Fiscal foresight and comprehensive tax reform *
(Preliminary and Incomplete)

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ABSTRACT. I characterize the effects of foresight regarding comprehensive tax reform on aggregate variables. I consider three reform types in a representative household neoclassical growth model: a pure consumption tax, a pure labor income tax, and a hybrid reform that represents a middle-ground. All three reforms eliminate the tax on capital income. I find that the post-reform long-run level of output is a function of the degree of foresight, but behaves differently for each type of reform. The foreseen change in the steady state labor income tax rate is the primary force over the transition path to the new long-run equilibrium. For example, the household will reduce hours worked when they foresee a lower labor income tax rate. This leads to a recession until the new tax rate takes effect. The recession mitigates some of the tax reform’s ability to stimulate growth, which is dependent on the degree of foresight. Therefore, precisely when the household receives news of tax reform relative to implementation alters the effectiveness of the reform’s ability to “stimulate growth,” which is an often cited goal of policy-makers. In general, I find that replacing the labor and capital income taxes with a pure consumption tax leads to the highest gain in long-run output regardless of the degree of foresight, but I caution that this depends entirely on the household’s ability to intertemporally substitute labor supply.

Keywords: Foresight, Tax Reform, Revenue Neutrality, Long-run Output
JEL Codes: H24, H25, D81, D90

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1 Introduction

Many significant changes in fiscal policy have taken place recently. For example, the American Recovery and Reinvestment Act of 2009 cut taxes, increased funds for education and entitlement programs and funded construction to the tune of $787B. One of its goals is to spur economic activity and invest in long-term growth. This is often also the goal of comprehensive tax reform, discussion of which has once again entered the limelight due to a foreseen structural deficit as projected by the Congressional Budget Office. Presently, the president calls for tax reform that generates higher revenues to reduce the deficit while the chairmen of the House Ways and Means Committee and the House Budget committee call for lower income tax rates and a wider tax base which maintains revenue neutrality. People expect that changes in fiscal policy will address the looming structural deficit, while legislators will want to avoid policies with recessionary outcomes due to the recent economic turbulence. It is with this premise that I justify the following analysis on the effects of comprehensive tax reform on the macroeconomy, especially when legislators allow their constituents varying degrees of foresight prior to reform.

I define comprehensive tax reform as a change in one or more of the steady state consumption, labor income and capital income tax rates. I focus on three flavors of reform: a pure consumption tax reform, a pure labor income tax reform and a hybrid tax reform. I stress the importance of the fiscal authority’s ability to influence the outcomes of comprehensive tax reform by varying the lag between announcement of the policy and its implementation. Precisely how the steady state tax rates change upon implementation will determine whether or not additional foresight is advantageous in achieving long-run gains in output. I compare the long-run change in output when the household has foresight to calculations from a steady state analysis that is oblivious to the transition path. The steady state analysis predicts that all three types of reform lead to long-run gains in output while maintaining revenue neutrality. However, the dynamic model under foresight deviates drastically from these steady state predictions. I find that the most significant effect on long-run output comes from a foreseen change in the steady state labor income tax rate whereby the household makes an optimal intertemporal substitution of labor. For example, if the household foresees a lower labor income tax rate then they reduce current hours worked in favor of working more in the future. This substitution immediately causes a recession when the household receives news of the reform. The recession, which is prolonged with greater degrees of foresight, then partially mitigates the long-run boost in output resulting from implementation of the lower tax rate. Given this, I find that the pure consumption tax is more effective at increasing long-run output under less foresight since it calls for a reduction in the labor income tax rate. On the other hand, the pure labor income income tax is more effective at increasing long-run output when the household is allowed a greater degree of foresight. The hybrid tax reform leads to a boost in long-run output
that is relatively invariant to the degree of foresight. Generally, I find that the pure consumption tax reform is more effective than the hybrid tax reform, and that the hybrid tax reform is more effective than the pure labor income tax reform with the goal of increasing long-run output.

