ECONOMIC GROWTH AND TAX POLICY

Scheduled for a Public Hearing
Before the
HOUSE COMMITTEE ON WAYS AND MEANS
on May 18, 2017

Prepared by the Staff
of the
JOINT COMMITTEE ON TAXATION

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CONTENTS

INTRODUCTION AND SUMMARY

The House Committee on Ways and Means has scheduled a public hearing on May 18, 2017, on how tax reform will grow our economy and create jobs across America. This document,[1] prepared by the staff of the Joint Committee on Taxation, includes an overview of economic growth and the effect that taxes may have on economic growth.

Part I of this document discusses four principal determinants of economic growth that tax policy may be able to influence. These are changes in labor supply, capital investment, human capital accumulation, and technological progress. In general, output (the real value of goods and services) is a function of the amount of labor and capital supplied and the productivity of that labor. Growth (increases in output) can occur through the supply of additional hours of labor with existing levels of capital and existing technologies. However, growth also occurs if workers are made more productive. Only the latter, however, improves wages and living standards. Workers become more productive if their personal skills, referred to as human capital, improve through increases in education or other training and experience. Workers also become more productive if they have access to more capital, as a result of investment, or better capital, which can result from the development of new technologies.

Tax policy may influence growth because it may affect these inputs to production. Taxes on labor reduce the returns to supplying additional labor, and capital income taxes reduce the returns to supplying additional capital, thus potentially reducing economic output. Tax policy changes might mitigate any negative growth effects from current taxes, for example, by selective subsidies that support formal education and job training, or that promote investments in research and new technologies.

Part II of this document provides some historical data on growth in productivity, real gross domestic product ("GDP"), the labor force and changing labor force participation rates, and in workers' real compensation per hour.

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[1] This document may be cited as follows: Joint Committee on Taxation, *Economic Growth and Tax Policy* (JCX-19-17), May 16, 2017. This document can also be found on the Joint Committee on Taxation website at www.jct.gov.

I. ECONOMIC GROWTH

A. Overview

Determinants of economic growth

One goal that policymakers often pursue when designing tax policy—and economic policy in general—is promoting economic growth. A common measure of a country's economic performance is the change in its GDP, defined as the market value of final goods and services produced by labor and property within a country during a given time period. Economic growth typically refers to increases in GDP, although economists have proposed broader measures of economic well-being.[2] Economists have identified a number of factors that affect economic growth, including geography, political institutions, property rights, mechanisms for technology diffusion, and financial markets.[3] This document, however, will focus on four specific factors that are particularly relevant for tax policy: labor supply, physical capital (*e.g.*, equipment, buildings, and infrastructure), human capital (*e.g.*, education and health), and technological progress (*i.e.*, improvements in how labor and capital can be combined to produce goods and services). One review of the economic research on growth concludes that differences in physical capital account for 20 percent of cross-country differences in income, while differences in human capital and total factor productivity ("TFP"), also known as multifactor productivity, account for 10 to 30 percent and 50 to 70 percent, respectively.[4] TFP encompasses factors that affect growth through channels other than physical capital and human capital, such as technology and the efficiency of resource allocation in the economy, and has been the subject of much study.[5]

Tax policy and economic growth

To understand how tax policy may change GDP by affecting labor supply, physical capital, human capital, and technological progress, it is useful to think of GDP as being the product of the amount of labor supplied in the economy and the average productivity of that labor. Labor productivity is a reflection of a number of factors, including workers' human capital, the physical capital with which they work, and the technology available to them.

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[2] For example, see Joseph E. Stiglitz, Amartya Sen, and Jean-Paul Fitoussi, "Report by the Commission on the Measurement of Economic Performance and Social Progress," Commission on the Measurement of Economic Performance and Social Progress, 2009. Among other things, the report advocates the incorporation of more subjective measures of economic well-being. The report is available at http://www.stiglitz-sen-fitoussi.fr/documents/rapport_anglais.pdf.

[3] For a discussion of these factors, see Daron Acemoglu, *Introduction to Modern Economic Growth*, Princeton University Press, 2009.

[4] Chang-Tai Hsieh and Peter J. Klenow, "Development Accounting," *American Economic Journal: Macroeconomics*, vol. 2, no. 1, January 2010, pp. 207-223.

[5] See Daron Acemoglu, *Introduction to Modern Economic Growth*, Princeton University Press, 2009.

Tax policy can directly influence the level of labor supply, physical capital, human capital, and technology in an economy by changing the after-tax returns to certain economic activities or changing the cost of pursuing such activities. Lowering individual tax rates on wages, for example, can increase labor supply by raising the after-tax returns to labor.[6] Reducing business income tax rates increases the after-tax return to capital and can encourage businesses to invest in physical capital, which could make workers more productive. Policies that lower the cost of education can encourage individuals to invest in their human capital, and policies that subsidize research may promote technological innovation. To the extent that these policies increase labor supply, raise physical and human capital, and promote technological innovation, they will increase economic output.

While these policies encourage economic activities that, by themselves, can promote economic growth, they have a budgetary cost. If they increase Federal budget deficits, the resulting decrease in national savings and private domestic investment may offset at least some of the growth effects of these policies in the long run.[7]

Tax policy and economic efficiency

While taxes may affect economic output directly as discussed above, taxes may also affect output levels indirectly by influencing how efficiently resources, such as labor and capital, are allocated in the economy. As economic resources are allocated more efficiently (*i.e.*, are increasingly directed to their most productive use), average labor productivity increases. Taxes generally lead to economy-wide distortions that reduce economic efficiency, but in some cases taxes can correct for market failures and thereby increase economic efficiency. The effect of taxes on economic efficiency depends on both the nature of the tax and the economic activity being taxed.

Taxes and reductions in economic efficiency: distortions in labor and capital markets

In general, any system of raising revenue alters the prices of goods and services, or the supply of labor or capital, and potentially distorts economic decision-making. These distortions generally lead to economic inefficiencies to the extent that the tax system is not correcting for market failures.[8] In analyzing tax systems, economists often emphasize the importance of

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[6] The increase in the after-tax return to labor may cause the worker to substitute some time spent working for time previously spent in leisure (the "substitution effect"). However, an increase in income also increases the ability to enjoy more leisure (the "income effect"), which has an offsetting effect on labor supply. Labor supply increases only if the substitution effect outweighs the income effect.

[7] Jonathan Huntley, "The Long-Run Effects of Federal Budget Deficits on National Saving and Private Domestic Investment," CBO Working Paper 2014-02, February 2014.

[8] An exception to this is a "head tax" or "lump sum" tax, which imposes a fixed tax on all individuals without regard to any behavior. Such a tax reduces the after-tax resources available to the individual, but does not change prices and thus does not distort choices a consumer faces in the absence of the tax. For a review of measures

marginal tax rates because, they argue, marginal tax rates affect incentives for taxpayers to work, to save, or to take advantage of various tax preferences.[9] These incentives may distort taxpayer choice, which in turn may promote an inefficient allocation of society's labor and capital resources. A less efficient allocation of labor and capital resources leaves society with a lower level of output of goods and services than it would enjoy in the absence of the distortions caused by the tax system.

Economists have shown that the efficiency loss from taxation increases as the marginal tax rate increases. That is, a one percentage point increase in a marginal tax rate from 40 percent to 41 percent creates a greater efficiency loss per dollar of additional tax revenue than a one percentage point increase in a marginal tax rate from 20 percent to 21 percent.[10] Thus, to minimize economic inefficiency, economists in general have long recommended a broad base of taxation to keep marginal tax rates as low as possible to raise a given level of revenue. A broader base may also promote a more efficient allocation of resources by eliminating preferential treatment of certain activities over others and by reducing the scope of distortionary behavioral responses to taxation.

<u>Taxes and increases in economic efficiency: correcting for market failures</u>

While taxes may have distortionary effects, tax policy can lead to a more efficient allocation of resources when it is used to correct for market failures. A common economic rationale for government intervention in certain markets (including many aspects of energy markets and the market for innovation) is that there may be "externalities" in the consumption or production of certain goods. The externalities lead to "market failures," wherein either too little or too much of certain economic activity occurs relative to the socially optimal level of activity. An externality exists when, in the consumption or production of a good, there is a difference between the cost (or benefit) to the participants in the market for the good from its consumption or production and the cost (or benefit) to society as a whole. When the economy-wide, or "social," costs of a certain economic activity (*e.g.*, production or consumption of a certain good) exceed the private costs of that activity, a negative externality exists, and the level of that activity is above that which is socially optimal. In contrast, when the social benefits from a certain

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of the efficiency cost of taxation, see Alan J. Auerbach and James R. Hines, "Taxation and Economic Efficiency," in Alan J. Auerbach and Martin Feldstein (eds.), *Handbook of Public Economics,* vol. 3, pp. 1347-1421.

[9] The marginal tax rate is the rate that applies to the last dollar of income earned by the taxpayer. As a result of phase-outs and phase-ins of tax preference items (such as income exclusions or deductions and credits), a taxpayer's effective marginal tax rate may differ from the taxpayer's statutory marginal tax rate. In contrast to a taxpayer's marginal tax rate, a taxpayer's average tax rate is the taxpayer's total tax paid as a percentage of the taxpayer's total income.

[10] The magnitude of the efficiency loss from taxation depends upon a measure of the taxpayer's behavioral response, or the elasticity, and the square of the total effective marginal tax rate. Hence, a small change in an effective marginal tax rate can create an efficiency loss that is large in relation to the change in revenue. For a detailed discussion of this point, see Joint Committee on Taxation, *Methodology and Issues in Measuring Changes in the Distribution of Tax Burdens* (JCS-7-93), June 14, 1993, pp. 20–31 and Harvey S. Rosen, *Public Finance,* McGraw-Hill, 2004.

activity exceed the private benefits, a positive externality exists, and the level of that activity is below that which is socially optimal.

The reason the level of economic activity is either above or below that which is socially optimal in markets with externalities is that individuals and firms generally take into account the personal, or private, benefits and costs of their decisions, and ignore the benefits received, and costs incurred, by other market participants. Thus, they engage in economic activity up to the point where their private marginal benefit equals their private marginal cost. But, from an economy-wide perspective, economic activity should occur up to the point where the social marginal benefit (*i.e.*, the benefits accruing to the entire economy and not only to the individual or firm engaged in the activity) equals the social marginal cost (*i.e.*, the costs incurred by individuals and firms in the economy as a whole and not only by the individual or firm engaged in the activity). Privately optimal economic decisions may not be socially optimal. Absent some intervention, private actions lead to the socially optimal level of consumption or production only when there are no externalities, because only in that case are private costs and benefits equal to social costs and benefits.

Taxes are one tool that policymakers can use to correct for market failures. For example, policymakers can promote activities that create positive externalities through a tax subsidy to lower the after-tax price of the good to the consumer or increase the after-tax profit to the producer. An example where a positive externality is thought to exist is in basic scientific research, as the social payoffs to such research are not fully captured by private parties that undertake, and incur the cost of, such research. This is one rationale for the tax credit for increasing research activities.[11] In addition, policymakers can discourage activities that lead to negative externalities by taxing those activities to raise the after-tax price to the consumer or decrease the after-tax profit to the producer. Pollution is an example of a negative externality, because the costs of pollution are borne by society as a whole rather than solely by the polluters themselves. An example of a tax policy to raise the after-tax price of certain pollutants is the excise tax on ozone-depleting chemicals.[12]

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[11] Sec. 41.

[12] Sec. 4681.

B. Labor Supply

Labor supply and economic growth

The amount of labor supplied in the economy is a fundamental determinant of economic output. Increases in labor supply, holding average labor productivity constant, increase economic output. Tax policy affects labor supply by changing the after-tax returns to working. A number of factors—including labor market regulations and the size and demographic profile of the population—can influence the total amount of labor supplied in the economy. Declines in labor force participation among the young may reflect increased school enrollment, while changes in the demand for certain types of skills may explain some of the decline in labor force participation among prime-aged males. The change in labor force participation among older workers may also be attributable to changes in skills demanded as well as to changes in social security and movement away from defined benefit retirement plans. General aging of the population may also be responsible for a decline in labor force participation rates, as retirees constitute a larger share of the population and have lower participation rates than prime-age workers.[13]

Changes in the U.S. labor force, the civilian employment to population ratio, and the labor force participation rate over time are shown in Figures 4, 5, and 6 in Part II of this document. The labor force has grown faster than the population, though the growth has not been uniform. For example, Figure 6 in Part II depicts the rise, and relatively recent decline, in labor force participation rates among women between 1948 and 2016, and the general downward trend in labor force participation rates among men in the same period.

In the basic economic model of labor supply, an individual decides how to allocate time between two activities—labor and leisure. One important determinant of this choice is the wage that an individual receives from working (*i.e.*, the return to labor). An increase in wages has two countervailing effects on an individual's labor supply decision. On the one hand, an increase in wages increases the opportunity cost of leisure (*i.e.*, forgone wages) and encourages individuals to consume less leisure and work more (the "substitution effect"). On the other hand, an increase in wages increases individual income, which will lead to an increase in the consumption of goods and activities that typically rise with income, including leisure (the "income effect"). Economists generally find that the substitution effect outweighs the income effect, so an increase in wages increases labor supply.[14]

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[13] See Willem van Zandweghe, "Interpreting the Recent Decline in Labor Force Participation," *Federal Reserve Bank of Kansas City Economic Review*, vol. 97, no. 1, First Quarter 2012, pp. 5-34 and Chinhui Juhn and Simon Potter, "Changes in Labor Force Participation in the United States," *Journal of Economic Perspectives*, vol. 20, no. 1, Summer 2006, pp. 27-46.

