^{\beta-1} n^{1-\beta} g_I^{\alpha} - X \qquad (A1)$$

$$\frac{\dot{n}}{n} = \frac{(t_k - sF)\beta k^{\beta-1} n^{1-\beta} g_I^{\alpha} + \alpha sFk^{\beta} n^{1-\beta} g_I^{\alpha-1} - Z(\alpha + \beta) - \beta\frac{c}{k} + X}{(\frac{1}{\sigma} + \beta)} \qquad (A2)$$

$$\frac{\dot{k}}{k} = [1 - sF]k^{\beta-1} n^{1-\beta} g_I^{\alpha} - \frac{c}{k} - Z \qquad (A3)$$

$$\frac{\dot{g}_I}{g_I} = sFk^{\beta} n^{1-\beta} g_I^{\alpha-1} - Z \qquad (A4)$$

where $F = (1 - \beta)t_n + \beta t_k$, $Z = (z + \delta)$ and $X = (\rho + \delta + z)$. For results that can be interpreted economically, the equations are simplified using the parameter values of $\gamma = 1$. The system of equations (A1)-(A4) is log-linearized as follows.

$$\frac{dlnc}{dt} = (1 - t_k)\beta e^{(\beta-1)(lnk - lnn)} e^{\alpha lngI} - X \qquad (A5)$$

$$\frac{dlnn}{dt} = \frac{1}{(\frac{1}{\sigma} + \beta)}[(t_k - sF)\beta e^{(\beta-1)(lnk - lnn)} e^{\alpha lngI} + \alpha sFe^{\beta lnk} e^{(1-\beta)lnn} e^{(\alpha-1)lngI} - \beta e^{(lnc - lnk)} + X - Z(\beta + \alpha)] \qquad (A6)$$

$$\frac{dlnk}{dt} = (1 - sF)e^{(\beta-1)(lnk - lnn)} e^{\alpha lngI} - e^{(lnc - lnk)} - Z \qquad (A7)$$

$$\frac{dlng_I}{dt} = sFe^{\beta lnk} e^{(1-\beta)lnn} e^{(\alpha-1)lngI} - Z \qquad (A8)$$

From these equations, the following three steady state conditions arise.

$$e^{(\beta-1)(lnk^* - lnn^*)} e^{\alpha lngI^*} = \frac{X}{\beta(1 - t_k)}$$

$$e^{(lnc - lnk)} = (1 - sF)\frac{X}{\beta(1 - t_k)} - Z$$

$$e^{\beta lnk} e^{(1-\beta)lnn} e^{(\alpha-1)lngI} = \frac{Z}{sF}$$

A first-order Taylor-series approximation to equations (A5)-(A8) around their steady state values is made and the resulting system of equations is put into matrix form.

$$\begin{bmatrix} \frac{d\ln c}{dt} \\ \frac{d\ln n}{dt} \\ \frac{d\ln k}{dt} \\ \frac{d\ln g_I}{dt} \end{bmatrix} = \begin{bmatrix} 0 & (1-\beta)X & (\beta-1)X & \alpha X \\ \frac{Z\beta^2(1-t_k) - \beta(1-sF)X}{(\frac{1}{\sigma}+\beta)(1-t_k)} & \frac{(1-\beta)[DX+\alpha Z(1-t_k)]}{(\frac{1}{\sigma}+\beta)(1-t_k)} & \frac{[(1-t_k)+\beta D]X - Z\beta(1-t_k)(1-\alpha)}{(\frac{1}{\sigma}+\beta)(1-t_k)} & \frac{\alpha[DX - Z(1-\alpha)(1-t_k)]}{(\frac{1}{\sigma}+\beta)(1-t_k)} \\ \frac{Z(1-t_k)\beta - (1-sF)X}{\beta(1-t_k)} & \frac{(1-sF)(1-\beta)X}{\beta(1-t_k)} & \frac{[X(1-sF) - Z(1-t_k)]}{(1-t_k)} & \frac{(1-sF)\alpha X}{\beta(1-t_k)} \\ 0 & (1-\beta)Z & \beta Z & -(1-\alpha)Z \end{bmatrix} \begin{bmatrix} \ln(\frac{c}{c^*}) \\ \ln(\frac{n}{n^*}) \\ \ln(\frac{k}{k^*}) \\ \ln(\frac{g_I}{g_I^*}) \end{bmatrix}$$

where $Z = (z + \delta)$, $B = (1 - F)$, $X = (\delta + \rho + z)$ and $D = (t_k - F)$. Using computational software, the four eigenvalues of this system – denoted λ_1, λ_2, λ_3 and λ_4 – can be derived from the above 4x4 matrix. Two positive and two negative eigenvalues result indicating the system is saddle path stable. Each eigenvalue has a corresponding eigenvector comprised of four values – denoted $v_{1,i}$, $v_{2,i}$, $v_{3,i}$, and $v_{4,i}$, where $i = 1, 2, 3, 4$. With these results, the paths of the log values of c, n, k and g_I can be described as follows.