The reforms under investigation in this paper are high-level imitations of actual proposals. They imitate some of the reforms investigated by Altig, Auerbach, Kotlikoff, Smetters, and Walliser (2001) such as the Hall and Rabushka (2007) flat tax, retail sales tax and the X tax (a consumption tax with a progressive income tax). However, the foundation of their model is a perfect foresight Auerbach and Kotlikoff (1987) dynamic life-cycle simulation model with intra/inter-generational inequality, tax preferences, a progressive social security system, a medicare system and actual tax schedules. In stark contrast, the neoclassical growth model is this paper does not include any of these features, but it does consider limited foresight; this simplification allows me to highlight the long-run implications of varying degrees of foresight. As well, all tax rates used in this paper can be considered “flat” rates since there is a representative household. A wide variety of models have been utilized to assess the outcomes of consumption tax reform including the use of detailed population data by Gentry and Hubbard (1997), overlapping generation models as in Jorgenson and Wilcoxon (1997) and simpler artificial economies such as that employed by Correia (2010). The model here could be described as a simple artificial economy where I conclude that replacing the labor and capital income tax with a consumption tax is in general most effective at boosting long-run output under any degree of foresight, but particularly at shorter degrees of foresight; however, I do not consider the effects on the distribution of wealth between households or perform welfare analysis as other papers do. There is a branch of the tax reform literature that makes use of the neoclassical growth model, but focuses on the role of human capital. These include King and Rebelo (1990), Lucas (1990), Jones, Manuelli, and Rossi (1997), and Hendricks (1999). The later two contain an elastic labor supply, which is an important feature of my model due to the static and dynamic substitution of labor and leisure with changes in the labor income tax rate, realized and foreseen.

I see an opportunity to contribute to the tax reform literature by addressing announcement effects and uncertainty regarding its implementation. First, I will analyze the announcement effects and attempt to answer the following questions:

- How does the degree of foresight, the lag between announcement and implementation, affect the long-run outcomes of comprehensive tax reform?

- How does the result change if a fraction of households are liquidity constrained or have limited access to capital and bond markets? [to be completed]

- How does the result change if a fraction of households are oblivious to announced changes in future tax rates? [to be completed]
Second, I will address household uncertainty surrounding the tax reform decision-making process. Some households are surely attempting to anticipate tax reform as it is frequently discussed by pundits and politicians in the mainstream. For example, if they believe a national sales tax is a legitimate solution being considered by policy-makers to address a looming structural deficit, then in expectation they attach positive probability to an outcome with a higher steady state consumption tax rate. How does the future possibility of a national sales tax affect the macroeconomic equilibrium today? What does the transition path look like when tax reform news is received with uncertain outcomes? This avenue of research will effectively combine the issue of foresight—the lag between policy announcement and implementation with certainty—and uncertainty over the credibility of chatter regarding comprehensive tax reform (e.g. recent deliberations by President Obama’s Deficit Panel or documents such as Congressman Paul Ryan’s *A Roadmap for America’s Future*). [to be completed]

The paper follows with an outline of the neoclassical growth model and its optimality conditions in Section 2. After calibrating the model to the United States, I discuss the impulse response functions of persistent shocks to each of the three tax rates in the linearized model. Section 3 begins with an overview of the steady state calculations where the labor choice is a function of tax rates. Then I introduce the three types of comprehensive tax reform in detail and the resulting long-run outcomes. The simulation with foresight is discussed in Section 4 along with the underlying economic forces. The results are contrasted with the steady state analysis in Section 3. Section 5 concludes the paper.

## 2 The Model

The analysis is performed in a neoclassical growth model with the following features. The infinitely-lived representative household lives in discrete time finding it pleasing to eat and displeasing to work. Their wealth includes after-tax labor income, after-tax rent from capital (with an allowance for depreciation), interest on one-period bonds, non-depreciated capital, and transfers from the government. The production technology is constant-returns-to-scale Cobb-Douglas with capital and labor as the factors of production. Government spending and tax policies are exogenously specified, but lump-sum transfers to the household will adjust to keep the path of debt bounded.

The infinitely-lived household’s problem is to

\[
\max_{\{c_t, n_t, b_t, k_t\}_{t=0}^{\infty}} E_0 \sum_{t=0}^{\infty} \beta^t \left[ c_t^{1-\sigma} - \phi \frac{n_t^{1+\eta}}{1 + \eta} \right]
\]

(1)
subject to the household’s budget constraint

\[(1 + \tau^c_t) c_t + k_t + b_t = (1 - \tau^n_t) w_t n_t + \left[ 1 + (1 - \tau^k_t) \left( r^k_t - \delta \right) \right] k_{t-1} + R_{t-1} b_{t-1} + z_t. \]  

(2)

\(\sigma\) is the constant relative risk-aversion parameter and \(\eta\) is the constant Frisch elasticity of labor supply. \(c_t, n_t, b_t, k_t, z_t\) are consumption, hours worked, one-period bonds, capital stock and government transfers. \(\tau^c_t, \tau^n_t\) and \(\tau^k_t\) are proportional tax rates levied against consumption, labor income and capital income. \(\delta\) is the rate of depreciation of capital. \(R_{t-1}\) is the real return on one-period bonds issued by the government. The household supplies labor and capital to a perfectly competitive firm whose problem is to maximize profits,

\[\max_{k_{t-1}, n_t} y_t - w_t n_t - r^k_t k_{t-1},\]  