[14] These studies are described below. It is important to note that the responsiveness of labor supply (*i.e.*, hours worked) to taxes depends on a number of factors, including the institutional features of the labor market. For example, if workers have difficulty adjusting the number of hours they work (*e.g.*, they have a generally fixed 40-hour work-week), their labor supply may be less responsive to changes in taxes than would be the case if they had

Taxes affect labor supply by affecting the after-tax return to labor. Increases in the tax rate on labor reduce the after-tax return to labor and provide an incentive for individuals to work less. Partially offsetting this effect, increases in taxes reduce after-tax income and provide an incentive to work more to replace the lost income. This can have two effects on economic output. First, reductions in labor supply lead to reductions in economic output (holding average labor productivity constant). Second, a tax on labor may reduce economic output indirectly by distorting work effort and occupational choice (lowering average labor productivity). A large economics literature, summarized below, has studied the effect of taxes on hours worked, while fewer studies have been conducted on the effect of taxes on work effort and occupational choice.[15] A number of studies separately identify the effect of taxes on the hours worked by those individuals who are already employed (the "intensive margin" or "hours margin"), and the effect of taxes on the decision to work or not (the "extensive margin" or "participation margin"). Responses on both the intensive and extensive margins affect the amount of labor supplied in the economy.

Empirical studies

The empirical literature relating to taxes on labor income and labor supply studies the labor supply decision for a variety of subgroups of the population, as well as labor supply in the economy as a whole.[16] Although labor supply estimates for even the same population subgroup

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more flexibility in choosing the number of hours they work. For a discussion of how these adjustment costs, and other factors, may affect estimates of the responsiveness of labor supply to tax changes, see Raj Chetty, "Bounds on Elasticities with Optimization Frictions: A Synthesis of Micro and Macro Evidence on Labor Supply," *Econometrica*, vol. 80, no. 3, May 2012, pp. 969-1018.

[15] Research on the responsiveness of taxable income to changes in tax rates partly accounts for the possible distortions of tax on work effort and occupational choice, to the extent that taxable income is determined by work effort and occupational choice. For example, if individual income tax rates are lowered, and work effort increases without any change in hours worked, that may increase the amount of income a worker receives (*e.g.*, bonuses) but does not affect hours worked (*i.e.*, labor supply). However, observed changes in taxable income as a result of changes in tax rates are not solely attributable to changes in work effort. An additional behavioral response is often for taxpayers to shift income into a form that is taxed more favorably. For a discussion of the literature on responsiveness of taxable income to change in tax rates, as well as the limitations in this line of research, see Emmanuel Saez, Joel Slemrod, and Seth H. Giertz, "The Elasticity of Taxable Income with Respect to Marginal Tax Rates: A Critical Review," *Journal of Economic Literature*, vol. 50, no. 1, pp. 3-50, March 2012.

[16] For reviews, see Robert McClelland and Shannon Mok, "A Review of Recent Research on Labor Supply Elasticities," Congressional Budget Office Working Paper 2012-12, October 2012; Michael P. Keane, "Labor Supply and Taxes," *Journal of Economic Literature*, vol. 49, no. 4, December 2011, pp. 961-1075; and Richard Blundell and Thomas MaCurdy, "Labor Supply: A Review of Alternative Approaches," in Orley Ashenfelter and David Card (eds.), *Handbook of Labor Economics*, vol. 3, North-Holland Publishing Co., 1999, pp. 1559-1695. The literature discussed herein refers primarily to studies that rely on variation in labor supply at the micro-level (in contrast to variation in aggregate labor supply) in response to taxes to estimate the sensitivity of labor supply to taxes. For a discussion of comparison of the micro- and macro-based literatures, see Raj Chetty, Adam Guren, Dayanand Manoli, and Andrea Weber, "Does Indivisible Labor Explain the Difference between Micro and Macro Elasticities? A Meta-Analysis of Extensive Margin Elasticities," in Daron Acemoglu, Jonathan Parker, and Michael Woodford (eds.), *NBER Macroeconomics Annual*, vol. 27, no. 1, 2012, University of Chicago Press, pp. 1-56.

may vary across studies, general qualitative conclusions have been developed for the responsiveness of certain population subgroups relative to others; these conclusions are described below.

Gender and marital status

The economics literature generally finds that the labor supply decisions of men and single women are less responsive to taxes than the labor supply decisions of married women.[17] Married women tend to be more responsive than men and single women on both the hours margin and participation margin. That is, higher taxes on wages are more likely to cause married women than men or single women to reduce their hours worked or exit the labor force entirely. In contrast, lower taxes on wages are more likely to cause married women, relative to men or single women, to increase their hours worked or to participate in the labor force. Studies have also found that labor supply of prime-age males is particularly unresponsive to taxes.[18]

Income level

Most empirical studies find that the labor supply decisions of low-income individuals are generally more responsive to taxes than the labor supply decisions of high-income individuals.[19] In particular, a number of papers studying the effect of the earned income tax credit find that it has a substantial effect on labor force participation among single mothers (the participation margin), although it has a negligible effect on the number of hours worked of those single mothers who are already employed (the hours margin).[20]

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[17] Robert McClelland and Shannon Mok, "A Review of Recent Research on Labor Supply Elasticities," Congressional Budget Office Working Paper 2012-12, October 2012.

[18] Emmanuel Saez, Joel Slemrod, and Seth H. Giertz, "The Elasticity of Taxable Income with Respect to Marginal Tax Rates: A Critical Review," *Journal of Economic Literature*, vol. 50, no. 1, pp. 3-50, March 2012. Prime-age males are defined as males ages 25 to 54.

[19] Robert McClelland and Shannon Mok, "A Review of Recent Research on Labor Supply Elasticities," Congressional Budget Office Working Paper 2012-12, October 2012.

[20] Nada Eissa and Hilary W. Hoynes, "Behavioral Responses to Taxes: Lessons from the EITC and Labor Supply," in James M. Poterba (ed.), *Tax Policy and the Economy*, vol. 20, 2006, pp. 73-110.

C. Capital Investment

Capital investment and economic growth

As discussed above, economic output may be understood as the product of labor supply and average labor productivity. Capital investment affects economic output by influencing average labor productivity. Capital investment takes on a variety of forms—such as equipment, buildings, factories, intellectual property, and transportation infrastructure—and is undertaken by both businesses and the government.[21] Although economists recognize the importance of capital in determining the amount of output a country produces, it is difficult to disentangle the relative contribution of the *quantity* of capital from that of the *quality* of capital (*i.e.*, the technology embodied therein) to economic growth. Nonetheless, the general consensus is that capital-output ratios—a measure of an economy's investment intensity—explain approximately 20 percent of cross-country differences in economic output.[22]

Tax policy and capital investment

A primary way tax policy can promote capital investment is by lowering the user cost of capital, which is the opportunity cost that a firm (user) incurs as a consequence of owning a capital asset.[23] A firm will purchase an asset only if the value of the goods produced by the asset meets or exceeds the user cost of capital. If the marginal return exceeds the user cost of capital, a firm can increase its profits by undertaking the investment. If the marginal return is less than the user cost, the firm would decrease its profits by undertaking the investment. Firms invest up to the point where the marginal return to capital assets just equals the user cost of capital. Thus, the user cost of capital is the return that equates the discounted present value of the investment's expected cash flow with the investment's cost, *i.e.*, it is the real before-tax internal rate of return on a marginally profitable investment.[24] If a firm can choose between production technologies, for example between one that is labor-intensive and another that is capital-intensive, then a key variable for the firm to consider is the user cost of capital. If the user cost of capital is relatively high, the firm may choose a less capital-intensive technology and vice versa.

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[21] This document focuses on capital investment made by businesses. The government also makes capital investments, including in infrastructure. For a discussion of investment by the Federal government in infrastructure, and the role of tax policy, see Congressional Budget Office and Joint Committee on Taxation, *Subsidizing Infrastructure Investment with Tax-Preferred Bonds*, October 2009.

[22] For a discussion, see Francesco Caselli, "Accounting for Cross-Country Income Differences," Phillipe Aghion and Steven N. Durlauf (eds.), *Handbook of Economic Growth*, vol. 1A, 2005, pp. 680-741. The measure of capital used in constructing capital-output measures typically includes both public and private investment.

[23] Harvey Rosen, *Public Finance*, Richard D. Irwin, Inc., 1985, p. 436. Dale W. Jorgenson, "Capital Theory and Investment Behavior," *American Economic Review*, vol. 53, no. 2, Papers and Proceedings of the Seventy-Fifth Annual Meeting of the American Economic Association, May 1963, pp. 247-259.

[24] James B. Mackie, III, "Unfinished Business of the 1986 Tax Reform Act: An Effective Tax Rate Analysis of Current Issues in the Taxation of Capital Income," *National Tax Journal*, vol. 55, June 2002, pp. 293-337.

The user cost of capital is a function of a number of tax and nontax variables, including: investment tax credits (if any), the statutory business income tax rate, the present value of tax depreciation deductions, the nominal corporate discount rate or cost of financing the asset, inflation, the present value of economic depreciation or decline in the value of the asset, and the appreciation or revaluation in the asset. Each variable represents a component of the cost of owning the asset (or, an offset to that cost) that must be recovered for the investment to be profitable.

The user cost of capital may be represented by the following equation:

$$user\ cost = \frac{(1-\theta-\tau*(x))}{(1-\tau)} \times [(i-\pi)+\delta-(\alpha-\pi)],$$

where θ is any investment tax credit,

τ is the statutory business income tax rate,

x is the present value of the tax depreciation deductions,

i is the nominal corporate discount rate, reflecting the mix of debt and equity financing,

π is the inflation rate,

δ is the present value of the economic depreciation, and

α is the appreciation or revaluation in the asset.

The equation illustrates how various factors can affect the user cost of capital. Higher investment tax credits and more generous tax depreciation deductions reduce the cost of capital. A higher tax rate, including the effect of capital gains and dividend taxes at the individual level, increases the user cost of capital, as the firm must give a greater portion of its return to the government. Higher financing costs, represented by the nominal corporate discount rate, increase the cost of capital. The faster an asset wears out with age (that is, the higher the rate of economic depreciation), the higher is the user cost of capital. Higher inflation-adjusted appreciation or revaluation in the asset reduces the user cost of capital.

There are tradeoffs in tax policy that affect the user cost of capital. For example, if, to achieve a revenue-neutral tax change, the corporate tax rate were reduced at the same time that tax depreciation were made less generous, these two changes would have offsetting effects on the user cost of capital. The net effect (if any) could increase or decrease the user cost of capital. Economists on the staff of the Joint Committee on Taxation have studied the issue and have published a study simulating the macroeconomic effects of a number of hypothetical proposals that would reduce the top statutory corporate tax rate from 35 percent to 30 percent.[25] One of the

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[25] See Nicholas Bull, Timothy A. Dowd, and Pamela Moomau, "Corporate Tax Reform: A Macroeconomic Perspective," *National Tax Journal*, vol. 64, no. 4, December 2011, pp. 923-941.

proposals involved financing a revenue-neutral reduction in the corporate tax rate with a partial repeal of the Modified Accelerated Cost Recovery System ("MACRS"). The study found that the proposal would lower the economy's long-run capital stock by between 0.2 and 0.4 percentage points. These simulation results suggest that slowing down cost recovery methods could reduce investment even if the corporate tax rate is reduced at the same time.

Financing costs

The user cost of capital reflects the financial cost of capital, that is, the opportunity cost of funds, adjusted for expected inflation. Therefore, the user cost of capital depends on how the investment is financed: with debt, equity, retained earnings, or some combination thereof. That is, the financing cost, denoted by i in the equation, is the real before-tax rate of interest the firm must pay to acquire the asset if debt-financed, the real before-tax rate of return required by shareholders if the asset is equity-financed, the real before-tax cost of internal equity if the asset is financed with retained earnings, or some weighted average of the three.[26]

Economic depreciation and tax depreciation

The user cost of capital also incorporates the rate of economic depreciation of the asset, denoted by δ in the equation. Economic depreciation reflects the rate at which a capital asset falls in value as it ages.[27] Firms must earn enough from capital investments to recover this economic depreciation; otherwise they would be better off investing in some other asset.

Greater tax depreciation allowances tend to lower the user cost of capital. Tax depreciation, denoted by x in the equation, often differs from economic depreciation, and since 1981 has generally been accelerated relative to economic depreciation.[28] To the extent that tax depreciation has a larger (smaller) present value than does economic depreciation—accelerated depreciation or in the extreme case, expensing—the user cost of capital may be lower (higher) than in the absence of the tax allowances.[29] The tax law can promote an inefficient distribution

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[26] Robert S. Chirinko, "Corporate Taxation, Capital Formation, and the Substitution Elasticity between Labor and Capital," *National Tax Journal*, 55, June 2002, pp. 339-355. A more complete treatment would also include the tax treatment of the financiers at the individual level. See James B. Mackie, III, "Unfinished Business of the 1986 Tax Reform Act: An Effective Tax Rate Analysis of Current Issues in the Taxation of Capital Income," *National Tax Journal*, vol. 55, June 2002, pp. 293-337.

[27] The definition of depreciation relevant to measurement of true economic income is economic depreciation, the true loss of economic value. Paul A. Samuelson, "Tax Deductibility of Economic Depreciation to Insure Invariant Valuations," *Journal of Political Economy*, vol. 72, December 1964, pp. 604-606.

[28] For a more detailed discussion of the legislative background of the tax depreciation rules, see Joint Committee on Taxation, *Background and Present Law Relating to Manufacturing Activities within the United States* (JCX-61-12), July 17, 2012, pp. 28ff.