$$\ln c = \ln c^* + v_{1,1}e^{\lambda 1t}x_1 + v_{1,2}e^{\lambda 2t}x_2 + v_{1,3}e^{\lambda 3t}x_3 + v_{1,4}e^{\lambda 4t}x_4$$
$$\ln n = \ln n^* + v_{2,1}e^{\lambda 1t}x_1 + v_{2,2}e^{\lambda 2t}x_2 + v_{2,3}e^{\lambda 3t}x_3 + v_{2,4}e^{\lambda 4t}x_4$$
$$\ln k = \ln k^* + v_{3,1}e^{\lambda 1t}x_1 + v_{3,2}e^{\lambda 2t}x_2 + v_{3,3}e^{\lambda 3t}x_3 + v_{3,4}e^{\lambda 4t}x_4$$
$$\ln g_I = \ln g_I^* + v_{4,1}e^{\lambda 1t}x_1 + v_{4,2}e^{\lambda 2t}x_2 + v_{4,3}e^{\lambda 3t}x_3 + v_{4,4}e^{\lambda 4t}x_4$$

where x_1, x_2, x_3 and x_4 are the coefficients of integration are determined by the initial conditions. Because $\lambda_1 > 0$ and $\lambda_4 > 0$, $v_{11} = v_{21} = v_{31} = v_{41} = 0$ and $v_{14} = v_{24} = v_{34} = v_{44} = 0$ must hold for $c(t)$, $n(t)$, $k(t)$ and $g_I(t)$ to asymptote toward their steady states. In essence, $v_{i,1} > 0$ and $v_{i,4} > 0$ for $i = 1, 2, 3, 4$ would violate the transversality condition and $v_{i,1} < 0$ and $v_{i,4} < 0$ would lead to $c \rightarrow 0$, $n \rightarrow 0$, $k \rightarrow 0$ and $g_I \rightarrow 0$ as $t \rightarrow \infty$. Thus only λ_2 and λ_3 are relevant eigenvalues for the time paths and they represent the exponential speed by which the variables move toward their steady state values. The resulting equations are

$$\ln c = \ln c^* + v_{1,2}e^{\lambda 2t}x_2 + v_{1,3}e^{\lambda 3t}x_3$$
$$\ln n = \ln n^* + v_{2,2}e^{\lambda 2t}x_2 + v_{2,3}e^{\lambda 3t}x_3$$
$$\ln k = \ln k^* + v_{3,2}e^{\lambda 2t}x_2 + v_{3,3}e^{\lambda 3t}x_3$$
$$\ln g_I = \ln g_I^* + v_{4,2}e^{\lambda 2t}x_2 + v_{4,3}e^{\lambda 3t}x_3$$

Once the values for x_i, and $v_{j,i}$, are found, they can be combined with the new steady state values, k^*, n^* and g_I^* to define the system of log variables ln$c$, ln$n$, ln$k$ and lng_I. The path of revenues over time is derived by substituting these values into

$$R_t = [\beta t_k + (1 - \beta)t_n]k_t^{\beta}n_t^{1-\beta}g_{It}^{\alpha}$$

The numerical results in section five come from these derivations.

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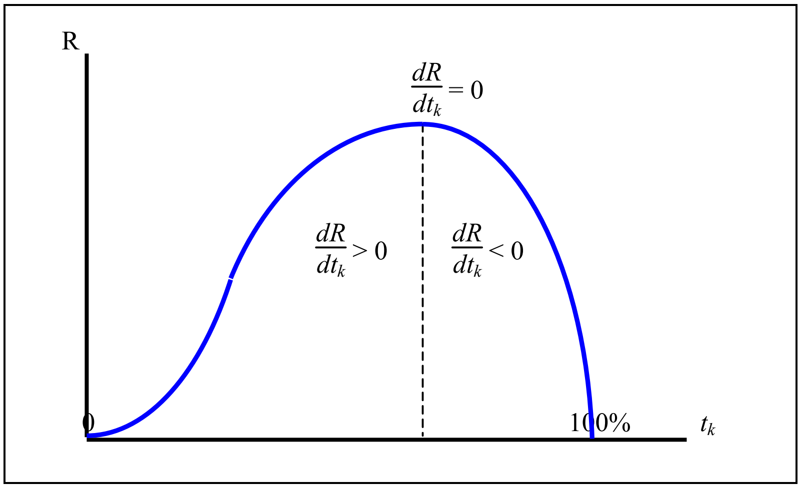