(3)

subject to the production technology,

\[y_t = k^\alpha_{t-1} n_t^{1-\alpha},\]  

(4)

where \(\alpha\) is the cost-share of capital. The resulting first order necessary conditions determine the wage rate,

\[w_t = (1 - \alpha) \frac{y_t}{n_t},\]  

(5)

and the rental rate of capital,

\[r^k_t = \alpha \frac{y_t}{k^\alpha_{t-1}}.\]  

(6)

The government sets policies that clear its budget constraint,

\[b_t + \tau^c_t c_t + \tau^n_t w_t n_t + \tau^k_t \left( r^k_t - \delta \right) k_{t-1} = R_{t-1} b_{t-1} + z_t + g_t.\]  

(7)

\(g_t\) is government spending. Combining the household and government budget constraints yields the aggregate resource constraint,

\[c_t + I_t + g_t = y_t,\]  

(8)

where the law of motion for investment is given by

\[I_t = k_t - (1 - \delta) k_{t-1}.\]  

(9)
The first order necessary conditions corresponding to the household’s optimization problem are

\[ \lambda_t = \frac{1}{c_t^\sigma \left(1 + \tau_t^c\right)} \]

\[ (1 - \tau_t^n) w_t = \phi n_t^\mu c_t^\sigma \left(1 + \tau_t^c\right) \]

\[ \frac{1}{R_t} = E_t \left\{ \beta \frac{\lambda_{t+1}}{\lambda_t} \right\} \]

\[ 1 = E_t \left\{ \beta \frac{\lambda_{t+1}}{\lambda_t} \left[1 + \left(1 - \tau_{t+1}^k\right) \left(r_{t+1}^k - \delta\right)\right] \right\} , \]

where \( \lambda_t \) is the marginal utility of wealth, and the remaining three conditions are the first order condition for labor, bond-Euler equation and the consumption-Euler equation.

2.1 CALIBRATION

This paper focuses on the qualitative results of the role of foresight (perfect and limited) on the transition path to the post-reform macroeconomic equilibrium. A rough calibration of the model inline with other papers with similar models is adequate to get a sense of what these results might look like for the United States. The calibrated parameters are listed in Table 1. I calibrate the model so that each time period is one quarter in length. For the fundamentals of the model, I borrow the risk aversion, Frisch elasticity, capital share and steady state hours worked from the benchmark U.S. calibration in Trabandt and Uhlig (2010) due to their detailed exposition on the relationship between these variables. The time preference rate implies a real annual return on debt of 4%. Other parameters are within a reasonable range as specified by the literature surrounding neoclassical growth models and the U.S. economy.

The tax rates represent the average marginal tax rates calculated from the National Income and Product Accounts over the period of The Great Moderation from 1987 to 2007. A detailed accounting of these rates along with the steady state shares is found in Appendix C. I choose this period of time for the following reasons. First, it begins at the time the Tax Reform Act of 1986 took effect. Yang (2007) gives a thorough overview of changes in federal income tax policy since World War II and indicates that the 1986 act is the most recent attempt at comprehensive reform with a legislative outcome. The act increased the lowest and decreased the highest marginal income tax rate and lowered the corporate income tax rate from 46% to 34%. It increased the number of exemptions, indexed the standard deduction to inflation and repealed the capital gains exclusion. It was thought that a structural reform of the tax code would be more effective at increasing tax revenue than simply increasing tax rates due the expected growth incentives. This motivation for tax reform is precisely the reason I think the present analysis is so important. (A good question is...
“Does the model predict an increase in tax revenues from such a comprehensive reform?” Yang cites that tax revenue was lost as a result of reform and in that regard it did not achieve its goal. [to be considered in more detail] Second, the past few years of macroeconomic data resulting from the financial crisis is omitted. Omission of this data is justified by a lack of financial friction in the model and its volatile nature.