[29] If full expensing of capital investment is permitted ($x = 1$) and there are no investment tax credits ($\theta = 0$), the tax term drops out of the user cost of capital equation above. If financing costs are nondeductible and there is no tax on investor returns, marginal investments bear a zero rate of tax.

of investment if it specifies tax depreciation rates that deviate from economic depreciation rates.[30] Some have argued, for instance, that depreciation provisions are more favorable to investment in equipment than investment in structures, which could result in a bias in favor of investment in equipment.[31] Nonetheless, tax rules can encourage more aggregate investment if tax depreciation rates, as a whole, are faster than economic depreciation rates.

Measuring economic depreciation

Although tax depreciation rates are defined by tax rules and relatively straightforward to calculate, measuring economic depreciation rates (*i.e.*, the change in market value of income-producing property) is more difficult. While economists have attempted to estimate economic depreciation rates for particular investments, no consensus has emerged regarding a general representation of a depreciation method applicable across broad classes of assets.[32] One method based on early estimates of economic depreciation is the alternative depreciation system ("ADS"). ADS assigns each investment a recovery period reflecting its useful life, and assumes that the investment depreciates in a straight-line pattern. The dollar amount of economic depreciation is assumed to be the same each year. For example, under ADS, agricultural machinery is assumed to have a useful life and recovery period of 10 years. Therefore, a $100 piece of agricultural machinery would have a constant depreciation deduction in the amount of $10 each year over its 10 year life. In the first year the depreciation rate would be 10 percent ($10/$100). In the second year, however, the remaining value is $90 while the tax depreciation deduction amount for the year is still $10, which represents a depreciation rate of 11.1 percent ($10/$90). The rate of economic depreciation for agricultural machinery varies under ADS from 10 percent in the first year to 100 percent in the tenth year.

However, some economists argue that assets do not depreciate by a constant dollar amount each year, but rather depreciate at a constant rate, that is, in a geometric pattern. In particular, some economists have found that assets depreciate the most in the first year of their useful life and by declining amounts in subsequent years. Data suggest that a geometric pattern, as opposed to a straight-line pattern, more closely matches the actual pattern of price declines for most asset types.

For example, one of the earliest and most prominent studies estimated that agricultural machinery depreciates at a 9.71-percent rate with a useful life of 17 years, which is longer than the ADS life.[33] The Bureau of Economic Analysis of the Department of Commerce ("BEA")

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[30] If tax depreciation equals economic depreciation ($x = \delta / (r + \delta)$) and there are no there are no investment tax credits ($\theta = 0$), then all types of marginal investments bear a rate of tax equal to the statutory rate (τ).

[31] Jane G. Gravelle, "Depreciation and the Taxation of Real Estate," Congressional Research Service Report RL3063, 2000.

[32] Jane G. Gravelle, "Whither Tax Depreciation," *National Tax Journal*, September 2001, pp. 513-526.

[33] Frank C. Wykoff and Charles R. Hulten, "The Measurement of Economic Depreciation," *Depreciation, Inflation, and the Taxation of Capital* (ed. Charles R. Hulten), 1981, pp. 81-125.

currently estimates an 11.79-percent rate of economic depreciation for agricultural machinery with a useful life of 14 years. In the case of agricultural machinery, the useful life under ADS may understate the economic useful life and therefore provide tax depreciation that is more generous than economic depreciation. A full comparison would need to adjust for the method of depreciation as well as the useful life.

BEA introduced a new methodology for calculating economic depreciation for purposes of the National Income and Product Accounts ("NIPA") in 1997 that relies on a constant rate of decay over estimated useful lives to compute rates of economic depreciation.[34] The purpose of these estimates is to measure the consumption of fixed capital for purposes of accurately measuring components of GDP. Instead of a small number of recovery periods for asset classes as under the present income tax depreciation rules, several hundred types of assets are identified. Each of these types is assigned a depreciation rate equal to the appropriate declining balance rates divided by the service life. BEA bases its economic depreciation patterns on empirical evidence of used asset prices in resale markets for each asset type wherever possible. The BEA describes its methodology for estimating economic depreciation as follows.

> BEA assumes most assets have depreciation patterns that decline geometrically over time. For any given year, the constant-dollar depreciation charge on an existing asset is obtained by multiplying the depreciation charge in the preceding year by one minus the annual depreciation rate.[35] BEA's geometric depreciation rates are derived by dividing declining balance rates by service lives.... Declining-balance rates are multiples of the comparable rate of depreciation that would be obtained for the first period of an asset's life using the straight-line method. Thus, when the declining balance rate is equal to 2 (referred to as a "double-declining balance"), the rate of depreciation in the first period of an asset's life is equal to twice the rate that would have been obtained using the straight-line method.[36]

On average the declining balance rate is 1.65 for equipment and 0.91 for private nonresidential structures. These serve as the default declining balance rates for assets for which no data are available. Table 1 provides the rate of economic depreciation, service life, and declining balance rate for selected types of assets, as estimated by the BEA. It also lists the recovery periods for these types of assets under the current ADS and MACRS tax rules.

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[34] For a detailed discussion of the BEA methodology, see Barbara M. Fraumeni, "The Measurement of Depreciation in the U.S. National Income and Product Accounts," *Survey of Current Business*, 77, July 1997, pp. 7–23.

[35] New assets are assumed, on average, to be placed in service at midyear, so that depreciation on them in the first year is equal to one-half the new investment times the depreciation rate.

[36] U.S. Department of Commerce, Bureau of Economic Analysis, *Fixed Assets and Consumer Durable Goods in the United States, 1925-97*, Washington, DC: U.S. Government Printing Office, September, 2003, p. M-6, M-7.

Table 1.−BEA Economic Depreciation Rates and Service Lives Compared to ADS and MACRS Recovery Periods for Selected Asset Types

Type of Asset	BEA Rate of Depreciation	BEA Service Life	BEA Declining Balance Rate	ADS Class Life	MACRS Recovery Period
Software - Pre-packaged	0.5500	3	1.6500	3	3
Software - Custom*	0.3300	5	1.6500	3	3
Machinery (except tractors) - Construction	0.1550	10	1.5500	6	5
Equipment - Railroad	0.0589	28	1.6500	14	7
Farm tractors	0.1452	9	1.3064	4	3
Ships and boats	0.0611	27	1.6500	18	10
Machinery (except tractors) - Agricultural	0.1179	14	1.6500	10	7
Equipment (1978 and later years) - Office and accounting	0.3119	7	2.1832	6	5
Manufacturing structures	0.0314	31	0.9747	40	39
Office buildings, including medical buildings	0.0247	36	0.8892	40	39
Educational buildings	0.0188	48	0.9024	40	39
1-to-4-unit residential structures (new)	0.0114	80	0.9100	40	27.5
Trucks - Government, noncombat	0.2875	6	1.7252	6	5
Trucks - Used for trucking & other services (1992 & after)	0.1725	10	1.7252	6	5

*Excludes software development costs deducted in accordance with Rev. Proc. 2000-50, 2001-1 C.B. 601, as modified by Rev. Proc. 2007-16, 2007-1 C.B. 358.
Source: Bureau of Economic Analysis, Rev. Proc. 87-56.

Statutory business income tax rate

The income tax system also influences the user cost of capital through the statutory business income tax rate. The income tax raises the user cost of capital by increasing the required before-tax return to generate the same after-tax revenue to the firm. This requires more productive assets than would be needed without the additional cost of the income tax. More productive assets are more expensive than less productive assets.[37] A greater total cost for assets may increase the value of economic depreciation, partially offsetting the effect of the tax rate on the user cost of capital. To the extent that financing costs are (not) deductible against the business income tax, this may decrease (increase) the user cost of capital through the effect on the discount rate or opportunity cost of funds.

User cost of capital and investment

As described above, the tax system directly affects the user cost of capital. The effect of the tax system on investment, however, depends on how sensitive investment is to changes in the user cost of capital. If investment is relatively responsive to the user cost of capital, then policymakers can influence the level of investment by enacting changes in the business income tax rate, depreciation allowances, investment tax credits, or taxation of returns to investment at the individual level.

[37] A machine capable of producing 100 units of output per hour should cost more than a machine capable of producing only 50 units of output per hour.

Effective marginal tax rates on investment

In general

One way to measure the potential inefficiency in the allocation of capital is to calculate the effective marginal tax rate on investment. The effective marginal tax rate combines various features of the tax code as applied to a particular investment into a single rate that would offer the same investment incentives if that rate were applied directly to economic income.[38] The effective marginal tax rate may be calculated from the user cost of capital.[39] The effective marginal tax rate is the rate that would leave an after-tax real rate of return sufficient to cover the real financing costs of the investment and economic depreciation. Effective marginal tax rates are often used as a measure of investment incentives in lieu of the user cost of capital on which they are based. Tax changes that increase the user cost of capital also increase the effective marginal tax rate. Similarly, tax changes that reduce the user cost of capital also reduce the effective marginal tax rate. Increases (decreases) in the effective marginal tax rate tend to decrease (increase) investment in the long run, and thus decrease (increase) the size of the aggregate capital stock.

Economic output, however, depends not only on the size of the capital stock but also on its composition. In the absence of taxes, the operation of a competitive economy causes capital to flow to sectors where it is expected to earn the highest rate of return. This results in an allocation of investment that produces the largest amount of national income. However, if effective marginal tax rates differ across sectors of the economy, more capital may accumulate in lightly taxed sectors, and less capital may be invested in highly taxed sectors. This may result in an inefficient allocation of capital to sectors in which it earns a lower pre-tax rate of return, reducing total productivity and potential output across all sectors. Thus, the effect of a reduction in the economy-wide effective marginal tax rate on investment could be partially offset if the disparity in effective marginal tax rates across sectors increases.

Table 2, below, reports recent estimates from the Congressional Budget Office ("CBO") of effective marginal tax rates on capital income.[40] The overall effective marginal tax rate on capital income is 18 percent. However, the rate varies significantly depending on the form of

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[38] While useful for measuring marginal incentive effects, effective marginal tax rates are not relevant for purposes of comparing tax burdens on investors in particular activities or industries. The calculation of effective marginal tax rates depends on a concept of long-run equilibrium in which all investors earn the same risk-adjusted after-tax rate of return; therefore, differences in effective marginal tax rates do not reflect differences in investor returns. See James B. Mackie, III, "Unfinished Business of the 1986 Tax Reform Act: An Effective Tax Rate Analysis of Current Issues in the Taxation of Capital Income," *National Tax Journal*, vol. 55, June 2002, pp. 293-337.

[39] For a detailed description of the methodology and calculations involved, see Congressional Budget Office, *Computing Effective Tax Rates on Capital Income*, December 2006, available at http://www.cbo.gov/ftpdocs/76xx/doc7698/12-18-TaxRates.pdf.

[40] For a detailed description of the assumptions and calculations involved, see Congressional Budget Office, *Taxing Capital Income: Marginal Tax Rates Under 2014 Law and Selected Policy Options*, December 2014, available at http://www.cbo.gov/sites/default/files/cbofiles/attachments/49817-Taxing_Capital_Income_0.pdf.

business organization, the source of financing, and the type of investment. This variation contributes to distortions in the allocation of capital, which may reduce economic output.

Distortions by organizational form

Table 2, below, shows that the effective marginal tax rate on all business investment is 29 percent, with a higher rate in the corporate sector (31 percent) than in the noncorporate sector (27 percent). This difference is due in part to the presence of a separate corporate income tax and in part to most noncorporate income being taxed at relatively lower marginal rates. However, this difference is partially offset by the relatively greater share of corporate income relative to noncorporate income that is received by tax-favored retirement accounts.

Table 2.−Effective Marginal Tax Rates on Capital Income (2014)

Overall	18
Business	29
Corporate	31
Debt financed	-6
Equity financed	38
Noncorporate	27
Debt financed	8
Equity financed	30
Housing	
Tenant occupied	24
Owner occupied	-2
Debt financed	1
Equity financed	-3

Source: Congressional Budget Office.

Distortions by source of investment financing

The effective marginal tax rates shown in Table 2, above, are computed based on the mix of debt and equity financing observed in the corporate sector. To show the sensitivity of rates to the source of financing, effective marginal tax rates are recomputed assuming either all debt or all equity financing. The marginal tax rate on income from an all-debt-financed corporate investment is -6 percent versus 38 percent for an all-equity-financed corporate investment. The negative rate on income from an all-debt-financed corporate investment is attributable in part to deductions for both accelerated depreciation and interest expense which, in combination, exceed taxable income. This is partially offset by individual taxes on the interest income received; however, much of that interest income is generally taxed at individual marginal tax rates lower than the corporate marginal tax rate at which the interest paid is deductible, or is not taxed because it is received by tax-favored accounts (individual retirement accounts or accounts of tax-exempt investors, such as pension funds and endowments).

The marginal tax rate on income from an all-equity-financed corporate investment (38 percent) is higher than the top statutory corporate tax rate (35 percent) because of individual income taxation of dividends and capital gains, mitigated by the share of such income received by tax-favored accounts. Although these income flows are generally taxed at favorable rates at the individual level, they are not deductible by the corporation. Without considering these individual-level taxes, the rate on equity-financed corporate investment is lower than the statutory rate because of accelerated depreciation.