Figure 1

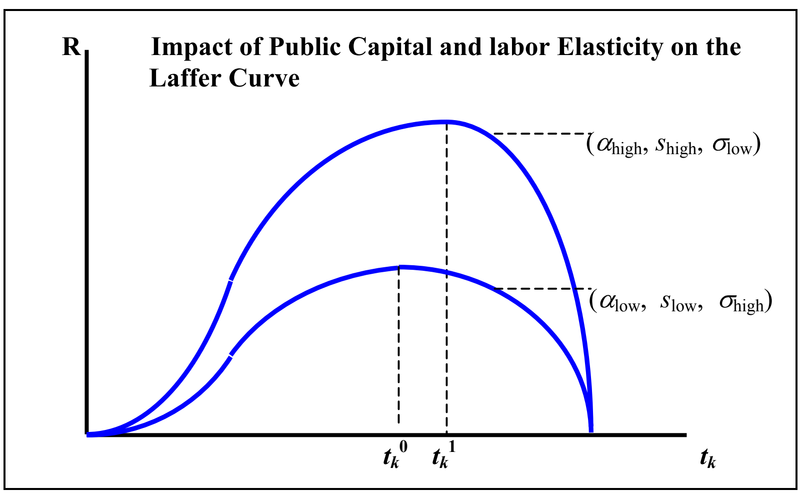

Figure 2

Feedback Effects and Laffer Peaks				
	M-W Model		**Model with Public Capital**	
Parameter Values: $\delta = 0.04$, $s = 0.1$, $\beta = 0.1$, $\alpha = 0.33$, $\sigma = 0.5$, $n = 0$, $z = 0.02$, $\rho = 0.05$, $\psi = 3$ and $\gamma = 1$.	*M-W parameters* $t_n = t_k = ¼$	*Feldstein parameters* $t_n = 0.45$ $t_k = ½$	*M-W parameters* $t_n = t_k = ¼$	*Feldstein parameters* $t_n = 0.45$ $t_k = ½$
Inelastic Labor Model (Elastic Labor Model)				
$\frac{dR}{dt_k}$ **Feedback Effect**	0.5 (0.474)	-0.4 (-0.447)	0.588 (0.536)	-0.471 (-0.565)
$\frac{dR}{dt_n}$ **Feedback Effect**	1 (0.833)	1 (0.576)	1.1765 (0.992)	1.1765 (0.699)
$\frac{dR_{tk}}{dt_k}$ **Feedback Effect**	0.833 (0.825)	0.5 (0.483)	0.863 (0.856)	0.475 (0.461)
$\frac{dR_{tn}}{dt_n}$ **Feedback Effect**	1 (0.889)	1 (0.727)	1.118 (0.994)	1.113 (0.806)
$\frac{dR}{dt_k}$ **Laffer Peak**	0.5 (0.489)	0.367 (0.3483)	0.863 (0.493)	0.475 (0.354)
$\frac{dR}{dt_n}$ **Laffer Peak**	NA (0.708)	NA (0.6875)	NA (0.723)	NA (0.693)
$\frac{dR_{tk}}{dt_k}$ **Laffer Peak**	2/3 (0.662)	2/3 (0.662)	0.652 (0.648)	0.646 (0.642)
$\frac{dR_{tn}}{dt_n}$ **Laffer Peak**	NA (0.75)	NA (0.75)	NA (0.75)	NA (0.7464)

Table 1

Dynamic Growth Effects Along Transition Path for a 1% Tax Cut (in percentage terms)				
	M-W Models		**Stinespring Models**	
	M-W parameters $t_n = t_k = ¼$	*Feldstein parameters* $t_n = 0.45$ $t_k = ½$	*M-W parameters* $t_n = t_k = ¼$	*Feldstein parameters* $t_n = 0.45$ $t_k = ½$
Elastic Labor Models				
Time	**Capital Tax Cut**	**Labor Tax Cut**	**Capital Tax Cut**	**Labor Tax Cut**
Immediate Impact	10.6	12.3	12.5	-99.28
1 year	13	12.6	20.2	-99.19
3 years	17.4	13	31	0
5 years	21.3	13.5	37.65	0
10 years	29.1	14.3	44.95	0.1
20 years	NA	NA	47.67	0.1
Steady State Impact	47	16.7	48.61	0.1

Table 2

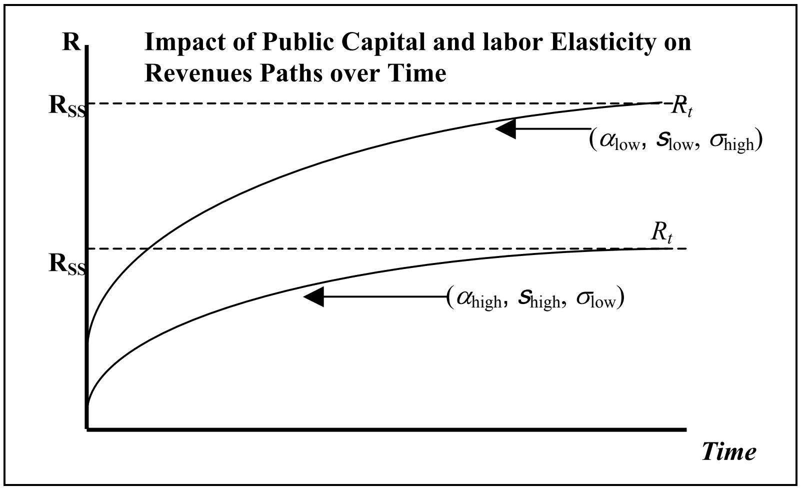
R
Impact of Public Capital and labor Elasticity on Revenues Paths over Time
RSS
Rt
(αlow, slow, σhigh)
RSS
Rt
(αhigh, shigh, σlow)
Time

Figure 3