Table 1: Model Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta$</td>
<td>Time Preference Rate</td>
<td>0.99</td>
</tr>
<tr>
<td>$\sigma$</td>
<td>Risk Aversion</td>
<td>2</td>
</tr>
<tr>
<td>$\eta$</td>
<td>Frisch Elasticity</td>
<td>1</td>
</tr>
<tr>
<td>$\delta$</td>
<td>Depreciation Rate</td>
<td>0.02</td>
</tr>
<tr>
<td>$\alpha$</td>
<td>Capital Share</td>
<td>0.38</td>
</tr>
<tr>
<td>$\bar{n}$</td>
<td>Steady state hours</td>
<td>0.25</td>
</tr>
<tr>
<td>$\phi$</td>
<td>Leisure Preference (Implied)</td>
<td>16.01</td>
</tr>
<tr>
<td>$\tau^c$</td>
<td>Consumption Tax Rate</td>
<td>5.68%</td>
</tr>
<tr>
<td>$\tau^n$</td>
<td>Labor Income Tax Rate</td>
<td>28.11%</td>
</tr>
<tr>
<td>$\tau^k$</td>
<td>Capital Income Tax Rate</td>
<td>28.47%</td>
</tr>
<tr>
<td>$z/y$</td>
<td>Steady State Transfers-to-Output</td>
<td>10.96%</td>
</tr>
<tr>
<td>$g/y$</td>
<td>Steady State Spending-to-Output</td>
<td>15.68%</td>
</tr>
<tr>
<td>$b/y$</td>
<td>Steady state Debt-to-Output</td>
<td>41.50%</td>
</tr>
</tbody>
</table>

2.2 Dynamics of Persistent Tax Rate Shocks

The following discussion provides some intuition on how a change in each of the tax rates affects equilibrium. Figure 1 shows the dynamic response of the variables in the model to a one-time unanticipated 1% shock to each of the consumption, labor income and capital income tax rates, which follow a first-order autoregressive process with rate of decay, $\rho = 0.95$. These impulse response functions result from the solution, given by Chris Sims’ GENSYS algorithm, to the log-linear model in Appendix B.

An increase in the consumption tax rate, $\tau^c$, results in a decrease in output, hours worked and consumption on impact. Evidently, the substitution from hours worked into leisure is the driving force here. The fall in hours worked increases the wage rate and decreases the return on capital due to complementarity of labor and capital in production. As the consumption tax rate decays back to its steady state value, the household increases hours worked, which raises the return on capital. Investment decreases as the capital stock approaches its long-run level. If the agent were
more risk averse, then hours worked and consumption would decrease less on impact. In that case, the agent is less sensitive to the increase in the relative price of current consumption over future consumption due to consumption smoothing.

An increase in the labor income tax rate, $\tau^n$, results in a fall in output, hours worked and consumption on impact. The fall in labor hours lowers the return on capital since there is complementarity between the marginal product of capital and labor in the production technology. This provides the agent with a disincentive to accumulate capital. A falling stock of capital coupled with increases in the after-tax wage rate and hours worked increases the return on capital, which encourages the agent to rebuild the capital stock. The response of consumption has a hump due to the increasing return on capital altering the consumption-savings decision. Tax revenues are higher than their initial steady state since the percent change in the increase in the tax rate is bigger than the percent change in the shrinking of the tax base.

An increase in the capital tax rate, $\tau^k$, increases consumption while decreasing hours worked and investment. There exists a wedge that raises the relative price of future-to-current consumption when income from intermediate goods is taxed as explained in Hall (1996). Consumption $i$ periods in the future carries a premium of $(1 - \tau^k)^i$ if consumed out of income from capital. This wedge distorts the consumption-savings decision unlike changes in the consumption tax rate. The agent receives a tax allowance for depreciated capital, which helps to alleviate part of the distortion and smooths the responses of consumption and investment.

3 Steady State Analysis

3.1 Calculating Steady State

Understanding the relationship between the labor choice and the steady state tax rates corresponding to some variety of reform will be a first-pass assessment of its effects on the macroeconomic equilibrium. Here I establish a benchmark to which I will compare the results under foresight. The household’s labor choice responds to incentives governed by the prevailing tax rates. I define comprehensive tax reform as a permanent change in one or more of consumption, labor income or capital income steady state tax rates. The solution for the model’s long-run stationary equilibrium as a function of the steady state tax rates follows Trabandt and Uhlig (2010).