Preference for investment in housing

Table 2, above, shows that investment for both tenant-occupied and owner-occupied housing is tax-favored relative to business investment as a whole, with effective marginal tax rates of 24 percent and -2 percent, respectively. Rental housing is taxed at a lower rate than other business investment because of relatively generous depreciation schedules and other tax preferences, and the large portion of rental housing investment that occurs outside of the corporate sector. The negative rate on owner-occupied housing reflects the deductibility of mortgage interest and real property taxes and the exclusion of implicit net rental income and certain capital gains from gross income.[41]

Distortions in investment across asset classes

Variation in effective marginal taxes rates on investment may lead to distortions in the pattern of investment in the economy by favoring investment in certain types of assets over others. Table 3, below, provides a list of effective marginal tax rates on capital income of C corporations for a subset of assets analyzed by CBO, as well as MACRS recovery periods. The wide range in effective marginal tax rates among those assets listed generally arises because of differences between tax depreciation (the tax rules specifying how the costs of certain assets are recovered over time) and economic depreciation (the actual rate at which income-producing property declines in value over time).[42] Generally, effective marginal tax rates greater than the statutory tax rate reflect tax depreciation slower than economic depreciation, and *vice versa*.

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[41] See discussion of tax incentives for owner-occupied housing in Joint Committee on Taxation, *Present Law, Data, and Analysis Relating to Tax Incentives for Residential Real Estate* (JCX-10-13), April 22, 2013.

[42] In its analysis, CBO used economic depreciation rates estimated by the Bureau of Economic Analysis. See Department of Commerce, Bureau of Economic Analysis, *Fixed Assets and Consumer Durable Goods in the United States, 1925–97,* September 2003, Table B, p. M-30; Table C, pp. M-31–M-32; available at https://bea.gov/national/pdf/Fixed_Assets_1925_97.pdf. This methodology for measuring depreciation rates is different from depreciation represented by ADS. For a more extensive list of effective marginal tax rates and asset types, see Congressional Budget Office, *Taxing Capital Income: Marginal Tax Rates Under 2014 Law and Selected*

Table 3, below, shows that the effective marginal tax rates on certain assets—such as pre-packaged software (39.7 percent), inventories (39.0 percent), and office and accounting equipment (39.0 percent)—can exceed the top statutory corporate tax rate.[43] Other relatively heavily taxed assets listed in the table include computers and peripheral equipment (38.6 percent), manufacturing buildings (36.4 percent), and commercial buildings (34.2 percent). Among those assets listed in the table, relatively lower rates apply to communications equipment (23.2 percent), communication structures (21.5 percent), petroleum and natural gas structures (18.7 percent), and mining structures (14.7 percent).

Table 3.−Effective Marginal Tax Rates on Capital Income of C Corporations by Asset Type and MACRS Recovery Periods (2014)

Asset Type	Effective Marginal Tax Rate	MACRS Recovery Periods*
Pre-Packaged Software	39.7	3
Inventories	39.0	nondepreciable
Office and Accounting Equipment	39.0	5 or 7
Computers and Peripheral Equipment	38.6	5
Manufacturing Buildings	36.4	39
Commercial Buildings	34.2	39
Land	34.0	nondepreciable
Office Buildings (Including Medical)	33.8	39
Educational Buildings	32.3	39
Medical Equipment and Instruments	30.6	5**
Construction Machinery	30.3	5
Electric Transmission and Distribution	28.1	20
Automobiles	27.9	5
Residential Buildings	27.9	27.5
Agricultural Machinery	25.9	7

Policy Options: Supplemental Data, December 2014, available at https://www.cbo.gov/sites/default/files/113th-congress-2013-2014/reports/49817-supplementaldata0.xlsx.

[43] Research suggests that current tax depreciation schedule for computers measures their actual loss in value in a zero-inflation environment. However, because the tax code is not indexed for inflation, the present value of depreciation allowances may be too small in the presence of positive inflation rates. Mark E. Doms, *et al.*, "How Fast Do Personal Computers Depreciate? Concepts and New Estimates," in James M. Poterba (ed.), *Tax Policy and the Economy*, vol. 18, MIT Press, 2004, pp. 37-80.

Asset Type	Effective Marginal Tax Rate	MACRS Recovery Periods*
Farm Buildings	25.2	10 or 20
General Industrial Equipment	24.5	7
Special Industrial Machinery	23.5	3, 5, 7, 15, or 20
Communications Equipment	23.2	5, 7, or 10
Communication Structures	21.5	5, 7, 15, or 39
Petroleum and Natural Gas Structures	18.7	7, 10, 15, or 20
Mining Structures	14.7	7

* MACRS recovery periods may vary for certain asset categories because, among other reasons, the asset categories include a range of assets with varying recovery periods based on either the specific asset type or the business activity in which the asset is used.
** Excludes items treated as materials and supplies. See Treas. Reg. Sec. 1.162-3.
Source: Congressional Budget Office, Section 168, and Rev. Proc. 87-56, 1987-2 C.B. 674.

Evidence on the effect of tax policy on investment

The effect of the tax system on investment depends on how sensitive investment is to changes in the user cost of capital. If investment is relatively responsive to the user cost of capital, then policymakers can influence the level of investment by enacting changes in the corporate tax rate, depreciation allowances, investment tax credits, and/or taxation of returns to investment at the individual level.[44]

On balance, the economic literature on tax policy and investment supports the conclusion that changes in taxes have a noticeable effect on investment. One survey of the literature, for example, concludes that investment is highly responsive to changes in the cost of capital.[45] One study looking at the effect of the various tax reforms occurring between 1962 and 1988 finds that tax policy had a strong influence on the level of equipment investment.[46] Another study looks at the effect of changes in taxes on capital spending, instead of only investment in equipment, and

[44] The discussion in this document does not discuss estimates of the user cost of capital derived from changes in the taxation of capital income earned by individuals. For an example of this analysis, see Danny Yagan, "Capital Tax Reform and the Real Economy: The Effects of the 2003 Dividend Tax Cut," *American Economic Review*, vol. 105, no. 12, December 2015, pp. 3531-3563.

[45] Kevin A. Hassett and R. Glenn Hubbard, "Tax Policy and Business Investment," *Handbook of Public Economics*, Volume 3, (eds. Alan J. Auerbach and Martin Feldstein), North-Holland Publishing Co., 2002, pp. 1293-1343.

[46] Jason G. Cummins, Kevin A. Hassett, and R. Glenn Hubbard, "A Reconsideration of Investment Behavior Using Tax Reforms as a Natural Experiment," *Brookings Papers on Economic Activity*, vol. 2, 1994, pp. 1-74.

finds substantially smaller (although still noticeable) effects, suggesting that equipment investment is more sensitive to changes in taxes than investment in other assets, such as structures.[47] The authors also provide evidence that tax policy has a stronger influence on the investment behavior of financially constrained firms, which suggests that firms with less access to capital markets are particularly sensitive to changes in tax incentives for investment. This conclusion is consistent with the results of a recent paper relying on more comprehensive tax data.[48] The general hypothesis that financially constrained firms respond more to tax incentives for investment than less financially constrained firms, however, is still the subject of some debate.[49] Another paper studied the relationship between taxes and investment in 14 OECD countries, including France, Germany, Japan, the United Kingdom, and the United States.[50] The authors find that tax changes had a strong effect on equipment investment, although the evidence is less conclusive for investment in structures.

While economic research suggests that tax policy, in a broad sense, can affect investment, conclusions concerning the effect of changes in cost recovery methods in particular are more nuanced. For example, the effect of bonus depreciation on investment depends on the recovery period for a particular type of property. One paper finds that the bonus depreciation provisions enacted in 2002 (30 percent bonus depreciation) and 2003 (50 percent bonus depreciation) had a positive impact on capital investment, although the increase was concentrated in long-lived business equipment.[51] Along similar lines, other research finds that utilization rates for the bonus depreciation measures were higher for industries, such as telecommunications, where the long-lived investments by a small number of firms accounts for the bulk of investment.[52]

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[47] Robert S. Chirinko, Steven M. Fazzari, and Andrew P. Meyer, "How Responsive Is Business Capital Formation to Its User Cost? An Exploration with Micro Data," *Journal of Public Economics*, vol. 74, no. 1, 1999, pp. 53-80.

[48] Eric Zwick and James Mahon, "Do Financial Frictions Amplify Fiscal Policy? Evidence from Business Investment Stimulus," *American Economic Review*, vol. 107, no. 1, January 2017, pp. 217-248. The paper provides estimates of the responsiveness of investment to changes in the user cost of capital that are significantly greater than many previous studies.

[49] See, for example, Steven Kaplan and Luigi Zingales, "Do Financing Constraints Explain Why Investment Is Correlated with Cash Flow?," *Quarterly Journal of Economics*, vol. 112, no. 1, 1997, pp. 169-215.

[50] Stephen Bond and Jing Xing, "Corporate Taxation and Capital Accumulation: Evidence from Sectoral Panel Data for 14 OECD Countries," *Journal of Public Economics*, vol. 130, October 2015, pp. 15-31.

[51] Christopher House and Matthew Shapiro, "Temporary Investment Tax Incentives: Theory with Evidence from Bonus Depreciation," *American Economic Review*, vol. 98, June 2008, pp. 737-768.

[52] Matthew Knittel, "Corporate Response to Accelerated Tax Depreciation: Bonus Depreciation for Tax Years 2002-2004," Office of Tax Analysis Working Paper 98, May 2007.

Another paper, which focuses more on investments in assets with shorter recovery periods, finds that bonus depreciation had no effect on investment.[53]

A study of the bonus depreciation provisions of 2002 and 2003, as well as legislation enacted in 2003 that increased the maximum section 179 deduction from $25,000 to $100,000, finds that the fraction of small businesses claiming section 179 expensing changed little between 2001 or 2002 (when a $24,000 maximum section 179 deduction limitation applied), and 2003, when the limitation on deductions was raised.[54] Among small businesses, 39 percent of individuals and 54 percent of corporations claimed bonus depreciation in 2002, compared to 33 percent of individuals and 49 percent of corporations in 2003, when bonus depreciation was made more generous.[55] These results could have arisen for a number of reasons. For example, the benefit of bonus depreciation is generally smaller, in present value terms, for investments in property with shorter recovery periods than longer recovery periods. In addition, bonus depreciation and expensing provisions have little value for firms in significant net operating loss ("NOL") positions, since they do not receive any current cash tax savings under the provisions if they do not have a tax liability in the current year or an ability to carry back the additional loss generated through bonus depreciation or expensing.[56]

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[53] Darrel Cohen and Jason Cummins, "A Retrospective Evaluation of the Effects of Temporary Partial Expensing," *Board of Governors of the Federal Reserve System Finance and Economics Discussion Series*: 2006-19.

[54] Matthew Knittel, "Small Business Utilization of Accelerated Tax Depreciation: Section 179 Expensing and Bonus Depreciation," *National Tax Journal Proceedings-2005, 98th Annual Conference*, 2005, pp. 273-286.

[55] *Ibid*., p. 284.

[56] These companies often choose to forgo bonus depreciation to avoid increasing NOL carryforwards. NOLs are only allowed to be carried back two years and carried forward 20 years, so by deferring the depreciation deductions otherwise eligible under the bonus regime, taxpayers effectively extend the 20-year carryforward window. Note that while bonus depreciation may create or increase an NOL, section 179 deductions are limited to taxable income for the year (sec. 179(b)(3)).

D. Human Capital

Education, skill acquisition, and growth

Human capital, that is, the productive capacity represented by the level of knowledge, skills, and health[57] of the labor force, has long been recognized as an important factor in economic growth as well as a strong determinant of the earnings of individuals. One review of the economics literature indicates an additional year of schooling is associated with an increase in individual earnings on the order of 10 percent.[58] Education includes not only formal schooling, but also skills acquired through on-the-job training or otherwise.

Education can affect growth in a number of ways. At the most basic level, education increases human capital, thereby raising labor productivity and increasing the aggregate level of output in an economy for a given amount of labor input. Many studies of cross-country growth comparisons find a positive association between economic growth and measures of schooling obtained.[59] In addition to increasing the level of output of an economy, education may influence the rate of growth of an economy by spurring technological change and process innovations.[60]

Education may also influence growth by facilitating the transmission of the knowledge to understand and implement new technologies. One study in this regard posits that human capital externalities could explain the long-run income differences between rich and poor countries.[61] The sharing of knowledge and skills across workers is thought to be the mechanism for these spillover externalities. Another recent study of manufacturing plants found that these plants were significantly more productive in cities with higher human capital, holding constant the level of human capital employed at the individual plant.[62] Most of this effect was found in high-technology manufacturing plants, and little in nonhigh technology plants. The study estimated that human capital spillovers accounted for an average of one-tenth of one percent increase in output per year in the 1980s. Other studies have documented that, holding individual human

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[57] While health is considered an aspect of human capital, this document does not focus on the effects of health on economic growth.

[58] Alan Krueger and Mikael Lindahl, "Education for Growth: Why and For Whom?," *Journal of Economic Literature*, vol. 39, no. 4, December, 2001, p. 1101.

[59] For a review of this literature, see B. Sianesi and J. Van Reenen, "The Returns to Education: Macroeconomics" *Journal of Economic Surveys*, Volume 17(2), 2003, pp 157-200.

[60] R. R. Nelson and E. Phelps, "Investment in Humans, Technology Diffusion and Economic growth," *American Economic Review*, vol. 56 (2), 1966.

[61] See R. E. Lucas, "On the Mechanics of Economic Development," *Journal of Monetary Economics*, 1998, vol. 22; and P. Aghion and P. Howitt, *Endogenous Growth Theory*, (Cambridge, MA. The MIT Press), 1998.

