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Capital Taxation During the U.S. Great Depression*

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ABSTRACT

Previous studies of the U.S. Great Depression find that increased government spending and taxation contributed little to either the dramatic downturn or the slow recovery. These studies include only one type of capital taxation: a business profits tax. The contribution is much greater when the analysis includes other types of capital taxes. A general equilibrium model extended to include taxes on dividends, property, capital stock, and excess and undistributed profits predicts patterns of output, investment, and hours worked that are more like those in the 1930s than found in earlier studies. The greatest effects come from the increased taxes on corporate dividends and undistributed profits.

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1. Introduction

Although there is no general agreement on the primary causes of the U.S. Great Depression—defined as both the sharp economic contraction in the early 1930s and the subsequent slow recovery—many do agree that fiscal policy played only a minor role. This conventional view is based on both empirical and theoretical analyses of the period. Although federal government spending notably increased during the 1930s, the data show that as a share of GDP, it did not increase enough to have had a large impact on economic activity overall (Brown, 1956). At the same time, income tax rates increased sharply, but taxes were filed by few households and paid by even fewer (Seltzer, 1968).[1] Feeding estimates of spending and tax rates into a standard neoclassical growth model, Cole and Ohanian (1999) confirm that the impact of fiscal policy during the 1930s was too small to matter. Here, I challenge that conventional view by extending the basic growth model in ways suggested by actual U.S. fiscal policies in the 1930s. My extended model improves on the basic model's predictions of U.S. economic activity during that decade and strongly suggests that fiscal policy did, in fact, play a major role in the Great Depression.

My primary extension is to include capital taxes that are not typically included in the basic growth model analyzed by Cole and Ohanian (1999) and many others. Standard practice is to model capital taxes as taxes on business profits.[2] I look as well at taxes on capital stock, property, excess profits, undistributed profits, and dividends. When these overlooked capital taxes are incorporated into the neoclassical framework, along with taxes on normal business profits, labor, and consumption, the model predicts patterns in aggregate economic activity that are much closer to those in U.S. data, especially U.S. investment, than previous studies have found.

Differentiating capital taxes paid by businesses and those paid by individuals plays a key role for my results. A major fiscal policy change in the 1930s is the sharp increase in tax rates on individual incomes, which include corporate dividends. Although few households paid income taxes, those who did earned almost all of the income distributed by corporations and unincorporated businesses. If the increases in rates were not completely unexpected, these households would have

[1] The percentage of the total population covered by taxable returns was 4.1 percent in 1929 and only 2.6 percent by 1933.

[2] See, for example, the business cycle studies of Braun (1994) and McGrattan (1994) and the Great Depression studies in Kehoe and Prescott (2007).

foreseen large declines in future gross returns on investments. An optimal response by companies would have been to distribute earnings in advance of the tax increases rather than to reinvest them. Thus, increasing the tax rate on dividends would naturally have had a significant effect on investment, even before 1932 when major changes were enacted. If, in addition to raising individual income tax rates, the government introduces a tax on the undistributed profits of corporations, as the U.S. government did in 1936, then investment is again negatively impacted. The introduction of such a tax would naturally affect the recovery in the second half of the 1930s.

In order to better capture the quantitative effects of the added taxes, I also extend the neoclassical growth model to allow for both tangible and intangible business investment (as do McGrattan and Prescott, 2010). I do this because the U.S. tax code allows businesses to reduce taxable income by expensing *intangible investment*—expenditures on things like advertising, research and development (R&D), and labor devoted to building up businesses. Here I assume that part of intangible investment is financed by owners of capital and expensed from corporate profits. The rest is financed by unincorporated business owners, who are paid less than their marginal value product with the expectation of realizing future profits or capital gains. The inclusion of intangible investments also potentially addresses concerns of Chari, Kehoe, and McGrattan (2007), who apply a business cycle accounting exercise to the 1930s and show that models with frictions manifested primarily as efficiency wedges and labor wedges are needed to account for fluctuations during this period. The inclusion of both intangible investment and time-varying taxes implies time variation in these key wedges.

With a tax system that includes key features of U.S. policy, the extended model predicts U.S. economic activity better than the basic model. That model predicts strongly counterfactual changes between 1929 and 1932: for example, a 1 percent rise in GDP instead of a 31 percent fall and a 2 percent rise in per capita hours worked instead of a 27 percent fall. The extended model predicts declines in both of these series, predictions that account for about 34 percent of the actual decline in GDP and 44 percent of the actual decline in hours of work. Perhaps more dramatically, the extended model improves on the predicted path of investment. Over the decade, U.S. investment first dropped sharply, between 1929 and 1932, then recovered a bit before again dropping sharply in 1938. The basic model badly misses that pattern; the extended model captures it. The extended model also does a better job in predicting the drop in equity values, which fell by roughly 30 percent by the end of the decade.

A closer look at these results reveals that distinguishing taxes paid on distributed profits from those on undistributed profits is the quantitatively most significant extension that I make. Simulations with the tax rates on these profits counterfactually set to zero yield predictions similar to the basic model. Variations in household expectations do affect the timing of the declines in investment, but all settings within an empirically plausible range yield large declines in investment, like those observed in U.S. data. Variations in parameters governing intangible investments do affect the size of intangible capital but do little to alter the predictions about tangible investment, even if I abstract from intangible investment altogether. Other sensitivity analyses—varying model parameters and adding other factors that could potentially depress economic activity—also leave the main result intact: fiscal policies, and more specifically policies related to the taxation of capital, did play a major role in the Great Depression.

Factors other than tax policy clearly were involved in the deep downturn and slow recovery of the 1930s. This is demonstrated, for example, by the fact that the model's initial consumption predictions do not line up well with the data. U.S. consumption fell sharply in the early part of the 1930s, yet both the basic model and the extended model miss that drop. In fact, the extended model actually predicts an initial rise. Expectations of higher future capital tax rates imply a sharp initial increase in distributions of business incomes, accomplished by decreasing both tangible and intangible investment. Increased distributions then lead, counterfactually, to increased consumption, which falls only when higher sales and excise taxes are imposed. Adding New Deal policies (as in the 2004 work of Cole and Ohanian) would help further account for the time series patterns in the later part of the decade. But we need other ways to account for the pattern of consumption in the early part.

My conclusions are broadly supported by evidence on changes in income tax rates and GDP in other countries during the 1930s and simulations of the model for the more recent U.S. Great Recession (2008–2009). I find that countries with the largest changes in top marginal tax rates were the most depressed during the 1930s. And I show that modeling uncertainty about the permanence of the Economic Growth and Tax Relief Reconciliation Act (2001) and the Jobs and Growth Tax

Relief Reconciliation Act (2003) leads to large declines in economic activities between 2007 and 2011, with the drop in predicted investment roughly equal to the drop in observed investment.

The paper is organized as follows. In Section 2, I describe extensions of the basic neoclassical growth model central to the analysis. In Section 3, I describe the source and construction of the main model inputs: tax rates, spending, and policy expectations. In Section 4, I compare the extended model's predictions to U.S. data and to predictions of the basic model, quantifying the role of various factors in the analysis. Section 5 provides supporting evidence that taxation may have played an important role in other countries during the 1930s and in the United States in the 2008–2009 downturn. Section 6 concludes.

2. Theory

To analyze U.S. fiscal policy in the 1930s, I use an extension of the basic neoclassical growth model that includes two features relevant for studying this period but missing from other studies. One is a more comprehensive specification of taxes than is typically used; the other is a distinction between tangible and intangible investment.

2.1. The Extensions

First, I identify and justify in more detail the two overlooked features to be included in the analysis.

The primary feature is taxes on property, capital stock, excess profits, undistributed profits, dividends, and sales in addition to taxes on wages and normal business profits. At the beginning of the 1930s, the source of most government revenue was indirect business taxes on property and sales and excise taxes. Over the decade, as deficits grew at all levels of government, legislators increased tax rates, especially rates of individual and corporate income taxes and sales and excise taxes. They also introduced taxes on capital stock and excess profits in 1933 and on undistributed business profits in 1936. Although the revenues on these additional tax sources never exceeded indirect business tax revenues, they directly impacted almost all capital owners in the United States.

The other feature I add to the basic model is the distinction between tangible and intangible investment. In order to accurately assess the impact of taxes, especially taxes on capital income, I take into account the fact that a significant amount of capital investment is expensed and thus nontaxable; this includes investment in advertising, R&D, and organizational capital. It has been argued that the stock of intangible capital at the start of the Great Depression was already large, and with taxes rising during the 1930s, companies had an incentive to further increase their intangible investments.[3] As a trustee of the Museum of Science and Industry noted in 1936, with taxes rising, "many manufacturers have concluded that it will be better business judgment to spend money for business promotion, advertising, newspaper campaigns, technical research, etc., in which they get full benefit of each dollar in building up business" (*New York Times*, July 23, 1936). This shift from tangible to intangible investment is also evident in statistics on R&D employment. For example, Mowery and Rosenberg (1989) report that between 1933 and 1940, employment of scientists and engineers in two-digit manufacturing industries nearly tripled, rising from 10,927 to 27,777, and the number of scientific personnel per 1,000 wage earners doubled, rising from 1.93 to 3.67.

2.2. The Extended Model

Now I describe the extended model that includes taxes relevant for the United States during the 1930s and a distinction between tangible and intangible investment. (See Appendix A for details on the basic model.)

The firms' aggregate production technology is characterized by two aggregate production relations, which represent two sectors of production—that of final output and that of new intangible capital:

$$y_t = \left(k_{Tt}^1\right)^\theta \left(k_{It}\right)^\phi \left(Z_t h_t^1\right)^{1-\theta-\phi} \tag{2.1}$$

$$x_{It} = \left(k_{Tt}^2\right)^\theta \left(k_{It}\right)^\phi \left(Z_t h_t^2\right)^{1-\theta-\phi}, \tag{2.2}$$

where θ is the tangible capital share of output and ϕ is the intangible capital share of output. Firms produce final output y using tangible capital k_T^1, intangible capital k_I, and labor h^1. Growth in labor-augmenting technical change is equal to γ, that is, $Z_t = (1+\gamma)^t$. Firms produce intangible

[3] See, for example, Fisher (1930, Chapters 8 and 9) for evidence of industrial research and inventions and improved methods of management engineering.

investment x_I—such as new brands, R&D, and patents—using tangible capital k_T^2, intangible capital k_I, and labor h^2. Growth in technical change is the same as in both sectors.

Note that k_I is an input to both sectors; it is not split between them, as tangible capital and labor are. A brand name is used both to sell final goods and services and to develop new brands. Patents are used by the producers and the researchers. (See McGrattan and Prescott, 2010, for the aggregation theory underlying this technology.) If $\phi = 0$, no intangible capital is accumulated and the production technology is the same as that of the basic model.

Given initial stocks of tangible and intangible capital stocks (k_{T0}, k_{I0}), the stand-in household chooses consumption c_t, hours of leisure ℓ_t, hours of work h_t, tangible investment x_{Tt}, and intangible investment x_{It} to maximize expected lifetime utility:

$$E \sum_{t=0}^{\infty} \beta^t \left[\log c_t + \psi \log \ell_t\right] N_t$$

subject to several constraints:

$$c_t + x_{Tt} + q_t x_{It} = r_{Tt} k_{Tt} + r_{It} k_{It} + w_t h_t + \kappa_t - \zeta_t$$

$$k_{T,t+1} = \left[\left(1 - \delta_T\right) k_{Tt} + x_{Tt}\right] / \left(1 + \eta\right) \quad (2.3)$$

$$k_{I,t+1} = \left[\left(1 - \delta_I\right) k_{It} + x_{It}\right] / \left(1 + \eta\right) \quad (2.4)$$

and nonnegativity constraints on investments $x_{Tt} \geq 0$ and $x_{It} \geq 0$. Total transfers are given by κ_t and total taxes are ζ_t. Here, all variables are in per capita units, population N_t grows at rate η, β is the time discount factor, and ψ is a parameter governing disutility of work. The relative price of intangible investment and consumption is q_t; the rental rates for tangible and intangible capital are denoted by r_{Tt} and r_{It}, respectively; and the wage rate for labor, w_t. Inputs are paid their marginal products.

The formula for per capita taxes paid by households is

$$\begin{aligned}
\zeta_t = {} & \tau_{ct} c_t + \tau_{ht} \left(w_t h_t - \left(1 - \chi\right) q_t x_{It}\right) + \tau_{kt} k_{Tt} + \tau_{ut} \left(\left(1 + \eta\right) k_{T,t+1} - k_{Tt}\right) \\
& + \tau_{pt} \{ r_{Tt} k_{Tt} + r_{It} k_{It} - \delta_T k_{Tt} - \chi q_t x_{It} - \tau_{kt} k_{Tt} \} \\
& + \tau_{dt} \{ r_{Tt} k_{Tt} + r_{It} k_{It} - x_{Tt} - \chi q_t x_{It} \\
& \quad - \tau_{kt} k_{Tt} - \tau_{ut} \left(\left(1 + \eta\right) k_{T,t+1} - k_{Tt}\right) \\
& \quad - \tau_{pt} \left(r_{Tt} k_{Tt} + r_{It} k_{It} - \delta_T k_{Tt} - \chi q_t x_{It} - \tau_{kt} k_{Tt}\right) \},
\end{aligned} \quad (2.5)$$

where τ_{ct} is the tax rate on consumption, τ_{ht} is the tax rate on labor income, τ_{kt} is the tax rate on property, τ_{ut} is the tax rate on undistributed profits, τ_{pt} is the tax rate on profits, and τ_{dt} is the tax rate on dividends. Note that taxable income for the tax on profits is net of depreciation and property tax, and taxable income for the tax on dividends is net of taxes on profits, property, and undistributed profits. In the model, as in the United States, the treatment of tangible and intangible income differs, as can be seen from the formula (2.5). Taxes on property and undistributed profits are levied on tangible capital and tangible net investment. For the purposes of taxation of profits, tangible investment is not expensed but intangible investment is. The asymmetric treatment also affects the incidence of the tax on dividends.

As do McGrattan and Prescott (2010), I assume that intangible investment is financed partly by the shareholders who are owners of capital and partly by business owners who are suppliers of labor; they refer to the equity accumulated by business owners as *sweat equity*. The distinction may matter because the tax treatments of capital and labor are different. Let χ denote the fraction of intangible investment financed by shareholders. In this case, the amount $\chi q x_I$ is financed by owners of capital and is, therefore, expensed from accounting profits rather than capitalized. The amount $(1-\chi) q x_I$ is sweat investment, which is financed by business owners who devote uncompensated time to building up their businesses.

The capital taxation studied here affects business activities, which is assumed to be those of corporations and nonfarm proprietors, but the remaining sectors account for about 36 percent of U.S. value added. To ensure that my model accounts line up with the U.S. accounts, I assume that choices of nonbusiness output, investment, and hours are set exogenously to be consistent with U.S. time series. Specifically, nonbusiness output y_{nt} less nonbusiness investment x_{nt} and any taxes on nonbusiness incomes is (exogenously) included with transfers to households κ_t. I also assume that leisure is time available after supplying hours to business production h_t and to nonbusiness production h_{nt}, that is, $\ell_t = 1 - h_t - h_{nt}$. (See the time paths of U.S. nonbusiness activity in Appendix B, Table B.1.) These series are treated as inputs for the extended model simulations.

GDP in this economy is the sum of private consumption c, public consumption g, tangible investment x_T, and nonbusiness investment x_n; in per capita terms, GDP is thus $c + g + x_T + x_n$.

Measured investment, therefore, is the sum of business tangible investment x_T and nonbusiness investment x_n. Gross domestic income (GDI) is the sum of capital income less expensed investment, $r_T k_T + r_I k_I - \chi q x_I$, labor income less sweat investment $wh - (1-\chi) q x_I$, and nonbusiness capital income $y_n - wh_n$.

Finally, the value of business capital is given by

$$V_t = (1-\tau_{dt})(1+\tau_{ut}) K_{T,t+1} + [\chi(1-\tau_{dt})(1-\tau_{pt}) + (1-\chi)\tau_{ht}] q_t K_{I,t+1}, \tag{2.6}$$

where $K_{T,t+1}$ and $K_{I,t+1}$ are aggregate end-of-year tangible and intangible capital stocks, respectively. Notice that the value is directly affected by capital taxes through prices of capital and indirectly affected by capital taxes through their effects on the time variation of capital.

3. U.S. Fiscal Policy in the 1930s

To analyze the impact of fiscal policies on economic activity, I need to construct time series for tax rates and government spending. I also need to specify household expectations about future policy. In this section, I describe in detail how I construct these model inputs and relate them to U.S. policy during the 1930s.

3.1. Taxes

There are three main sources of tax data—at both the federal and state level—that are used to construct estimates of tax rates: individual income taxes, corporate income taxes, and indirect business taxes. Table 1 summarizes the tax rates used.

3.1.1. Individual Income Taxes

The first two series in Table 1 are average marginal tax rates constructed from tax returns on individual income and are the empirical analogues of the model rates τ_h and τ_d. The source of the first, the tax rate on labor income, is Barro and Redlick (2011), who sum the average marginal tax rates constructed from federal income tax data published in the U.S. Treasury Department's *Statistics of Income* (*SOI*), the Social Security payroll tax rates, and average marginal tax rates from state income tax data. The average marginal tax rate is a weighted sum of marginal tax rates

Table 1. U.S. Tax Rates, 1929–1939

	Individual Income		Corporate Profits			Indirect Business	
Year	Labor	Dividend	Normal	Excess[a]	Undistributed	Property	Sales
1929	3.60	9.51	11.00	−−	−−	1.41	2.89
1930	2.40	7.90	12.00	−−	−−	1.63	2.99
1931	1.80	7.71	12.00	−−	−−	1.60	3.40
1932	3.00	14.13	13.75	−−	−−	1.99	3.98
1933	3.20	14.41	13.75	2.00	−−	1.84	5.92
1934	3.60	16.70	13.75	2.00	−−	1.74	6.97
1935	4.10	19.09	13.75	2.00	−−	1.73	7.05
1936	5.50	25.04	15.00	2.00	5.00	1.71	6.90
1937	5.80	24.97	15.00	2.00	5.00	1.69	7.08
1938	4.60	20.23	19.00	2.00	5.00	1.59	7.10
1939	5.10	21.83	19.00	2.00	−−	1.62	7.19

[a] In combination with the capital stock tax.

for each income class, with weights equal to the fraction of income that the income class receives. Specifically, if income class i pays τ_i on an additional dollar of income earned and earns $y_i/\sum_i y_i$ of the total income, then the average marginal tax rate is computed as follows: $\hat{\tau} = \sum_i \tau_i y_i / \sum_i y_i$.

The source of Barro and Redlick's (2011) federal income tax rate is Barro and Sahasakul (1983), who calculate marginal tax rates for each class of *net income*, the measure of income used by the U.S. Internal Revenue Service (IRS) in the 1930s, which is essentially taxable income less exemptions. In order to compute a long time series, Barro and Sahasakul weight the rates by total incomes, which is a proxy for the measure of income used by the IRS in later years, namely, adjusted gross income. Total adjusted gross income, for filers and nonfilers (paying a tax rate of zero), is estimated to be 79 percent of national income and product account (NIPA) personal income during the 1930s. Estimates of the average marginal tax rate from the Social Security payroll tax rate, which is zero before 1937, are added by Barro and Sahasakul (1986).

To these rates, Barro and Redlick (2011) add average marginal income tax rates from state income tax data. They do this with the help of two tax calculators: TAXSIM (Feenberg and Coutts, 1993) and IncTaxCalc (Bakija, 2009). Starting with 1979, the first year in which state identifiers are included in the TAXSIM database, Barro and Redlick take a sample of returns and, for each year from 1929 through 1978, scale the components of income so that the change in per capita incomes on the returns matches the change in per capita personal income in NIPA. They then use IncTaxCalc, which has detailed information about tax rates by state, to compute marginal tax rates as the change in tax liabilities from an incremental change in income.