[62] Enrico Moretti, "Workers' Education, Spillovers and Productivity: Evidence from Plant-Level Production Functions," *American Economic Review*, vol. 94, no. 3, 2004, pp. 656-690.

capital constant, wages are higher in cities with higher human capital. One such study finds that a one percentage point increase in the share of college graduates in the labor force increases the wages of high school dropouts, high school graduates, and college graduates by 1.9 percent, 1.6 percent, and 0.4 percent, respectively.[63]

Recent work recognizes that time in school does not produce the same level of cognitive skills everywhere, and that the quality of schooling (as measured, for example, by performance on achievement tests) is important in determining the true effect of education on growth. These studies tend to find that the level of cognitive skills, rather than years of schooling per se, has the stronger association with economic growth.[64]

Many factors besides education, such as the institutional environment of a country, also play a role in economic growth.[65] However, education itself may foster these institutional factors that affect growth.[66] Research shows that education likely confers benefits for the larger community in addition to its impacts on productivity growth, including lower crime;[67] a more informed, civic-minded electorate;[68] increased social mobility;[69] and better community health.[70]

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[63] Enrico Moretti, "Estimating the Social Return to Higher Education: Evidence from Longitudinal and Repeated Cross-Sectional Data," *Journal of Econometrics*, vol. 121, no. 1-2, July-August 2004, pp. 175–212.

[64] See, for example, R.J. Barro, "Human Capital and Growth," *American Economic Review*, vol. 91, no. 2, 2001; Eric A. Hanushek, and L. Woessmann, "The Role of Cognitive Skills in Economic Development," *Journal of Economic Literature,* vol. 46, no. 3, 2008; Eliot A. Jamison, Dean T. Jamison, and Eric A. Hanushek, "The Effects of Education Quality on Income Growth and Mortality Decline," *Economics of Education Review,* vol. 26, no. 6, December 2007; S. Coulombe, and J.F. Tremblay, "Literacy and Growth," *The B.E. Journal of Macroeconomics*, vol. 6, no. 2, 2006.

[65] D. Acemoglu, S. Johnson, and J. A. Robinson, "Institutions as a Fundamental Cause of Long-Run Growth," in P. Aghion and S. N. Durlauf (eds.), *Handbook of Economic Growth*, 2005, pp 385-472.

[66] For a discussion of the relationship between education, institutional factors, and economic growth, see Edward L. Glaeser, Rafael La Porta, Florencio Lopez-de-Silanes, and Andrei Shleifer, "Do Institutions Cause Growth?," *Journal of Economic Growth*, Volume 9, no. 3, September 2004.

[67] Lance Lochner and Enrico Moretti, "The Effect of Education on Crime: Evidence from Prison Inmates, Arrests, and Self-Reports," *The American Economic Review,* vol. 94, no.1, 2004 pp. 155-189.

[68] Kevin Milligan, Enrico Moretti, and Philip Oreopoulos, "Does Education Improve Citizenship," *Journal of Public Economics*, vol. 88, no. 9-10, 2004, pp. 1667-1695; Thomas Dee, "Are There Civic Returns to Education?" *Journal of Public Economics*, vol. 88, no. 9, 2004, pp. 1697-1720.

[69] Daniel Aronson and Bhash Mazumder, "Intergenerational Economic Mobility in the U.S.: 1940 to 2000," *Journal of Human Resources*, vol. 43, no. 1, 2008 pp. 139-172.

[70] Michael Grossman, "Education and Non-Market Outcomes," in *Handbook of Health Economics,* vol. 1A, 2006, pp. 577-633.

Taxes and education

The private benefits of investments in education include the higher wages and better health that accrue to the individual with higher educational attainment.[71] However, as discussed above, education has many benefits that accrue to society at large in addition to those that accrue directly to the individual. Because an individual chooses to invest in education based on the private benefits he expects to accrue, in the absence of government intervention he may choose a level of investment that is lower than socially optimal. In addition, investments in education differ from other types of investments in that they are neither collateralizable (students are often unable to offer potential lenders collateral for a loan)[72] nor diversifiable (a given student can only invest in his own education). Because such investments in education are neither collateralizable nor diversifiable, levels of investment in education are expected to be lower than optimal for economic growth.[73] Governmental subsidies for education may correct this underinvestment in the private market by increasing investment to levels that are consistent with the existence of both private and public benefits of education.

While the majority of governmental support for education occurs on the expenditure side of the budget, and most of this occurs at the State and local level, the Federal government also supports all levels of education through the provision of a variety of tax preferences. Present law includes a variety of provisions that provide tax benefits to individual taxpayers for education expenses.[74] These provisions include tax benefits for current expenses, such as the American Opportunity, Hope, and Lifetime Learning credits, the above-the-line deduction for certain higher education expenses, and the exclusions for employer-provided education assistance and scholarships. A deduction for education expenses generally is allowed under section 162 if the education or training (1) maintains or improves a skill required in a trade or business currently engaged in by the taxpayer, or (2) meets the express requirements of the taxpayer's employer, or

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[71] David Card, "The Causal Effect of Education on Earnings," in *Handbook of Labor Economics*, vol. 3, 1999, pp. 1801-1863; David Cutler and Lleras Muney, "Education and Health: Evaluating Theories and Evidence," in Robert F. Schoeni *Making American Healthier: Social and Economic Policy as Health Policy*; Chinhui Juhn, Kevin M. Murphy, and Brooks Pierce, "Wage Inequality and the Rise in Returns to Skill," *Journal of Political Economy*, vol. 101, no. 3, 1993, pp. 410-442.

[72] For an early articulation of the problem and a possible equity alternative see Milton Friedman, "The Role of Government in Education," in Robert A. Solo (ed.), *Economics and the Public Interest*, Rutgers University Press, 1955, pp. 123-144. For a recent discussion, see Jennifer A. Delaney and Dhammika Dharmapala, "'Pay It Forward' and Higher Education Subsidies: A Median Voter Model," *Contemporary Economic Policy*, forthcoming, and Nicholas Barr, Bruce Chapman, Lorraine Dearden, and Susan Dynarski, "Getting Student Financing Right in the U.S.: Lessons from Australia and England," Centre for Global Higher Education Working Paper No. 16, March 2017.

[73] Caroline M. Hoxby, "Tax Incentives for Higher Education," in James M. Poterba (ed.), *Tax Policy and the Economy*, vol. 12, 1998, pp. 49-82.

[74] For more detail on federal tax benefits for education, see Joint Committee on Taxation, *Background and Present Law Related to Tax Benefits for Education* (JCX-133-15), October 5, 2015.

requirements of applicable law or regulations, imposed as a condition of continued employment.[75]

Present law also includes tax benefits for saving for future education expenses, including qualified tuition programs and Coverdell education savings accounts. Tax benefits are provided for past expenses through the allowance of a deduction for the payment of certain student loan interest and an income exclusion for the value of certain cancelled student loan indebtedness. Tax benefits are also provided for educational institutions through a variety of provisions, including (1) a tax exemption for, and deduction for charitable contributions to, educational organizations, and (2) an exclusion of interest on State and local government private activity bonds for education.

Of all these provisions, the credits for tuition for post-secondary education (*i.e.*, the American Opportunity and Lifetime Learning credits) and the deduction for charitable contributions to educational institutions are the two largest tax expenditures for education, with total estimated values of $19.6 billion and $10.5 billion, respectively, for fiscal years 2017.[76]

Many economists voice concern that because Federal tax credits for higher education generally target middle-class families, and because individuals from middle-class families are generally more likely to enroll in post-secondary education than lower income families, these credits may benefit students who would have attended college even in the absence of Federal aid.[77] Existing studies exploring the effect of Federal tax credits on post-secondary enrollment rates are few and somewhat mixed. One such study demonstrates no effect of tax credits on enrollment decisions of students who would not attend college in the absence of tax-based aid,[78] and another study suggests a small positive effect on these students.[79] Several studies which examine the effect of other types of aid on enrollment may provide some insight into the expected effect of tax-based aid. These other studies generally find that significant increases in

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[75] Treas. Reg. sec. 1.162-5(a).

[76] Joint Committee on Taxation, *Estimates of Federal Tax Expenditures for Fiscal Years 2016-2020* (JCX-3-17), January 30, 2017.

[77] See, for example, Bridget Terry Long, "How do Financial Aid Policies Affect Colleges? The Institutional Impact of the Georgia HOPE Scholarship," *Journal of Human Resources*, vol. 39, no. 4, 2004, pp. 1045-1066, and Caroline M. Hoxby, "Tax Incentives for Higher Education," in James M. Poterba (ed.), *Tax Policy and the Economy*, vol. 12, MIT Press, 1998, pp. 49-82.

[78] Bridget Long, "The Impact of Federal Tax Credits for Higher Education," in Caroline M. Hoxby (ed.), *College Choices: The Economics of Which College, When College, and How to Pay For It*, pp. 101-168. University of Chicago Press, 2004.

[79] Nicholas Turner, "The Effect of Tax-Based Federal Student Aid on College Enrollment," *National Tax Journal*, vol. 64, no. 3, 2011, pp. 839-362.

funding, such as with the Georgia HOPE scholarship program,[80] Social Security student benefits,[81] and State and institutional grants,[82] lead to increases in enrollment.

[80] Christopher Cornwell, David Mustard, and Deepa Sridhar, "The Enrollment Effect of Merit Based Financial Aid: Evidence from Georgia's HOPE Program," *Journal of Labor Economics*, Vol. 24, No. 4, 2006, pp. 761-786.

[81] Susan M. Dynarski, "Does Aid Matter? Measuring the Effect of Student Aid on College Attendance and Completion," *American Economic Review*, vol. 93, No. 1, 2003, pp. 279-288.

[82] Thomas J. Kane, "A Quasi-Experimental Estimate of the Impact of Financial Aid on College-Going," *NBER Working Paper No. 9703*, 2003. Wilbert van der Klaauw, "Estimating the Effect of Financial Aid Offers on College Enrollment: A Regression-Discontinuity Approach," *International Economic Review*, vol. 43, No. 4, 2002, pp. 1249-1287.

E. Technological Progress

<u>Technological progress and economic growth</u>

One of the central findings in the literature on growth is that technological progress is the main driver of long-run economic growth.[83] While increases in labor supply and the capital stock may increase the level of economic output, technological progress—which, among other things, improves how labor and capital can be combined to produce goods and services—is the most important determinant of long-run growth rates in economic output.

The knowledge generated from research activities forms the foundation on which technological progress is built.[84] One important economic feature of this knowledge, and knowledge in general, is that it is "nonrival" in consumption: one firm's consumption of knowledge does not preclude another firm from consuming it. An implication of this feature is that the results of research conducted by one firm may, absent market restrictions, benefit other firms, which may profit from the commercialization of those results. In other words, costly scientific and technological advances made by one firm may be cheaply copied by its competitors. Since an individual firm may not capture the full "spillover" benefits of its research activities, a market failure may exist because the social benefits of research conducted by the firm can exceed its private benefits. Economists have generally found that the social return to research can be substantially greater than its private return.[85] Therefore, firms may underinvest in research relative to what is socially optimal.[86]

Some institutions—such as a patent system—address the market failure by giving a firm the exclusive right to commercialize the results of its research for a fixed period of time. The firm therefore has a temporary monopoly on the commercial application of its research results and can capture at least some of the spillover benefits of its research. Under such a system, a

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[83] See Francesco Caselli, "Accounting for Cross-Country Income Differences," in Phillipe Aghion and Steven N. Durlauf (eds.), *Handbook of Economic Growth*, vol. 1A, North-Holland Publishing Co., 2005, pp. 679-741; and Charles I. Jones, "Growth and Ideas," in Philippe Aghion and Steven N. Durlauf (eds.), *Handbook of Economic Growth*, vol. 1B, North-Holland Publishing Co., 2005, pp. 1063-1111.

[84] Research findings typically need to be translated into some form of commercial application before they can contribute to the production of economic output. In other words, knowledge, by itself, is typically insufficient to improve how goods and services are produced.

[85] For a survey of these studies, see Bronwyn H. Hall, Jacques Mairesse, and Pierre Mohnen, "Measuring the Returns to R&D," in Bronwyn H. Hall and Nathan Rosenberg (eds.), *Handbook of the Economics of Innovation*, vol. 1, North-Holland Publishing Co., 2010, pp. 1033-1081.

[86] Economists have also identified channels through which firms may overinvest in research. For example, multiple firms may pursue parallel lines of research with the goal of being the first to create and patent a new good. In this case, research expenditures may be duplicative. However, some studies find that, even when accounting for some of the channels through which firms may overinvest in research, optimal investment in research is significantly greater than actual investment. See Charles I. Jones and John C. Williams, "Measuring the Social Returns to R&D," *Quarterly Journal of Economics*, vol. 113, no. 4, Nov. 1998, pp. 1119-1135.

firm generally invests in more research than it would in the absence of a patent system. In addition to granting patent protection, governments have also addressed this market failure through direct spending, research grants, and favorable anti-trust rules.

Tax policy and innovation

If too little research is being undertaken because of any private-market bias, a tax subsidy is one method to increase research to approach the optimal level. The effect of tax policy on research activity is largely uncertain, however, because there is relatively little consensus regarding the magnitude of the responsiveness of research to changes in taxes and other factors affecting its price.

The United States provides two types of tax benefits to taxpayers who undertake research activities: tax credits for research activity and current expensing of research-related expenditures.[87] These two types of benefits each carry different incentives with potentially different effects on research activity. For example, the research credit is incremental and only benefits research expenditures above a base level. The incentive effects per dollar of revenue loss of incremental credits, those that apply to marginal investments in research, may be larger than the incentive effects of expensing policies, which apply to both marginal and inframarginal investments. To the extent that research activities are responsive to the price of research activities, the research and experimentation tax credit should increase research activities beyond what they otherwise would be. However, certain complexities and compliance costs of the present law research credit could affect that result. Therefore, after accounting for potentially lower administrative and compliance costs, expensing of research costs may be preferable to incremental credits.