To construct average marginal tax rates on dividend income from federal tax data, I use the same methodology as Barro and Sahasakul (1983). Specifically, I use dividend income for each net income class as weights and dividend income from NIPA to determine the income of nonfilers.[4] For the marginal tax rates, I use only surtaxes prior to 1936 because dividend income was not subject to the normal rate in this period. One additional adjustment is needed because some dividend income accrues to fiduciaries, but the *SOI* does not categorize it the same way each year in my sample. Dividend income of fiduciaries is included with all other dividend income between 1929 and 1935 and later with fiduciary income. Thus, for 1936 to 1939, I increase the *SOI*'s reported dividend income by an amount equal to the *SOI*'s fiduciary income multiplied by an estimate of the fraction of income fiduciaries earn from dividends. My estimate of this fraction is the ratio of dividend income reported on IRS Form 1041 (filed by all fiduciaries) to the balance income on Form 1041, which is the total income fiduciaries have available for distribution.

To construct the tax rates on dividends, τ_d, I add estimates of average marginal tax rates for state income taxes, but use a different algorithm than do Barro and Redlick (2011), in part because of the many policy changes that potentially impact the concentration and deferral of dividend income between 1929 and 1979, when state identifiers are first available in TAXSIM. For the years 1929–1939, I use state tax rate schedules from the Tax Research Foundation (1930–1942), data on the distribution of dividend income across net income classes on federal returns from the *SOI*, and data on the fraction of dividends reported on federal returns by state from the *SOI*. In essence, for each year and each state, I compute an average marginal tax rate for dividend income using the tax schedule for that year and state and the distribution of dividend incomes for that year reported on federal tax returns.[5] I then construct a weighted average across states with weights equal to the fraction of dividend income earned by residents of the states.

[4] NIPA table 7.16 shows the relation of IRS dividends paid by corporations and NIPA dividends in personal income. The main differences are intercorporate dividends plus net dividend income paid to foreigners. Holland (1962) and U.S. Treasury (1948) estimate that underreported amounts on tax returns are small.

[5] Data on the distribution of dividend income are available from the California Franchise Tax Commissioner for

3.1.2. *Corporate Income Taxes*

The tax rate on profits used in the model simulations, τ_p, is estimated to be the sum of the tax rate on normal business profits and the effective rate due to the capital stock tax in combination with the excess profits tax. For the normal business profit tax, I use the statutory corporate income tax rate. This series is shown in the fourth column of Table 1. For the excess profits tax, used in combination with the capital stock tax, I follow Brown (1949) and treat them in combination like an effective tax on business profits. This choice is motivated by the actual U.S. tax system in the 1930s. Companies had to declare a value for their capital stock, and a tax was assessed on that value. To avoid having companies declare a capital value that was too low, the government used an excess profits tax as a penalty. For example, in 1934, if profits exceeded 12.5 percent of the declared capital stock value, then companies paid a 5 percent tax on the excess profits. To avoid this penalty, companies tended to declare a high value for capital, and they paid roughly 2 percent of profits because of this tax in addition to their normal tax bill. (See Brown, 1949.) For this reason, the tax rate I use in model simulations is an estimate of the normal tax on profits plus an additional 2 percent that is indirectly assessed through the capital stock tax.

For the tax on undistributed profits, τ_u, which was in effect for the years 1936–1938, I use an effective rate of 5 percent. This rate implies a ratio of revenues for the undistributed profits tax relative to the GDP taxes in the model that is roughly equal to the ratios reported in the *SOI*. For 1936–1937, the revenues are on the order of 18 percent of GDP per year, whereas in 1938 it is only about 1 percent of GDP.

3.1.3. *Indirect Business Taxes*

Also included in the analysis are indirect business taxes on property, τ_k, and consumption, τ_c, which yielded the bulk of government revenues during the entire decade of the 1930s. These tax rates are shown in Table 1's columns labeled *Property* and *Sales*. The source of the data is taxes on imports and production in NIPA. To construct the rate for the property tax, I divide the property tax revenues for corporations and nonfarm proprietors by the sum of the capital stocks of

1938. Assuming x_i, y_i are the dividend incomes for net income class i reported for federal taxes and California taxes, respectively, I find that the correlation between x and y is 95 percent.

corporations and nonfarm proprietors.[6] To construct the rate for the tax on consumption, I divide the sales and excise tax revenues by the measure of consumption defined in Appendix B.

3.2. Government Spending

In addition to time-varying tax rates, households face time-varying government spending. (See Appendix B for data sources and definitions related to the U.S. national accounts.) The input to the model simulations is per capita government consumption relative to a trend of $(1+\gamma)^t$, where, recall, γ is the growth rate of labor-augmenting technical change.[7] The series is shown in Table B.1 as "public" consumption to distinguish it from private consumption. In 1929, the measure of detrended public consumption was 5.8 percent of 1929 real per capita GDP. By 1939, public consumption relative to trend had risen by 50 percent.

3.3. Policy Expectations

Before I can simulate the time series for the model, I need to describe households' assumptions about future government spending and taxes. With taxes on many different sources of capital income and investments that are tax deductible, expectations could potentially play a significant role. Thus, here I detail my assumptions, at least for my initial *benchmark* expectations.

Table 2 summarizes the benchmark expectations as a transition matrix of a Markov process governing the evolution of fiscal policies. The rows of the table, or transition matrix, show the current state, denoted s_t, and the columns of the table show the future states, denoted s_{t+1}. The values in the rows and columns are the years 1929 through 1939. A current state of 1930 means that fiscal policy in this state is the same as it was in the United States in 1930. I assume that spending and tax rates are functions of s_t, for example, $\tau_{dt} = \tau_d(s_t)$. Notice that most transitional probabilities in Table 2 are zero (and so not listed). Transiting from the 1930 state, the only possible states for the next year are fiscal policies equivalent to U.S. policies observed in 1929,

[6] Estate tax rates also rose significantly during the 1930s, but the revenues are small relative to those on property. In McGrattan (2011) I construct an alternative estimate for τ_k using both tax sources and find the differences to be too small to affect the results.

[7] Government investment is included with nonbusiness investment.

1930, and 1931. Households are assumed to put equal weight on each of those possible future states.[8]

The parameterization in Table 2 assumes that there is uncertainty in 1930–1931 and again in 1936–1937 because of actual U.S. events. The initial uncertainty about tax and spending policies early in the decade was not fully resolved until the U.S. Revenue Act of 1932 was enacted. Before then, households were warned that spending bills in Congress could not be financed out of current revenue streams. Newspapers throughout 1930 and 1931 included headlines like "Hoover Warns Congress to Economize or be Faced by Tax Rise of 40 Per Cent" (*New York Times*, February 25, 1930). But households were not sure if the government would raise taxes during a depression, as the following newspaper excerpt indicates.

> Some, who were pessimistically inclined, believed it would be necessary to recommend to the next Congress even higher taxes for 1931 than those carried in the 1928 revenue law, in order to avert a serious deficit at the end of the fiscal year 1931. The more general belief, however, is that the 1928 rates will be permitted to stand even if a deficit results, as it is felt that a move to increase taxes would further accentuate the economic depression which is given much concern. It was indicated at the Treasury that Secretary Mellon felt it was too early to talk with definiteness about the tax situation but that he would go into a full discussion of the subject . . . in his annual report in Congress in December. (*New York Times*, August 22, 1930)

Households remained uncertain about the specifics of the final bill until it was enacted and signed in 1932. Then they knew that individuals faced large increases in marginal income tax rates.

For several years thereafter, new revenue acts were introduced. In 1933, it was a tax on capital stock and excess profits (part of the National Industrial Recovery Act). In 1934, the main policy changes were designed to prevent tax avoidance. In 1935, increases in surtaxes on individuals were made. The main change in 1936 was the introduction of the undistributed profits tax. This change was likely to have surprised most Americans, since the tax was not proposed until a speech by President Roosevelt in March 1936. Congress went along with the proposal, and the law was passed soon thereafter and made applicable to income during the entire calendar year. In modeling

[8] Treating each input as an independent random variable that can take on a continuum of values involves working with an enormous state space. Here, I can take advantage of the fact that the exogenous inputs are highly correlated.

Table 2. Transition Matrix for Benchmark Model Simulation

Policy Today Like	Next Period's Policy Like That of										
	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939
1929	1										
1930	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$								
1931	$\frac{1}{3}$		$\frac{1}{3}$	$\frac{1}{3}$							
1932					1						
1933						1					
1934							1				
1935											1
1936								$\frac{2}{3}$	$\frac{1}{3}$		
1937									$\frac{2}{3}$	$\frac{1}{3}$	
1938											1
1939											1

expectations, I have chosen parameters in the transition matrix of Table 2 consistent with the 1936 law being a completely unanticipated change. Notice that starting from a policy like that of 1935, households expect a policy like that of 1939; the income tax rate schedule of 1939 is the same as 1936, but undistributed profits taxes were not taxed. During and after 1936, there is uncertainty about the permanence of the undistributed profits tax, which is modeled as nonzero probabilities of staying with the same policy (1936) or transiting to the next year (1937). This is done for 1937 as well, since there was uncertainty about whether the policy would continue. The probability weights of 2/3, 1/3 generate a time pattern of revenues like that observed. In 1938, it was clear that the undistributed profits tax would be eliminated.

4. Quantitative Predictions for the U.S. Economy

I now feed the U.S. fiscal policies along with estimates of policy expectations into the extended model and compute equilibrium paths that can be compared with U.S. time series during the 1930s. I also compare the extended model's predictions with those of the basic model and show that there is a marked improvement and demonstrate that conclusions about the importance of fiscal policy are reversed. As a first step, I choose parameters for the extended model.

4.1. Model Parameters

For my simulations, I set growth rates as follows: $\gamma = 0.019$ and $\eta = 0.01$. The time series for nonbusiness activities are set exogenously to be equal to U.S. values. (The detrended paths of nonbusiness hours, investment, and output are shown in Table B.1.) The parameter χ, which governs the fraction of expensing done by capital owners, is set equal to 0.5 as in McGrattan and Prescott (2010).

The remaining parameters are set so that aggregates in the model economy are equal to their U.S. analogues in 1929.[9] Specifically, in addition to the values of tax rates, government spending, and nonbusiness variables discussed earlier, I use 1929 values from U.S. data for real GDP, real consumption, real tangible business investment, real tangible business capital, real business compensation measured as in NIPA, and per capita hours. (See Table B.1.) This implies parameter values of $\psi = 2.055$, $\beta = 0.98$, $\delta_T = 0.0358$, $\theta = 0.236$, and $\phi = 0.113$. Because the intangible depreciation rate and the share of intangible capital in production ϕ cannot be separately identified, I normalize δ_I to 0 and show in McGrattan (2011) that this choice is made without loss of generality.