The responsiveness of research expenditures to research tax credits

As with any other commodity, economists expect a firm to undertake more research expenditures as the price paid by the firm falls. Economists often refer to this responsiveness in terms of price elasticity of demand, which is measured as the ratio of the percentage change in the quantity demanded to a percentage change in price. For example, if demand for a product increases by five percent as a result of a 10-percent decline in price paid by the purchaser, that

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[87] Secs. 41 and 174. For more detail on federal tax benefits for research activities, see Joint Committee on Taxation, *Background and Present Law Relating to Manufacturing Activities Within the United States* (JCX-61-12), July 17, 2012. In the case of expensing, amounts are expended to create an asset with a future benefit. In most other instances this would result in the capitalization and recovery through amortization of such costs. The inherent issue with expenses incurred in research and development is whether or not an asset of any value is being (or will be) created. At the time the amounts are expended, such a determination is often impossible. Further, research and development costs usually are incurred with the goal of creating a new or improved product, service, process or technique, but more often than not, the efforts do not succeed. As such, U.S. Generally Accepted Accounting Principles ("GAAP") do not require the capitalization and amortization of research and development costs. See Accounting Standards Codification ("ASC") 7330, Research and Development.

product is said to have a price elasticity of demand of -0.5.[88] One way of reducing the price paid by a buyer for a commodity is to grant a tax credit upon purchase. A tax credit of 10 percent (if it is refundable or immediately usable by the taxpayer against current tax liability) is equivalent to a 10-percent price reduction. If the commodity granted a 10-percent tax credit has a price elasticity of -0.5, the amount consumed will increase by five percent. Thus, if a flat research tax credit were provided at a 10-percent rate, and research expenditures had a price elasticity of -0.5, the credit would increase aggregate research spending by five percent.[89]

While most, if not all, published studies report that the research credit induces increases in research spending, some initial empirical analyses of the elasticity of research spending to changes in the cost of research activities generally indicate that the price elasticity for research is between zero and negative one (*i.e.*, relatively inelastic).[90] However, a subsequent review of empirical studies of the research credit suggests that an additional dollar of the research credit generates an additional dollar of investment in research.[91]

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[88] For simplicity, this analysis assumes that the product in question can be supplied at the same cost despite any increase in demand (*i.e.*, the supply is perfectly elastic). This assumption may not be valid, particularly over short periods of time, and particularly when the commodity–such as research scientists and engineers–is in short supply.

[89] It is important to note that not all research expenditures need be subject to a price reduction to have this effect. Only the expenditures that would not have been undertaken otherwise–so called marginal research expenditures–need be subject to the credit to have a positive incentive effect.

[90] One author has suggested that the variability in estimates of the price elasticity of research highlights the dependence of the estimates on the choice of dataset and the precise estimating methodology. For example, the results yield a range of estimates for the effect of tax incentives on research expenditures, with a larger elasticity in data sets drawn from tax returns than in those drawn from publicly available data. See Nirupama Rao, "Do Tax Credits Stimulate R&D Spending? The Effect of the R&D Credit in Its First Decade," *Journal of Public Economics*, vol. 140, August 2016, pp. 1-12.

[91] Bronwyn Hall and John Van Reenen, "How Effective Are Fiscal Incentives for R&D? A Review of the Evidence," *Research Policy*, vol. 29, May 2000, p. 449-469. This survey reports that more recent empirical analyses have estimated higher elasticity estimates. One recent empirical analysis of the research credit has estimated a short-run price elasticity of -0.8 and a long-run price elasticity of -2.0. The author of this study notes that the long-run estimate should be viewed with caution for several technical reasons. In addition, the data used for the study cover the period 1980 through 1991, containing only two years under the revised credit structure. This makes distinguishing short-run and long-run effects empirically difficult, particularly as it may take firms some time to appreciate fully the incentive structure of the revised credit. See Bronwyn H. Hall, "R&D Tax Policy During the 1980s: Success or Failure?" in James M. Poterba (ed.), *Tax Policy and the Economy*, vol. 7, MIT Press, 1993, pp. 1-35. Another recent study examined the post-1986 growth of research expenditures by 40 U.S.-based multinationals and found price elasticities between -1.2 and -1.8. However, the estimated elasticities fell by half after including an additional 76 firms that had initially been excluded because they had been involved in merger activity. See James R. Hines, Jr., "On the Sensitivity of R&D to Delicate Tax Changes: The Behavior of U.S. Multinationals in the 1980s" in Alberto Giovannini, R. Glenn Hubbard, and Joel Slemrod (eds.), *Studies in International Taxation*, University of Chicago Press 1993. Also see M. Ishaq Nadiri and Theofanis P. Mamuneas, "R&D Tax Incentives and Manufacturing-Sector R&D Expenditures," in James M. Poterba, (ed.), *Borderline Case: International Tax Policy, Corporate Research and Development, and Investment*, National Academy Press, 1997. While their study concludes that one dollar of research tax credit produces 95 cents of research, they note that time

However, the same survey notes that most of this evidence is not drawn directly from tax data. For example, effective marginal tax credit rates are inferred from publicly reported financial data and may not reflect limitations imposed by operating losses or the alternative minimum tax ("AMT"). The study notes that because most studies rely on "reported research expenditures," a "relabeling problem" may exist whereby preferential tax treatment for an activity gives firms an incentive to reclassify expenditures as qualifying expenditures. If this occurs, reported expenditures increase in response to the tax incentive by more than the underlying real economic activity. Thus, reported estimates may overestimate the true response of research spending to the tax credit.[92]

A more recent analysis of changes to the research credit enacted in the Omnibus Budget Reconciliation Act of 1989 ("OBRA89")[93] finds a larger elasticity for research expenditures.[94] The OBRA89 changes redefined the base amount used to calculate qualified incremental research expenditures that determine the amount of the credit. As a result of these changes, fewer firms overall were eligible for the credit, but a greater percentage of eligible firms had sufficient positive tax liability to use the credit. This study finds that the research credit "induced approximately $2.08 of additional research and development spending per revenue dollar forgone by the U.S. Treasury in the post-OBRA89 period."[95]

Studies on the effectiveness of the research credit generally look at its effect on research expenditures, and not the effect of those research expenditures on growth. Those studies that do attempt to quantify the effect of research expenditures on growth are subject to a significant amount of uncertainty.[96] For example, it is difficult to find objective measures of productivity, and of the stock of knowledge created by research expenditures, that can be used for empirical

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series empirical work suffers from poor measures of the price deflators used to convert nominal research expenditures to real expenditures.

Other research suggests that many of the elasticity studies may overstate the efficiency of subsidies to research. Most R&D spending is for wages and the supply of qualified scientists is small, particularly in the short run. Subsidies may raise the wages of scientists, and hence research spending, without increasing actual research. See Austan Goolsbee, "Does Government R&D Policy Mainly Benefit Scientists and Engineers?," *American Economic Review*, vol. 88, May 1998, pp. 298-302.

[92] Bronwyn Hall and John Van Reenen, "How Effective Are Fiscal Incentives for R&D? A Review of the Evidence," *Research Policy*, vol. 29, May 2000, p. 463.

[93] Pub. L. No. 101-239.

[94] Sanjay Gupta, Yuhchang Hwang, and Andrew P. Schmidt, "Structural Changes in the Research and Experimentation Credit: Success or Failure?," *National Tax Journal*, vol. 64, June 2011, pp. 285-322.

[95] *Ibid*, p. 316.

[96] For a discussion of the sources of this uncertainty, see Bronwyn H. Hall, Jacques Mairesse, and Pierre Mohnen, "Measuring the Returns to R&D," in Bronwyn H. Hall and Nathan Rosenberg (eds.), *Handbook of the Economics of Innovation*, vol. 1, North-Holland Publishing Co., 2010, pp. 1033-1081.

analysis.[97] It is also difficult to establish links between research expenditures within certain firms, or within industries, or even within specific countries, because other firms or industries may also benefit from technological development produced by those expenditures.[98] Moreover, it is difficult to separate the effects of research expenditures from other possible influences on productivity.[99]

97 *Ibid.*

98 *Ibid.*

99 *Ibid.*

II. BACKGROUND DATA

Growth in economic output can generally be thought of as having two components. There can be more labor and labor can be more productive. A change in labor productivity may itself be further decomposed into three components: the contribution resulting from capital/labor substitution (referred to as capital deepening), the contribution of changes in labor composition, and the contribution of multifactor productivity.[100]

Labor productivity is defined as the ratio of the real value of goods and services sold to final consumers to the labor hours used to produce that output. The contribution of capital deepening to labor productivity is related to the capital services per hour worked, weighted by the share of capital income in total capital and labor costs. It reflects both the quality and quantity of capital. Capital deepening makes workers more productive by providing more capital for each hour of work. The contribution of labor composition to labor productivity measures the effect of shifts in the age, education, and gender composition of the workforce, weighted by the share of labor compensation in total capital and labor costs. This recognizes that not every hour of labor is equally productive and that changes in, say, the experience of the workforce can change average labor productivity. Multifactor productivity measures output per unit of a combination of labor and capital inputs used to produce that output. It reflects changes in technology, economies of scale, managerial skill, and organization of production. A change in multifactor productivity reflects the residual change in output that cannot be accounted for by the change in combined inputs. An increase in multifactor productivity increases labor productivity whenever a given amount of capital and labor inputs may be used more efficiently in the production of goods and services.[101]

Figure 1, below, presents the growth of the U.S. private nonfarm business sector and allocates this growth between increases in labor and increases in average labor productivity. It further shows the source of changes in average labor productivity. The top black line shows average annual growth rates in nonfarm real value output. These rates are the sum of the growth rate in labor and growth rate in average labor productivity. For the period from 1948 through 2016, shown in the first column, private nonfarm business sector output grew at an average annual rate of 3.4 percent, comprised of 1.2 percent growth in hours worked and 2.2 percent growth in average labor productivity. Multifactor productivity growth is responsible for about half the change in labor productivity, contributing almost as much to overall economic growth as average annual increases in hours worked. Capital deepening contributed about 0.8 percentage points to labor productivity and economic growth, while changes in the composition of the labor force were responsible for the remaining approximately quarter-percentage point of growth.

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[100] Other decompositions of growth are possible. For a discussion, see Charles R. Hulten, "Growth Accounting," in Bronwyn H. Hall and Nathan Rosenberg (eds.), *Handbook of the Economics of Innovation*, vol. 1, North-Holland Publishing Co., 2010, pp. 987-1031.

[101] For a detailed description of the methods and data underlying these measures, see Bureau of Labor Statistics, "Technical Information about the BLS Multifactor Productivity Measures," September 26, 2007, available at http://www.bls.gov/mfp/mprtech.pdf.

Figure 1.−U.S. Private Nonfarm Business Sector
Sources of Output and Productivity Growth

Source: Bureau of Labor Statistics and calculations by the staff of the Joint Committee on Taxation.

These components of growth vary over the period. The second through eighth columns of the figure show the growth rates for each decade in the period.[102] Private nonfarm business sector output growth was strongest in the 1960s and the 1990s and weakest in the period since 2000. From 2000-2010, a decline in hours worked offset above average growth in labor productivity. Since 2010, hours worked have increased at nearly twice the post-war average annual rate, accelerating at a faster rate than even during the 1970s and 1980s when women and baby boomers were entering the labor force and expanding total labor hours. However, since 2010, labor productivity has been especially weak (0.5 percent per year) due to negative effects of capital inputs and below average multifactor productivity, resulting in below average economic growth.

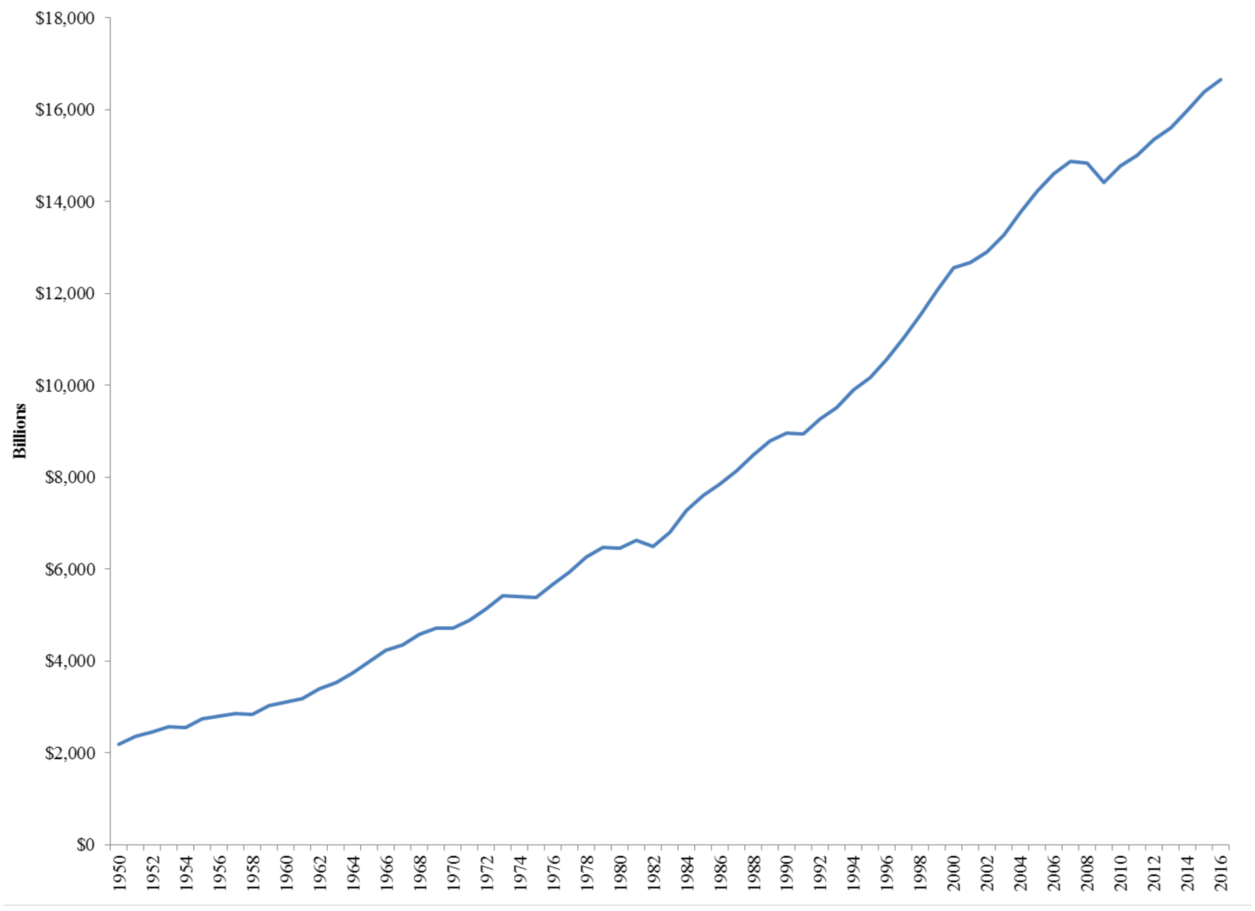
[102] Cumulative average annual growth rates are sensitive to the beginning and ending points of each period. Choice of beginning and ending points is somewhat arbitrary. While others have tried to identify inflection points in productivity data (see, *e.g.*, Dale W. Jorgenson, Mun S. Ho, and Kevin J. Stiroh, "A Retrospective Look at the U.S. Productivity Growth Resurgence," *Journal of Economic Perspectives*, vol. 22 no. 1, Winter 2008, pp. 3-24.), the purpose here is more modestly to show that the components vary over time.

Overall labor productivity growth was strongest in the 1960s led by the highest growth rates of multifactor productivity and above average capital deepening. Changes in the composition of the labor force have improved productivity steadily throughout the decades, except for the 1970s, when it had almost no effect on labor productivity or overall growth.

Capital deepening added the most to labor productivity and economic growth in the early 2000s, surpassing the previous high rates in the 1960s, increasing more than a third faster than the post-war average. The trend of more capital deepening that had begun in the 1990s, however, reversed itself since 2010, when less capital per worker has lessened overall growth.

Figure 2, below, shows the cumulative effect of input (labor and capital) and productivity growth on output, as measured by real GDP, since 1950. Over this period, real GDP grew at an average annual rate of 3.13 percent.

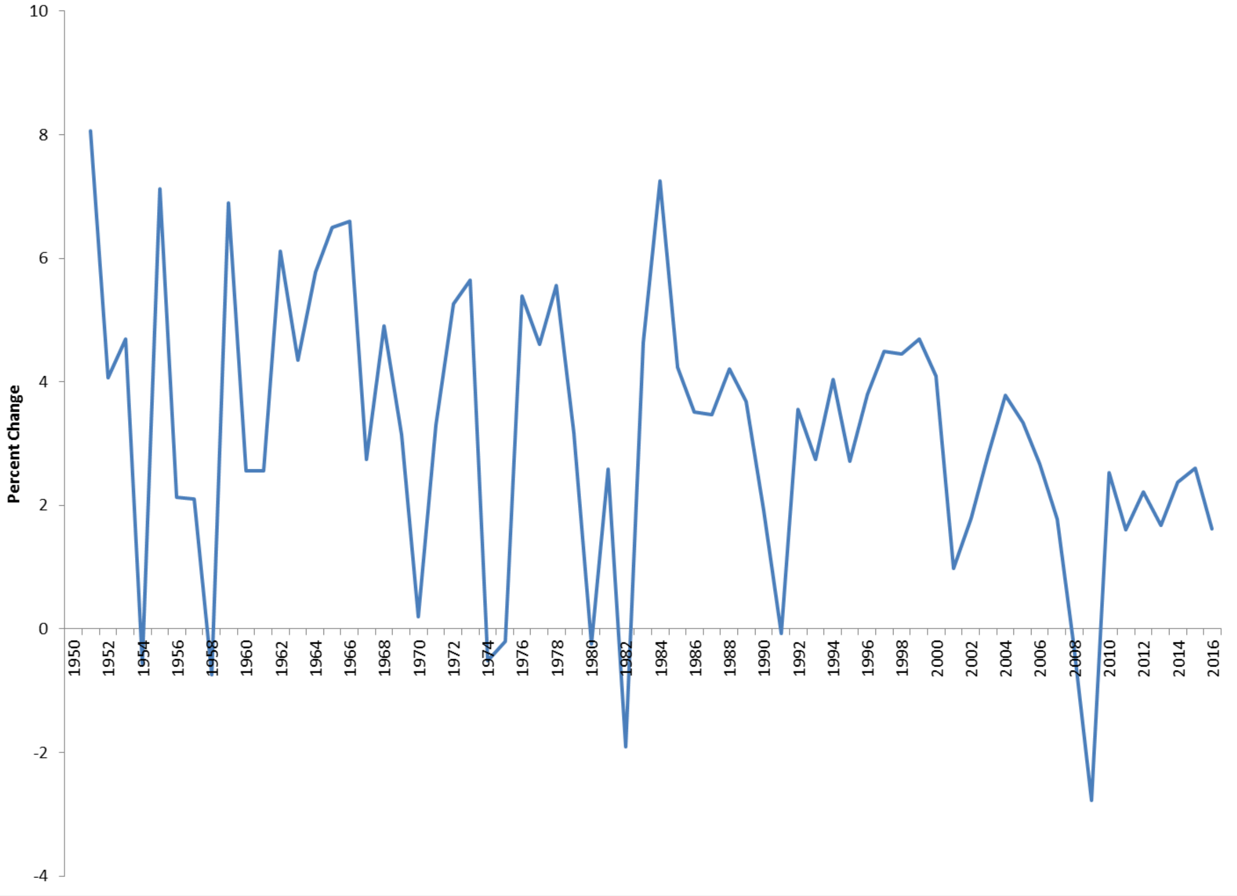
Figure 2.–U.S. Real GDP, 1950-2016



Source: Department of Labor (Bureau of Labor Statistics) and calculations by the staff of the Joint Committee on Taxation.

Figure 3, below, shows the annual percent change in real GDP growth over the same period. Figure 3A shows average annual growth rates by decade from 1950 to 2016. Figure 3B shows average annual growth rates by decade from 1946 to 2016.

Figure 3.–Annual Percent Change in Real GDP



Source: Department of Labor (Bureau of Labor Statistics), and calculations by the staff of the Joint Committee on Taxation.

Figure 3A.–Average Annual Growth Rates by Decade, 1950 to Present

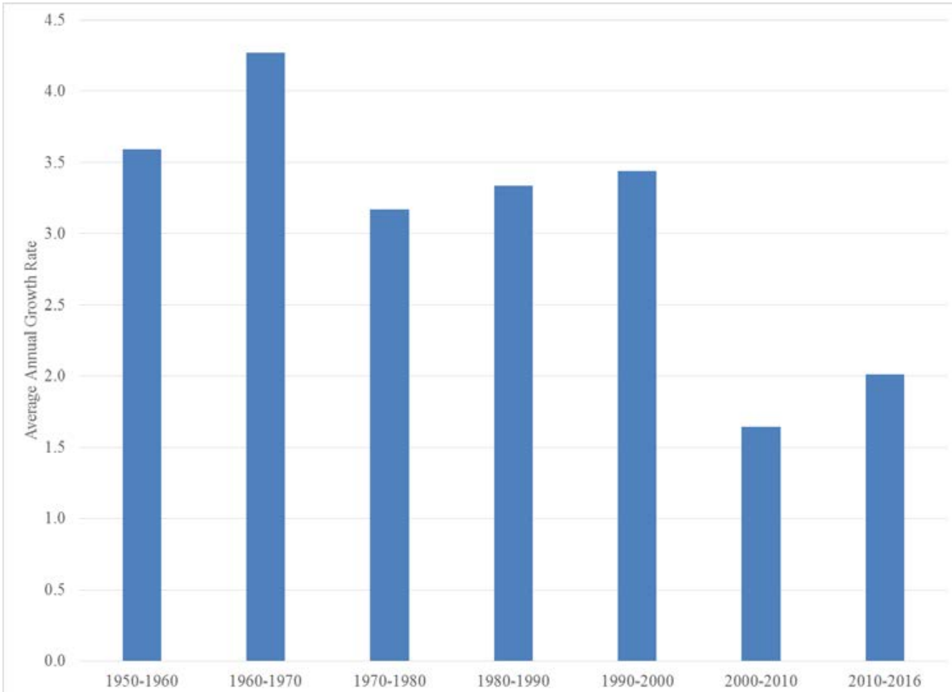
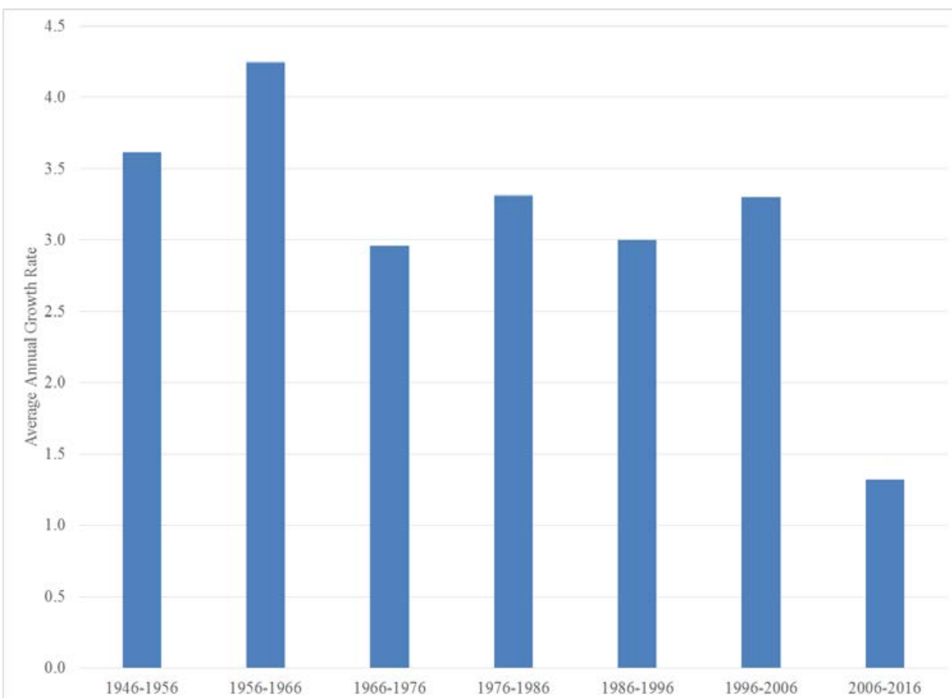


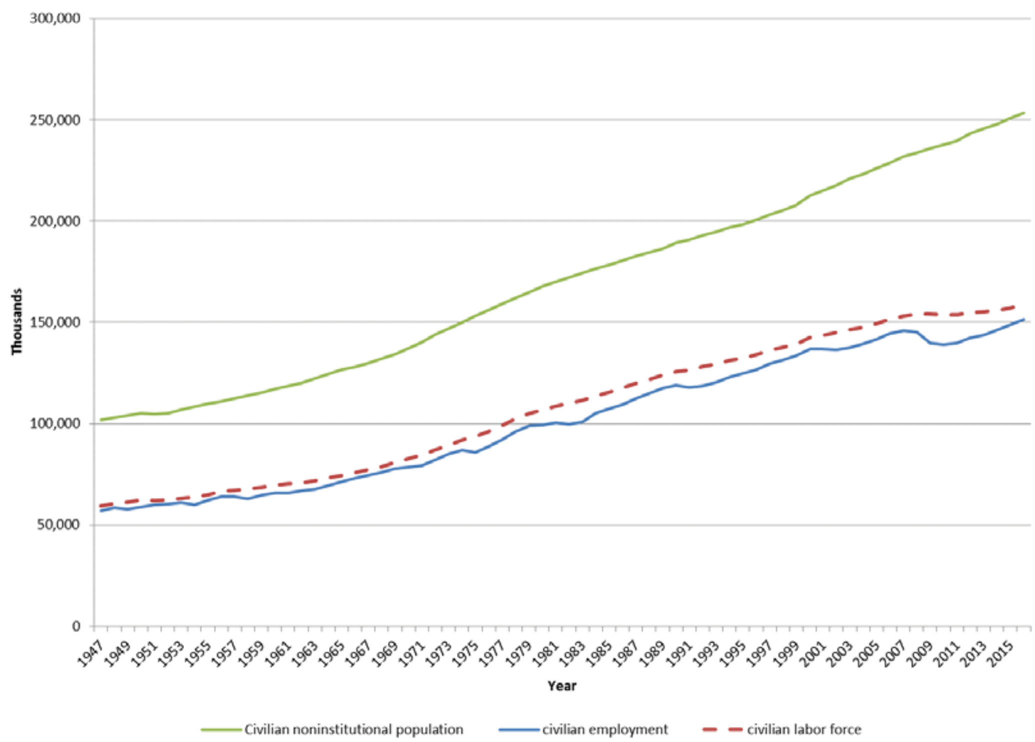
Figure 3B.–Average Annual Growth Rates by Decade, 1946 to Present



Source: Department of Labor (Bureau of Labor Statistics), and calculations by the staff of the Joint Committee on Taxation.