For both versions of the model, I compute equilibrium paths starting with initial capital stocks consistent with 1929 observations. The transition matrix underlying expectations is given in Table 2, and the realized states for the paths I compute are $s_0 = 1929$, $s_1 = 1930$, and so on, until $s_{11} = 1939$. Thus, the sequence of fiscal policies that model households face is the same as that U.S. households faced. Because the actual policies are the basis of household expectations, I filter the actual series used as inputs—namely, the tax rates in Table 1, the public consumption in Table B.1, and the nonbusiness activities in Table B.1—and use only the low frequencies. (See Appendix B for more details and McGrattan 2011 for plots of the raw data and the smoothed series used for the model inputs.)

[9] The same exercise is done for the basic model. See Appendix A for details.

4.2. Model Predictions

In Figures 1–4, I plot the equilibrium paths for real investment, real consumption, real GDP, and hours worked in the basic and extended growth models along with their counterparts from actual U.S. time series. All series are in per capita terms and, with the exception of hours, detrended by the growth in labor-augmenting technical change (that is, $(1+\gamma)^t$). The U.S. data are detrended in the same way. The series are then indexed so that 1929 equals 100. (See Appendix B for more details on data construction and sources.)

Figure 1 establishes my main result, namely, that abstracting from key features of U.S. fiscal policy makes a big difference in the model's prediction of real investment as measured in NIPA.[10] In the basic version of the model, with only taxes on profits and wages included and no untaxed investment, real investment *rises* 2 percent relative to trend between 1929 and 1932 and eventually falls by 2 percent. On the other hand, the extended model predicts an immediate and sharp fall in tangible investment, much like that in the U.S. economy. In both the extended model and the data, declines occur in the period 1929–1932 and then again in 1938.

The fact that investment falls and tax rates rise also has implications for equity values. The predicted value shown in equation (2.6) is the sum of the value of tangible capital plus intangible capital. With a rise in tax rates, prices and quantities fall, but the model predicts more gradual changes than those of actual stock market values. For example, the real market value of all stocks traded on the New York Stock Exchange fell 57 percent below trend between 1929 and 1932 and by 1939 was below trend by 32 percent. (See U.S. Commerce, 1932–1950.) The model does predict a significant decline between 1929 and 1939, reaching a low of 27 percent below trend, but the drop is gradual because the changes in tax rates and capital stocks are gradual. By 1932, predicted stock values are only 9 percent below trend.

Figure 2 shows the consumption paths for the basic and extended models in comparison with U.S. data. Neither model does well in predicting real consumption, but the extended model does a bit better. In the data, real consumption drops sharply relative to trend and stays close to its 1933 low through the rest of the decade. In the basic model, consumption barely changes from its

[10] The conclusion does not change if, in the basic model, I use Joines' (1981) tax rates—as Cole and Ohanian (1999) do—or add a nonbusiness sector. See McGrattan (2011).

1929 level. In the extended model, the consumption path counterfactually rises before 1932. The optimal response to high future capital taxes is high current distributions of business capital.[11] Taxes on consumption do rise during the 1930s, but not significantly until after 1932. At that point, consumption in the extended model does decline sharply.

Predictions for real GDP are shown in Figure 3. Not surprisingly, given the predictions for investment and consumption, neither of the models accounts for the full fall in observed GDP. But the extended model shows a large improvement over the basic model prediction, which has the wrong sign. The basic model predicts a 1 percent *rise* in detrended real GDP between 1929 and 1932, rather than a 31 percent fall. This picture is the basis of conventional wisdom that fiscal policy can be safely ignored. The extended model, however, predicts an initial decline in real GDP that is about 33 percent of the actual decline. The decline in model GDP is not greater because households consume more in the early part of the decade when businesses increase distributions.

Figure 4 shows hours worked per capita for the basic and extended models along with the U.S. data. As in the case of GDP, the prediction of the basic model has the wrong sign. The basic model predicts a 2 percent *rise* in per capita hours of work between 1929 and 1932, rather than a 27 percent fall. Households work more because labor income tax rates actually fall in the first part of the Depression, and taxes on business profits have little impact on labor inputs in this period. The extended model, however, predicts an initial decline in hours of work that is about 34 percent of the actual decline. This decline occurs even though the tax rate on labor income falls initially because other taxes are included in the analysis that impact hours of work.

The extended model has another channel for spending, namely, intangible investment, but its price is also affected by expected increases in capital tax rates. Figure 5 shows the extended model's patterns of business tangible and intangible investments. Notice that, initially, tangible investment falls sharply as distributions are increased, while intangible investment falls less sharply. Both fall because businesses are distributing more, but part of intangible investment is financed by the labor of business owners. In the later part of the decade, when undistributed profits taxes

[11] The large deviation between consumption patterns in theory and data cannot be resolved by introducing the type of financial frictions proposed by Bernanke and Gertler (1989). Taxes on dividends and undistributed profits have the same impact on economic activity as the agency costs in their model. Both impact the price of capital, leading to declines in investment and increases in consumption.

are introduced, there is a shift from tangible investment to intangible investment because the tax affects the relative price of the two types of investment.

Overall, the results show that the extended model's predictions for the impact of U.S. fiscal policy are greater than those of the basic model. And the impact is nontrivial, especially for tangible and intangible investments. This overturns the standard result that fiscal policy played little or no role in the U.S. Great Depression.

4.3. Investigating the Results

To better understand the quantitative contribution of the various factors included in the extended model, I simulate variants of the model and compare the new predictions to those of the benchmark simulation. Here, I show that the primary factors driving the quantitative results are taxes on dividends in the early part of the decade and taxes on undistributed profits in the latter part. The choice of expectations does affect the pattern of the investment series but, within an empirically plausible range, does not overturn the main conclusions. Neither does the inclusion of an untaxed investment: allowing firms to invest in untaxed intangible investment has only a small effect on their choice of tangible investment. Finally, I show that including factors specifically intended to depress consumption at the start of the Depression and to further depress hours of work over the decade do not worsen the fit of investment.[12]

4.3.1. Tax Rates Set to Zero

I start by demonstrating that the introduction of taxes on distributed and undistributed profits is critical for the results. I do this by turning them off, one at a time.[13]

Here, I restrict attention to tangible investment, which is shown in Figure 6. (See McGrattan, 2011, for plots of other series.) If the tax rate on dividends is equal to zero, the model cannot account for the huge decline in tangible investment that occurred between 1929 and 1932. In this

[12] See McGrattan (2011) for additional experiments and sensitivity analyses.

[13] In McGrattan (2011) I redo the exercise for all of the taxes and find that these are quantitatively most important.

case, the tax rate tomorrow equals the tax rate today and there is not a huge shift in returns to capital.

If the tax rate on undistributed profits is counterfactually set to zero in 1936–1938, then the model cannot account for the 1938 recession. In this case, the relative price of tangible and intangible capital is only varying with the tax rate on profits, τ_{pt}, and the changes are not large enough to induce a large shift between these types of investments.

The results in Figure 6 are not altered if instead of setting the tax rate on dividends to zero, I set it equal to any constant. As I'll show in the next section, what matters is the expectation of next period's tax rate *relative* to today's.

4.3.2. Alternative Policy Expectations

Next, I show how the quantitative results depend on household expectations about fiscal policy changes. To do this, I compute the extended model's equilibrium for three alternative assumptions about these expectations. One is the benchmark set of assumptions used in the initial simulation. A second assumes that in 1930, households put the probability of staying with 1930 policy for another year at 100 percent; the same can be said for 1931. The transition matrix for 1932 and after is the same as in Table 2. I call this alternative *Myopic, 1930–1931.* The third alternative is to assume perfect foresight, that households have full knowledge of the path of spending and tax rates. I call this alternative *Perfect Foresight, 1930–1939.*

As is clear in Figure 7, the model's predictions of tangible investment do seem different with the different assumptions. If households place no probabilistic weight on the higher tax rates of the 1930s, as is true in the myopic example, then tangible investment does not fall initially as much as it does in the benchmark. However, there is still a first-order effect on investment and one much larger than the basic growth model prediction. If households have perfect foresight, then they react immediately and sharply to the news by setting tangible investment to zero.

The primary determinant for the fall in tangible investment is expectations about future changes in the tax rate on dividends. The reason for the large decline is that households anticipate large changes in the effective return to capital. To see this, consider the households' intertemporal first-order condition for tangible capital when nonnegativity constraints are not binding on investment:

$$\frac{(1+\tau_{ut})\,(1-\tau_{dt})}{(1+\tau_{ct})\,\hat{c}_t} = \hat{\beta} E_t\Big[\frac{(1-\tau_{dt+1})}{(1+\tau_{ct+1})\,\hat{c}_{t+1}}\{(1-\tau_{pt+1})\,(r_{Tt+1}-\delta_T-\tau_{kt+1})+1+\tau_{ut+1}\}\Big], \qquad (4.1)$$

where expectations are conditioned on the state s_t, $\hat{\beta} = \beta/(1+\gamma)$, and variables with hats are per capita series detrended by technology growth; for example, $\hat{c}_t = c_t/(1+\gamma)^t$.[14] If tax rates on dividends are constant, then the terms $1-\tau_{dt}$ and $E_t(1-\tau_{dt+1})$ cancel. If, in addition, revenues are lump-sum rebated to households, then taxes on dividends have no effect because neither budget sets nor first-order conditions change. Similarly, if households have myopic expectations—by which I mean that every period they think the current tax rates they are facing will be in place forever—then tax rates on dividends have no effect even if they do actually change. However, if households put some probability of changing rates, then the terms $1-\tau_{dt}$ and $E_t(1-\tau_{dt+1})$ do not cancel, and the effective *gross* rate of return to capital is affected. With tax rates rising, effective rates of return are falling.[15]

Another difference worth noting about the experiments shown in Figure 7 is the reaction to news about the undistributed profits tax. In the benchmark simulation, this tax is completely unanticipated. In the perfect foresight case, it is completely anticipated. Thus, tangible investment sharply rises between 1931 and 1935 and falls when the tax is in effect.

4.3.3. No Intangible Investment

Next, I quantify the role of business intangible investment, which is expensed and thus not taxed. Specifically, I rerun the simulations for a version of the extended model with no intangible capital (that is, with $\phi = 0$ and parameters recalibrated to match 1929 observations). I compare its predictions with the benchmark predictions and find that the results are little changed.

A priori, there is reason to believe that variation in intangible investment would enhance the

[14] Intuition for the actual simulation is complicated by the fact that negativity constraints do bind in many states of the world.

[15] In a study of the U.S. Jobs and Growth Tax Relief Reconciliation Act of 2003, Chetty and Saez (2005) provide empirical evidence that cuts in dividend taxes have large and immediate effects on payout policies of firms with high levels of taxable noninstitutional ownership.

model's ability to match up with U.S. data because it generates movements in efficiency and labor wedges, as called for by Chari, Kehoe, and McGrattan (2007). The efficiency wedge is the ratio of GDP to $(K_T+K_n)^{1/3}H^{2/3}$, where K_T+K_n is the sum of aggregate tangible capital in the business and nonbusiness sectors and H is total hours of work. The labor wedge is the ratio of the marginal rate of substitution between leisure and consumption $\psi c/(1-h)$ and labor productivity measured as GDP divided by hours of work. Chari, Kehoe, and McGrattan (2007) show that these wedges varied a lot during the 1930s, which is puzzling for standard neoclassical theory. Using U.S. data to measure these wedges, I find that the efficiency wedge falls about 12 percent between 1929 and 1932 and then recovers by 1936, and the labor wedge falls 24 percent between 1929 and 1932 and remains low throughout the decade.

Performing the same exercise in the model, I do find that both wedges vary over the decade because intangible investment and capital vary. However, the movements in intangible investments are not large enough to generate movements in the model wedges comparable to those found in the data. The efficiency wedge constructed from the model time series falls only 1 percent between 1929 and 1932 before recovering. The labor wedge rises at first and then falls roughly 8 percent over the decade. Put another way, businesses do not shift much between tangible and intangible investment in response to changes in fiscal policies, as Figure 8 makes clear. Figure 8 compares tangible investment in the models with and without intangible investment; the two series are quite close. (See McGrattan, 2011, for plots of the other variables, which are also close.) In other words, the interaction between increased capital taxation and fluctuations in intangible investments is not driving any of the results in the benchmark version of the extended model with intangible capital.

4.3.4. Exogenous Wedges

Clearly, factors other than tax policy were involved in depressing consumption at the start of the Depression and hours of work throughout the decade. I next show that adding exogenous efficiency and labor wedges—specifically intended to generate dynamics of consumption and hours of work closer to U.S. patterns—does not worsen the fit of investment.

Wedges that vary exogenously can easily be added to a version of the model without intangible investment because the path for the efficiency wedge Z_t can be statically determined using the relation in (2.1) with data on capital stocks, labor inputs, and output in the business sector if $\phi = 0$. Similarly, I can replace the tax rate on labor τ_{ht} with a labor wedge that forces the intratemporal condition relating the wage to the marginal rate of substitution between consumption and leisure to hold.

Adding these exogenous wedges yields a much closer match between the model predictions and the U.S. data than was found in the benchmark simulation, in which wedges arose endogenously via the inclusion of intangible investment. For example, in Figure 9, I show a much improved prediction for consumption in the model with exogenous wedges. (See McGrattan, 2011, for plots of hours and GDP that also line up closely with U.S. data.) The consumption pattern fits much better because the changes in efficiency wedges act like negative productivity shocks that affect all components of GDP. The hours of work pattern fits much better because the labor wedge acts like a time-varying tax on labor that is much more severe than actual labor tax rates in the 1930s.

And, most importantly, the exercise shows that the pattern for investment is, if anything, closer to the actual pattern. This pattern is evident in Figure 10, which plots total investment for the two versions of the model. The inclusion of efficiency wedges that act like negative productivity shocks further depresses investment. However, the impact is not as large as it is for consumption because tangible investment is already close to zero in 1932 and is constrained to be nonnegative in equilibrium. Thus, the fit of investment is not worsened when the additional factors depressing the economy are included.

5. Other Countries and Time Periods

My analysis has focused on the United States in the 1930s. I have found that large increases in the tax rate on dividends—that are not a complete surprise—and large increases in the tax rate on undistributed profits can have a first-order impact on economic activity, especially investment. In this section, I provide some evidence of this effect for other countries and time periods.

5.1. Other Countries in the 1930s

Countries had a wide range of experiences during the 1930s. Some countries had little or no decline in economic activity, and some, like the United States, had dramatic declines. Although to the best of my knowledge, tax data are insufficient for countries outside of the United States to conduct the same analysis as above, I do have information about tax schedules and real per capita GDPs during this period. The information is suggestive that countries with the largest increases in income tax rates were also the most depressed.

In Table 3, I report the top marginal tax rates in 1929 and 1935 for seven countries that had significantly different experiences in the 1930s. A preferable measure would be the average marginal tax rate on dividends, but the necessary underlying data for this measure—namely, marginal tax rates and dividend income by income class—are not available for any country but the United States in this period. Thus, as a proxy for the change in the average marginal tax rate on dividends, I use the change in the top marginal rate on dividend income, since most dividends are earned by households in high income classes. Along with tax rates, I report the deviation in per capita real GDP relative to a growth trend of 1.9 percent per year for the year 1933. Figure 11 shows the detrended real GDP for Sweden, the United Kingdom, France, Australia, New Zealand, the United States, and Canada. Numbers in parentheses are the differences in the top marginal tax rates listed in Table 3.[16]

These data show that there is a strong negative correlation, roughly −94 percent, between the change in the top income tax rates and the deviation in per capita real GDP relative to trend in 1933. As noted above, what matters is the change in the tax rates, not the levels. Thus, the fact that the United Kingdom had high tax rates in this period is not relevant for the theory. What is relevant is that their tax policies changed little.

5.2. The United States in the Great Recession

The post-Depression time period provides additional opportunities to test the extended theory because the United States has had several instances of large tax changes. In this section, I consider the recent U.S. Great Recession (2008–2009) because it is a period in which future income tax rates

[16] Sources for the income tax rate schedules are Steinmo (1996) for Sweden, Tolley (1938) for the United Kingdom, Piketty (2001) for France, the Commonwealth of Australia (1932, 1942–1943) for Australia, Vosslamber (2010) for New Zealand, the U.S. Treasury (1916–2010) for the United States, and the Canadian Tax Foundation (1957) for Canada.

Table 3. Changes in Tax Rates and Real GDP in Six Countries

Country	Top Marginal Income Tax Rates (%) 1929 (1)	1935 (2)	Difference (2)−(1)	1933 Per Capita Real GDP Relative to Trend (percent)
Sweden	30.2	35.4	5.2	−10.8
United Kingdom	57.5	63.8	6.3	−11.1
France	41.7	50.4	8.7	−16.5
Australia[a]	27.0	42.5	15.5	−14.7
New Zealand[a]	22.5	39.0	16.5	−19.3
United States[a]	20.0	59.0	39.0	−35.8
Canada[a]	40.0	69.3	29.3	−38.3

[a] Rates differ by type of income. Table reports rates on dividend income.

were uncertain, but the nature of the uncertainty is relatively easy to model. (See a discussion of other postwar periods in McGrattan, 2011.) For this period, as in the U.S. Great Depression, I find that the timing and magnitude of potential income tax changes are consistent with a large decline in U.S. investment. I also find that the model accounts for roughly 28 percent of the observed decline in GDP and 45 percent of the observed decline in hours of work, with the only change in inputs being the change in expectations about future tax rates on dividend income.

Significant changes to tax policy were enacted when George W. Bush was the U.S. President: the Economic Growth and Tax Relief Reconciliation Act in 2001 and the Jobs and Growth Tax Relief Reconciliation Act in 2003. These policies—commonly referred to as the *Bush tax cuts*—lowered average marginal income tax rates relative to their 2000 level. For example, Barro and Redlick's (2011) estimate for the average marginal tax rate on labor income is 39 percent in 2000 and 35 percent in 2005. My estimate of the average marginal tax rate on dividend income is 15.5 percent in 2000 and 7.8 percent in 2005.[17] Nearly all of the legislated tax cuts were set to expire on December 31, 2010, but were extended by Congress for two years.

Relevant for household expectations are not only the tax policies but also the tax politics.

[17] The marginal tax rate for federal plus state taxes is from TAXSIM. An estimate of the fraction of equity held by nontaxed entities is found by summing holdings of pension funds, IRAs, and nonprofits. See McGrattan, 2011, for details.

Table 4. Expectations for 2004–2011 Model Simulation

	% Probability that Bush Tax Policies		
Expectations Formed in	Permanent in 2011	Expire in 2011	Extended until 2013
2004	100	0	0
2005	90	10	0
2006	90	10	0
2007	80	20	0
2008	50	50	0
2009	10	90	0
2010	25	25	50

In 2004, Bush was reelected and urged Congress to make permanent the tax policies enacted in 2001 and 2003. By 2007, many of the Democrats campaigning for the job of U.S. President in 2008 promised to let the policies expire on schedule. When Barak Obama was elected, he sought to make some of the legislated tax cuts permanent, but wanted tax rates of high earners to rise. Gains by Republican candidates in the 2010 midterm elections shifted sentiments yet again, with many Tea Party candidates promising to make the Bush tax policies permanent. As the deadline for expiration approached, proposals were made to extend the deadline, which was ultimately what was done.

These events motivate my choice of expectations shown in Table 4. I assume that, with the reelection of Bush in 2004, households expect the policies to be made permanent in 2011. With time, they are less certain and put more weight on the possibility that the legislation will expire as scheduled. For example, between 2007 and 2008, that expectation shifts, with households putting increasing weight on the probability that the policies will expire. With Obama's election, households become almost certain that they will expire. Then, in 2010, sentiment changes and the possibility of an extension is proposed.

To simplify the analysis, I compute equilibrium paths, starting in 2004, assuming that the only policies or inputs that might change over the sample period are average marginal income tax rates, τ_{ht} and τ_{dt}. A change in policy is never actually realized, so the tax rates on labor and dividend income stay at 35 percent and 7.8 percent, respectively, over the entire sample period. I abstract from all other changes considered in simulations of the Great Depression.