As discussed earlier, economic output grows with hours worked, and hours worked will be a reflection of the growth in population and the employment to population ratios. Figure 4, below, shows the growth in the U.S. civilian noninstitutional population,[103] the growth in the total civilian labor force (which includes those employed as well as those unemployed but seeking work), and the growth of total employment, from 1947- 2016. Over this period the civilian noninstitutional population grew 149 percent, with the total labor force and total employment growing further, by 168 percent and 166 percent, respectively.[104]

Figure 4.−Civilian Population, Labor Force, and Employment (Persons 16 Years of Age or Older), 1947-2016



Source: Department of Labor (Bureau of Labor Statistics), and calculations by the staff of the Joint Committee on Taxation.

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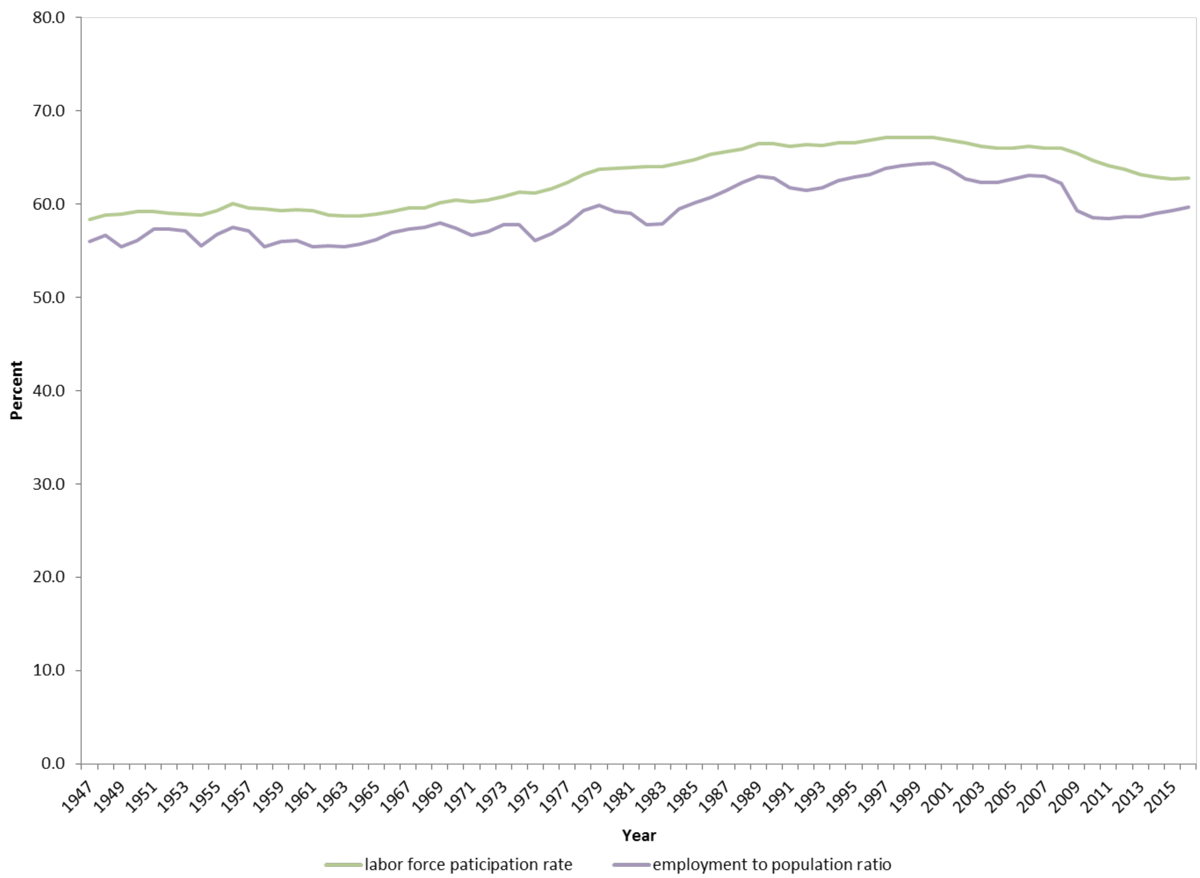
[103] Persons under 16 years of age are excluded from the official estimates because child labor laws, compulsory school attendance, and general social custom in the United States severely limit the types and amount of work that these children can do. Persons on active duty in the U.S. Armed Forces are excluded from coverage. The institutional population, which also is excluded from coverage, consists of residents of penal and mental institutions and homes for the aged and infirm.

[104] Data from the Bureau of Labor Statistics show that total hours worked in the private nonfarm business sector grew less over this period. While the nonfarm business sector does not reflect the entire economy, the lower growth in hours in this sector as compared to the economy wide employment figures above likely reflects growth in part-time employment over this period. See BLS series time series LNU02500000 and LNU02600000.

Figure 5, below, shows the civilian employment to population ratio and the labor force participation rate (the labor force as a percent of the civilian noninstitutional population over age 16). These figures reflect the numbers above, showing an increase in the labor force participation rate over this period from 58.3 percent to 63.2 percent, and a growth in the civilian employment to population ratio from 56 percent to 58.6 percent. This growth has not been uniform, however. Both the labor force participation rate and the civilian employment to population ratio peaked in 2000 at 67.1 and 64.4 percent respectively, and have since declined to their current levels, which were last seen in the late 1970s and early 1980s.

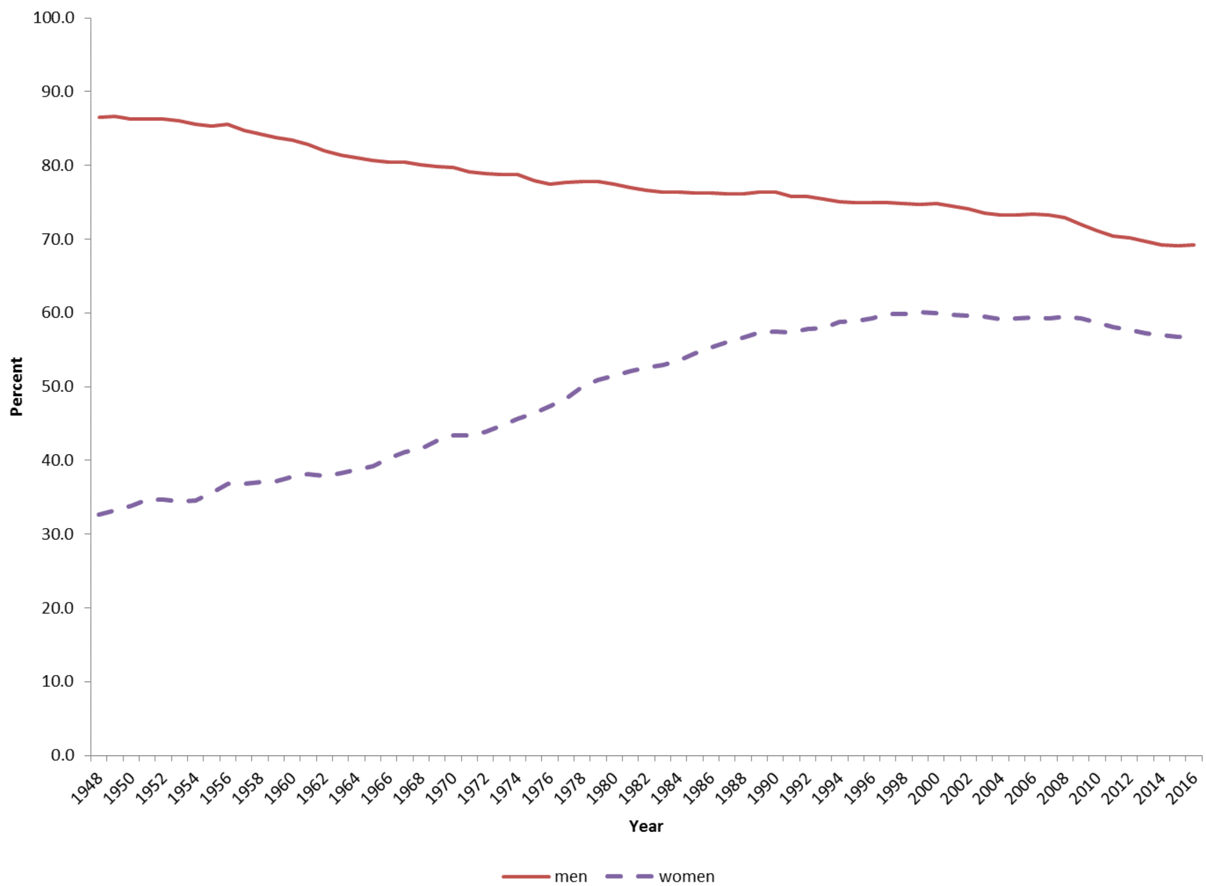
Figure 5.−Civilian Employment/Population Ratio and Labor Force Participation Rate, 1947-2016



Source: Department of Labor (Bureau of Labor Statistics), and calculations by the staff of the Joint Committee on Taxation.

Figure 6, below, shows the labor force participation rates of men and women from 1948 to 2016. The labor force participation rate of men declined from 86.6 percent in 1948 to 69.2 percent in 2016, while over the same period the labor force participation rate of women rose from 32.7 percent to 56.8 percent.

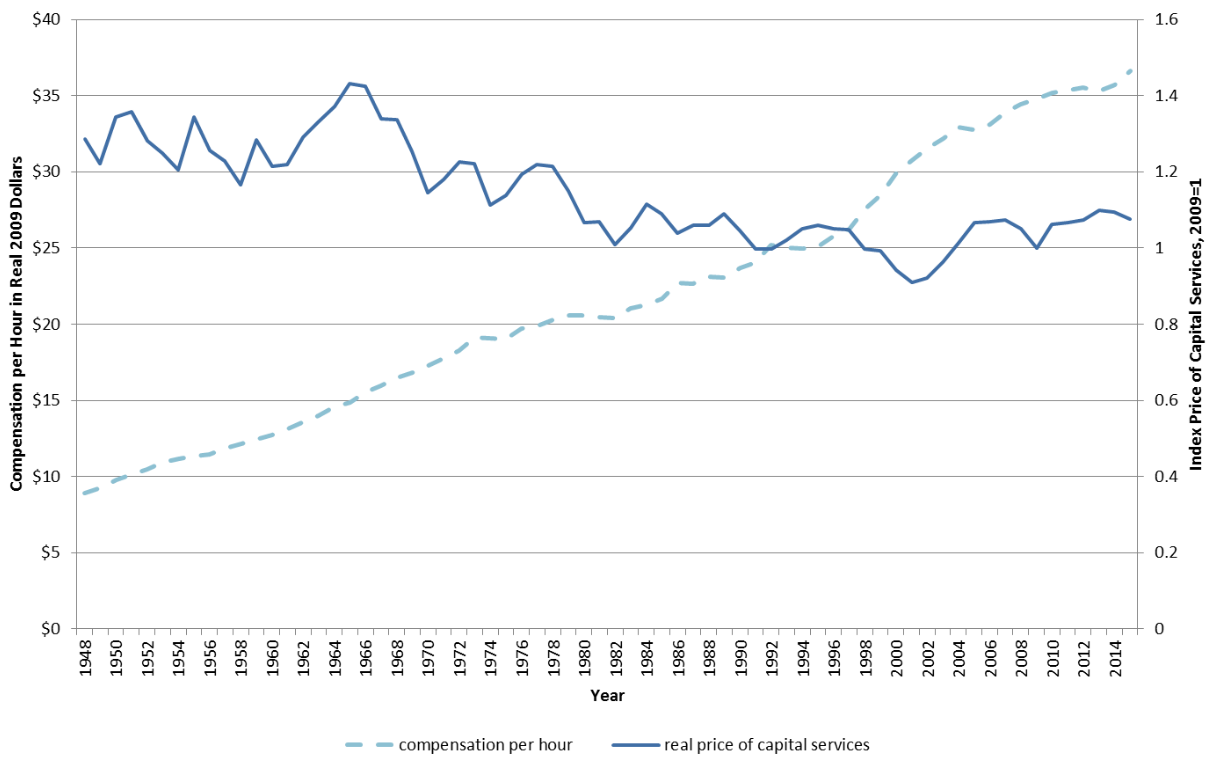
Figure 6.−Civilian Labor Force Participation Rates by Gender, 1948-2016



Source: Department of Labor (Bureau of Labor Statistics), and calculations by the staff of the Joint Committee on Taxation.

Figure 7 shows the cumulative effect of productivity growth on compensation per hour in the private nonfarm business sector. Compensation includes wages and salaries of employees plus employers' contributions for social insurance and private benefit plans, and all other fringe benefits. Since 1948, real compensation per hour has risen from under $8.92 per hour to $36.65 per hour in real 2009 dollars. A comparable measure for capital, the price of capital services, is shown in Figure 7 on the right axis. The price of capital services is defined as aggregate capital income divided by a unit of capital services and is set to a value of 1 in 2009. The price of capital services shows a modest downward trend over the same period.

Figure 7.–Real Compensation Per Hour and Price of Capital Services, 1948-2015
(private nonfarm business sector)



Source: Department of Labor (Bureau of Labor Statistics), and calculations by the staff of the Joint Committee on Taxation.