The results for business tangible investment are plotted in Figure 12. Two model predictions are displayed: one that assumes that only τ_d is stochastic and one that assumes that both τ_d and τ_h are stochastic. I include both to see how much each anticipated rate change affects the results. Figure 12 shows that both model predictions are a surprisingly close match to observed tangible investment, which falls close to 60 percent by mid-2009. Of course, how quickly and how steeply it drops off in the model is a function of the likelihood of an increase in tax rates. If the election of Obama had not had a significant effect on household expectations, the decline in investment would have been smaller.

In McGrattan (2011) I plot the equilibrium paths for other variables in the model, but here I summarize the results. In the case where households put some probability on both τ_d and τ_h rising in 2011, the drops in model business value added and hours of work account for 20 percent and 36 percent the actual declines. Suppose, alternatively, that households assume that only τ_d can possibly rise—say, because Obama increases rates on higher earners, who earn most of the dividends, but not on lower earners, who earn most of the labor income. In this case, the drops in model business value added and hours of work account for 28 percent and 45 percent of the actual declines. In both simulations, model consumption rises with increased distributions as in the simulations for the Great Depression. (I also rerun the experiments for alternative expectations, varying timing and magnitudes to show how they impact the results. See McGrattan, 2011.)

Overall, the simulation for the U.S. Great Recession is much like the simulation for the U.S. Great Depression: it demonstrates that anticipated changes in individual income taxes can have first-order effects on economic activity.

6. Conclusion

Many theories have been proposed for the large contraction of the 1930s and the slow recovery thereafter. Absent from the theories of Friedman and Schwartz (1963), Bernanke and Gertler (1989), Cole and Ohanian (2004), and many others is any role for fiscal policy in this decade.

This paper challenges the conventional view that fiscal policy played little or no role in the Great Depression. Government spending and a variety of tax rates rose significantly during this decade, or were expected to, and theory tells us that these events should have had an impact. Especially important are the sharp rise in tax rates on individual incomes, which include dividend income, and the introduction of the undistributed profits tax. Large changes in tax rates on dividends, when fed into the neoclassical growth model, imply a large drop in tangible investments and equity values, similar to what we observed at the start of the 1930s. In the later part of the 1930s, tax rates on undistributed profits were introduced and led to another dramatic decline in tangible investment.

Although the results show that capital taxation during the U.S. Great Depression had large effects, it cannot be the only overlooked factor in the analysis of the period. If the only change is a rise in tax rates, theory predicts that consumption counterfactually rises before 1932, with households anticipating some increases in income taxes and sales taxes. This deviation is also evident in standard theories of financial frictions and remains a challenge for those interested in accounting for the dramatic contraction in the early 1930s.

Appendix A: The Basic Model

Here I describe Cole and Ohanian's (1999) version of the neoclassical growth model which they use to reach the conclusion that fiscal policy played a small role in the U.S. Great Depression. In this model, given the initial capital stock k_0, the problem for the stand-in household is to choose consumption c, investment x, and hours worked h to maximize expected utility

$$E \sum_{t=0}^{\infty} \beta^t \{\log(c_t) + \psi \log(1 - h_t)\} N_t \qquad (A.1)$$

subject to the constraints

$$c_t + x_t = r_t k_t + w_t h_t - \tau_{pt}(r_t - \delta) k_t - \tau_{ht} w_t h_t + \kappa_t, \qquad (A.2)$$

$$k_{t+1} = [(1 - \delta) k_t + x_t] / (1 + \eta), \qquad (A.3)$$

where variables are written in per capita terms, $N_t = N_0(1+\eta)^t$ is the population in t, which grows at rate η, β is the time discount factor, ψ is a parameter governing the disutility of work, and δ is the depreciation rate of capital. Capital is paid rent r_t; labor is paid wage w_t. Taxes are levied on profits at rate τ_{pt} and on wages at rate τ_{ht}, and per capita government transfers are given by κ_t.

The aggregate production function is given by

$$Y_t = K_t^{\theta} (Z_t H_t)^{1-\theta}, \qquad (A.4)$$

where capital letters denote aggregates and θ is the capital share of output. The parameter Z_t is labor-augmenting technical change that is assumed to grow at a constant rate, $Z_t = (1 + \gamma)^t$. The firm rents capital and labor. If profits are maximized, then the rental rates are equal to the marginal products. The goods market clears, so $N_t(c_t + x_t + g_t) = Y_t$, where g_t is per capita government spending.

To be consistent with Cole and Ohanian (1999), I assume that the capital share θ is 0.33, the growth rate of the population η is 1 percent, and the growth rate of technology γ is 1.9 percent. Values of ψ, δ, and β are then set to ensure that 1929 levels of per capita hours, per capita real investment, and the per capita real capital stock in the model are consistent with U.S. data; this implies that $\psi = 2.33$, $\delta = 0.05$, and $\beta = 0.976$.[18]

[18] Cole and Ohanian (1999) compare steady states with government spending and tax rates set at 1929 and 1939 levels. The tax rates they use are estimated by Joines (1981). I instead compute the transition over the entire decade and use the tax rates of Barro and Redlick (2011) for τ_{ht} and the statutory rate on profits for τ_{pt}.

Appendix B: The Data

The main source for the national accounts data used in this study is the U.S. Department of Commerce, Bureau of Economic Analysis (BEA), which publishes the U.S. national accounts and fixed asset tables in the *Survey of Current Business* (available online at www.bea.gov), *SCB* hereafter. The main source for hours data is Kendrick (1961). In this appendix, I provide details on these data and the necessary adjustments that are made to make the model accounts consistent with the U.S. accounts.

B.1. National Accounts and Fixed Assets

The main components of GDP are found in Table 1.1.5 of the national income and product accounts (NIPA) from the *SCB* (1929–2010). GDP in the business sector is set equal to value added of corporations and nonfarm proprietorships. Nonbusiness output is residually defined as GDP less business value added.

B.1.1. Components of GDP

Consumption is defined to be personal consumption expenditures on nondurables and services, adjusted to include consumer durable services and to exclude sales tax. (Details of these adjustments are described below.) *Investment* is defined to be the sum of gross private domestic investment, government investment, net exports, and personal consumption expenditures on durables after subtracting sales taxes. *Business tangible investment* is defined to be the part of investment made by corporations and nonfarm proprietors. *Nonbusiness investment* is residually defined as investment less business tangible investment. *Government spending* is defined to be government consumption expenditures. All components of GDP are deflated by the GDP deflator (in Table 1.1.9) and population at midperiod (Table 2.1). The series are then divided by the growth in labor-augmenting technical change $(1+\gamma)^t$.

Components of GDP treated exogenously and used as inputs in the model simulations—namely, detrended government spending and detrended nonbusiness activities—are filtered using the algorithm proposed by Hodrick and Prescott (1997). I set their smoothing parameter (λ) equal to 1. The unfiltered series are displayed in Table B.1. The same smoothing procedure is used for the tax series displayed in Table 1. In a separate technical appendix (McGrattan, 2011), I plot all of the smoothed inputs along with the original time series.

B.1.2. Adjustments to Accounts

Two adjustments are made to GDP and its components to make them consistent with the model

Table B.1. U.S. National Accounts and Hours of Work

	Consumption		Aggregate Activity			Nonbusiness Activity		
Year	Private	Public	GDP	Investment	Hours	Output	Investment	Hours
1929	68.1	5.8	100.0	26.1	28.9	36.9	15.0	7.4
1930	63.3	6.1	89.0	19.6	26.6	33.2	12.1	7.3
1931	60.4	6.7	81.4	14.3	24.2	33.5	11.0	7.3
1932	54.3	7.1	69.2	7.8	21.2	30.8	7.4	7.0
1933	51.1	7.2	66.4	7.9	21.0	30.4	6.5	7.1
1934	51.6	7.8	70.4	11.0	20.8	29.3	7.3	6.8
1935	52.8	7.7	74.3	13.8	21.6	30.6	9.6	7.0
1936	56.0	8.3	81.8	17.4	23.3	32.5	10.6	7.3
1937	56.0	7.8	83.6	19.8	24.0	32.0	12.3	7.3
1938	54.8	8.3	78.5	15.6	22.1	31.9	12.0	7.1
1939	55.5	8.7	82.5	18.1	22.8	32.3	12.8	7.0

Note: GDP and components are in real, per capita terms and divided by an annual growth trend of 1.019^t. These series are further divided by the 1929 level for per capita real GDP. Hours are in per capita terms and divided by 5,000 which is an estimate of annual discretionary hours. Finally, all series are multiplied by 100.

accounts: sales taxes are subtracted, and services for consumer durables and government capital are added.

Sales Taxes. Unlike the NIPA, the model output does not include consumption taxes as part of consumption and as part of value added. I therefore subtract sales and excise taxes from the NIPA data on taxes on production and imports and from personal consumption expenditures, since these taxes primarily affect consumption expenditures.

Fixed Asset Expenditures. I treat expenditures on all fixed assets as investment. Thus, spending on consumer durables is treated as an investment rather than as a consumption expenditure and moved from the consumption category to the investment category. The consumer durables services sector is introduced in the same way as the NIPA introduces owner-occupied housing services. Households rent the consumer durables to themselves. Specifically, I add depreciation of consumer durables to consumption of fixed capital of households and to private consumption. I add imputed additional capital services for consumer durables to capital income and to private consumption. I assume a rate of return on this capital equal to 4.1 percent, which is an estimate of the return on other types of capital. A related adjustment is made for government capital. Specifically, I add imputed additional capital services for government capital to capital income and to public consumption.

B.2. Hours Per Capita

The primary source of the hours series is Kendrick (1961), Table A-X, total manhours. Nonbusiness hours are the sum of hours in the government and farm sectors. Business hours are total hours less nonbusiness hours. For per capita hours, I divide the manhours series by the population age 16 and over. The population series is Series A39 of the *Historical Statistics* of the U.S. Department of Commerce (1975).

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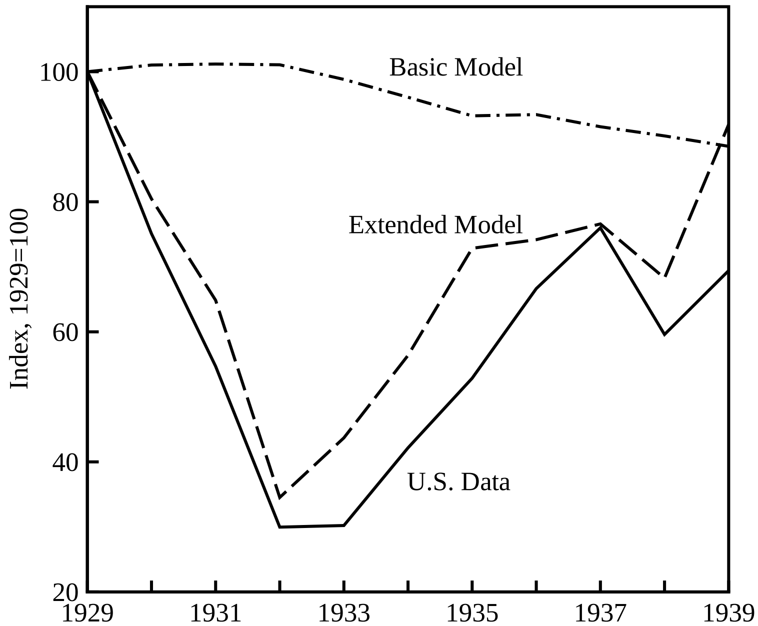

Figure 1. Detrended Real Investment in the United States and Two Versions of the Growth Model, 1929–1939

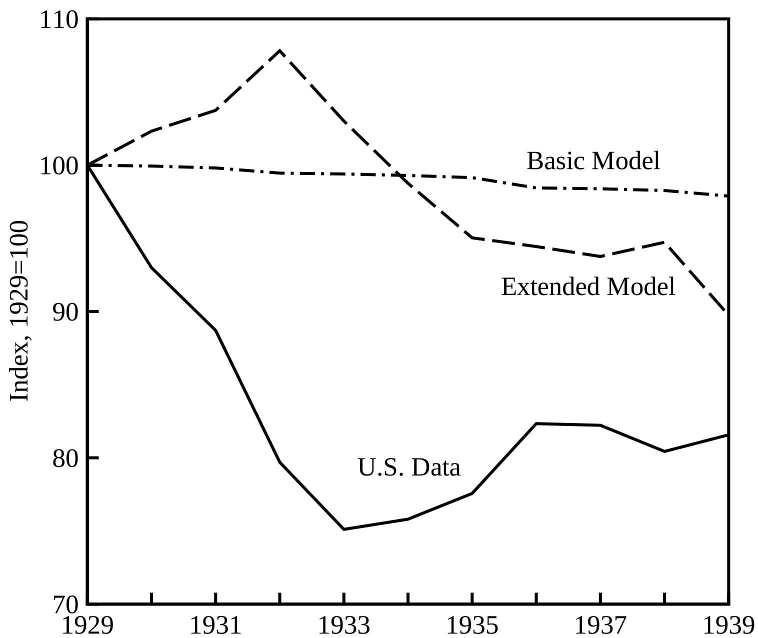

Figure 2. Detrended Real Consumption in the United States and Two Versions of the Growth Model, 1929–1939

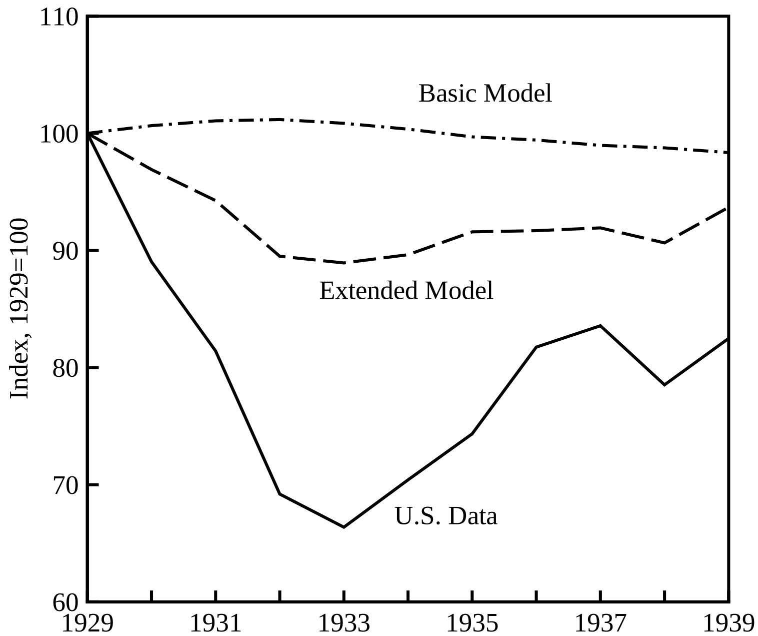

Figure 3. Detrended Real GDP in the United States and Two Versions of the Growth Model, 1929–1939

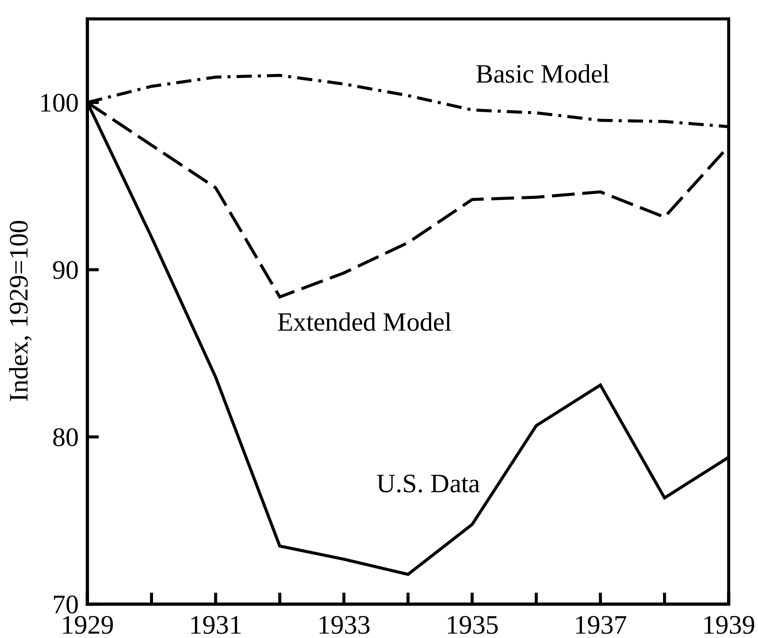

Figure 4. Hours Worked Per Capita in the United States and Two Versions of the Growth Model, 1929–1939

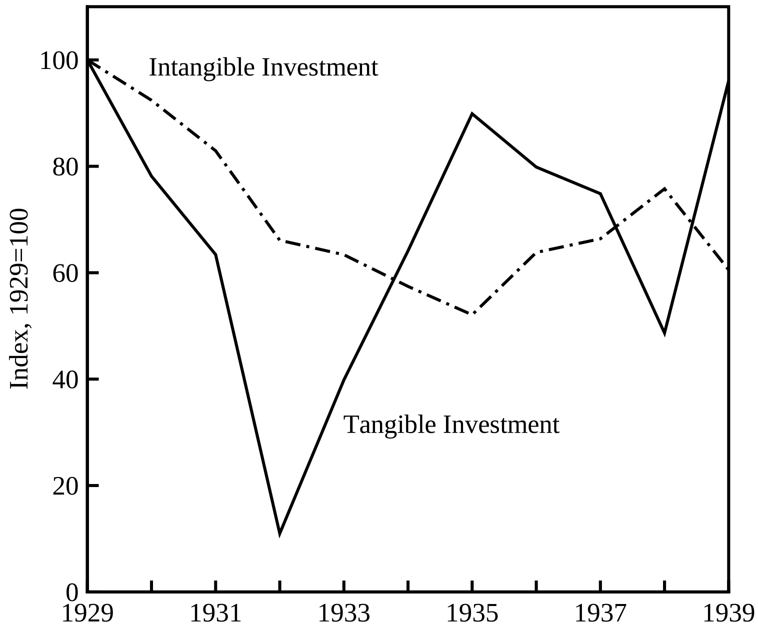

Figure 5. Detrended Real Business Tangible and Intangible Investment in the Extended Growth Model, 1929–1939

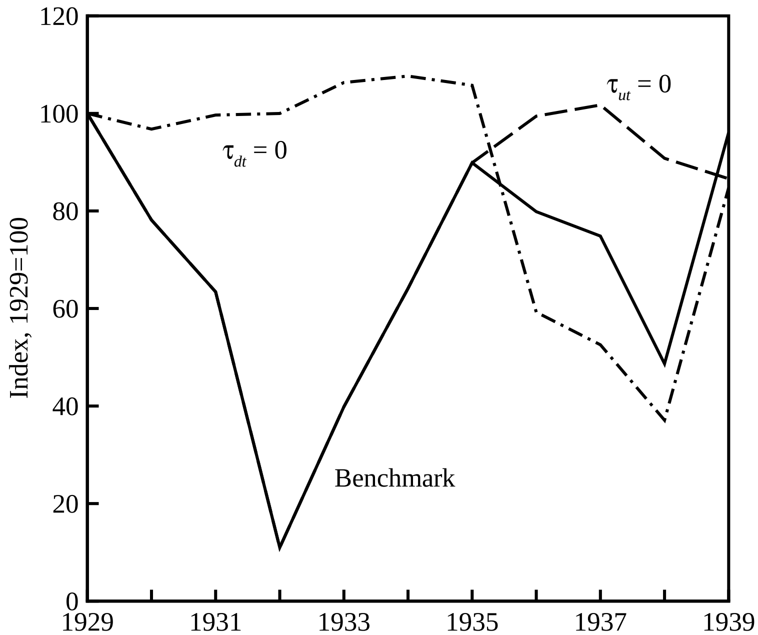

Figure 6. Detrended Real Business Tangible Investment in the Extended Growth Model, 1929–1939, with Alternative Assumptions for Capital Taxes

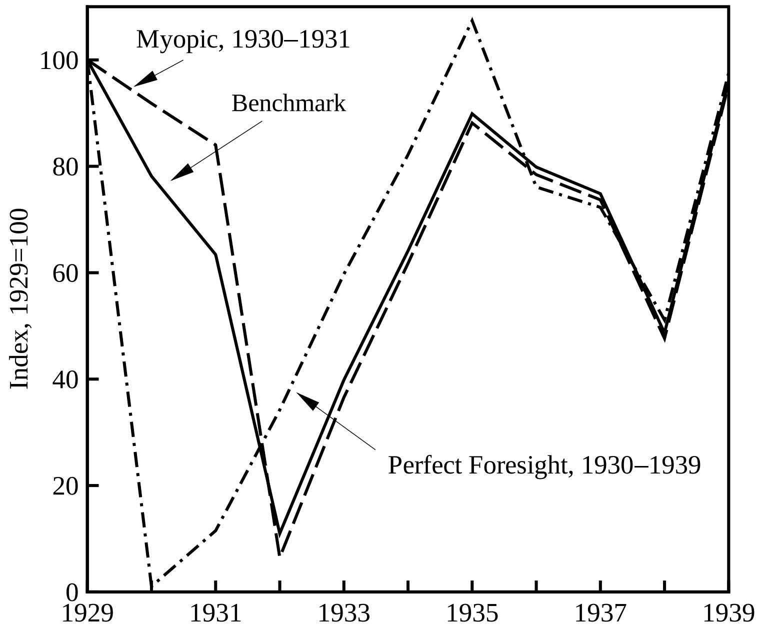

Figure 7. Detrended Real Business Tangible Investment in the Extended Growth Model, 1929–1939, with Alternative Assumptions for Expectations

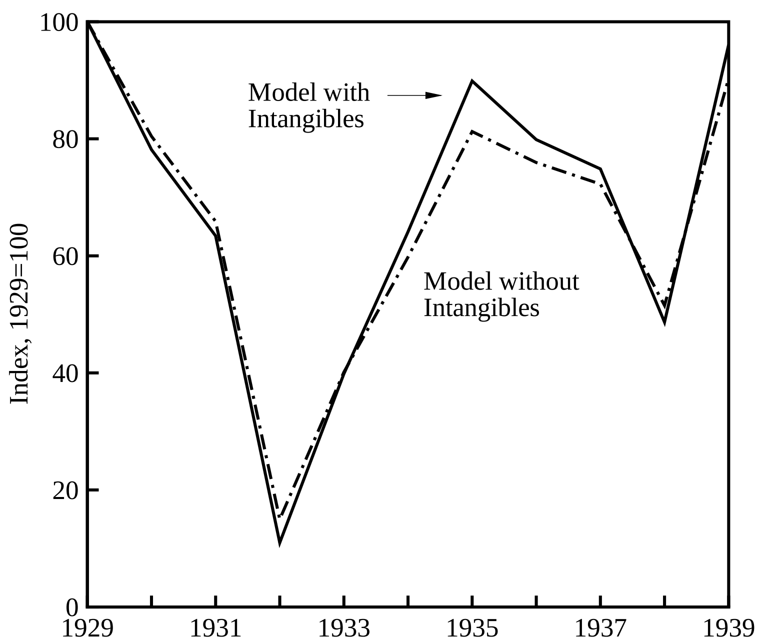

Figure 8. Detrended Real Business Tangible Investment in the Extended Growth Model, 1929–1939, with and without Intangible Investment

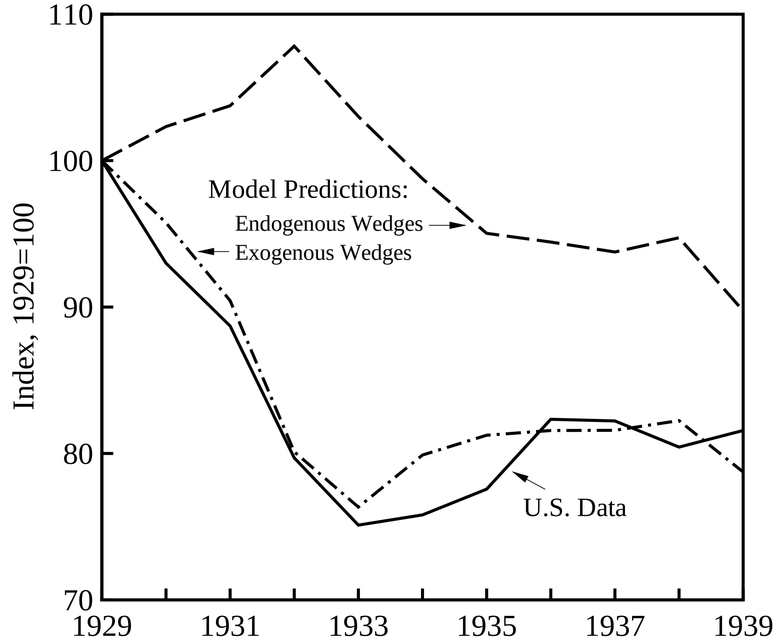

Figure 9. Detrended Real Consumption in the United States in the Extended Growth Model, 1929–1939, with Endogenous and Exogenous Wedges

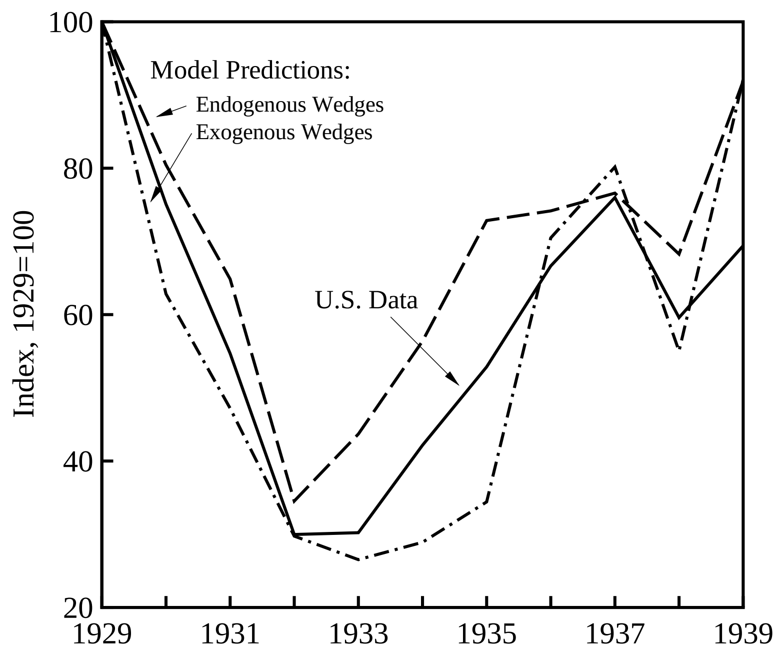

Figure 10. Detrended Real Investment in the United States in the Extended Growth Model, 1929–1939, with Endogenous and Exogenous Wedges

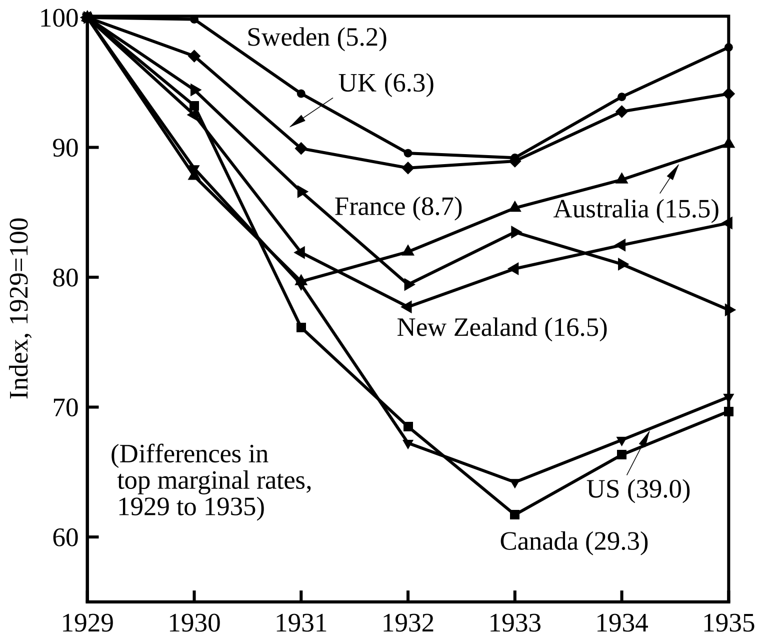

Figure 11. Detrended Real GDP for Six Countries with Different Tax Rate Schedules, 1929–1935

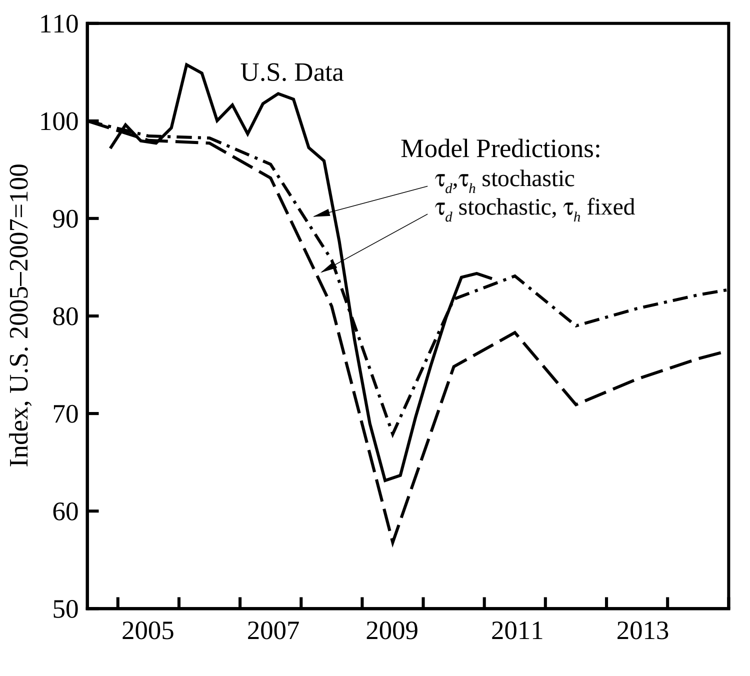

Figure 12. Detrended Real Business Tangible Investment in the Extended Growth Model, 2004–2014