In what follows, variables without the time subscript represent the steady state value. The consumption Euler equation in steady state sets the return on capital as a function of fundamentals,

$$r^k \equiv \frac{1}{\beta} - \frac{1}{1 - \tau^k} + \delta.$$ (14)
The steady state bond Euler equation yields the real return on debt, \( R = 1/\beta \). Then the steady state capital-to-output ratio,

\[
k/y = \alpha \left( \frac{R - 1}{1 - \tau k + \delta} \right)^{-1},
\]

comes from the firm’s first order condition. The production technology is solved for the output-to-labor ratio as a function of the capital-to-output ratio,

\[
n/y = (k/y)^{\alpha/(\alpha-1)}.
\]

The aggregate resource constraint is solved for the consumption-to-output ratio as a function of the optimal long-run labor choice,

\[
c/y(n^*) = 1 - \frac{g}{n^*} n/y - \delta k/y.
\]

I allow steady state transfers to adjust to clear the government budget constraint. Substituting the wage rate from the firm’s problem and marginal utility of wealth into the first order condition for labor from the household’s problem yields

\[
\left( 1 + \tau^c \right) \frac{\phi}{(1 - \tau^c)(1 - \alpha)} (\frac{c/y(n^*)}{n/y})^{\sigma} (\frac{n^*}{n/y})^{1-\sigma} = (n^*)^{-\left(\frac{\sigma+1}{\eta}\right)},
\]

which is a non-linear equation that has solution \( n^* \), the optimal labor choice.

Figure 2 shows the steady state values of variables in the model where the levels of debt and spending are fixed while (as tax revenues change) steady state transfers adjust to clear the government budget constraint. The X-axis represents a change in the steady state value in one of three rates while the other two rates are held at baseline values. Factor prices are fully determined by the steady state Euler equation and production technology so are unaffected by changes in the steady state consumption and labor tax rates.

An increase in the consumption tax rate is interpreted as an increase in the price of consumption and so the household substitutes into leisure in order to maximize lifetime utility. Fewer hours worked leads to lower output. The share of consumption-to-output inevitably declines since there is no change in the share of capital to output and government spending is fixed at the baseline level. The consumption tax Laffer curve is monotonically increasing since the implicit function of steady state hours worked as a function of the consumption tax rate is convex. A concave function is sufficient to yield a parabolic consumption tax Laffer curve.

An increase in the labor income tax rate reduces the opportunity cost of leisure. Output falls as hours worked fall, which again implies that the consumption-to-output share must decline due
to a fixed level of government spending. The labor income tax Laffer curve peaks at around 80% (which is an important consideration if current or proposed tax rates are near the peak) beyond which a cut in the tax rate actually increases tax revenue due to its growth effects.

An increase in the capital tax rate creates a disincentive to invest and thus reduces the ratio of capital to output. Complementarity of capital with the marginal product of labor in the production function leads to a lower wage rate. However, the household increases hours worked in order to maintain output. The net effect of a falling capital stock and rising supply of labor is a fall in output. The decrease in the share of capital (lower investment) offsets the crowding-out of private consumption by the government.

3.2 Revenue Neutral Tax Reform

For now, I will assume that the policy maker’s only constraint is to maintain long-run revenue neutrality with the baseline. (A stronger restriction is neutrality over the entire tax revenue path, which would require at least one tax rate to be flexible leading up to full implementation of the comprehensive tax reform). It is apparent from the tax revenue curves in the previous subsection that there are many combinations of tax rates that yield long-run revenue neutrality.

A particular combination of tax rates that maintain long-run revenue neutrality characterizes each flavor of comprehensive reform. For a pure consumption tax reform, the labor and capital income tax rates are zero while the consumption tax rate increases to maintain revenue neutrality. In a pure labor income tax reform, I set the consumption tax and capital income tax rates to zero, while letting the labor income tax rise to a rate that achieves revenue neutrality. For the hybrid reform, the consumption tax rate is half of the corresponding pure rate allowing the labor tax rate to decrease from the baseline to a rate that achieves revenue neutrality.

Table 2 shows the combination of tax rates in each reform that maintain long-run revenue neutrality with the baseline. In addition to tax revenue, the level of transfers, debt and government spending naturally remain unchanged post-reform as compared to the baseline. Table 3 shows the long-run impact of comprehensive tax reform on output, hours worked, consumption and capital. The pure consumption tax reform offers the highest gain in efficiency, increasing output 9.3%. The increase in output is driven by increases in hours worked and the capital stock. Consumption, unsurprisingly, increases by less than output due to the price of consumption no longer being distorted by the capital income tax rate. The pure labor income tax reform offers the lowest gain in efficiency, increasing output by a relatively more modest 3.9%; however, the gain is substantial. The higher labor tax rate as compared to the baseline is an incentive to work less and enjoy more leisure thus hours worked falls 3.7%. The hybrid reform represents a clear middle-ground in the long-run effects of comprehensive tax reform, with output increasing by 7.1% over the base-
line (halfway between the other reforms). It results in only a modest decline in hours worked as compared to the pure labor income tax and furthermore affects consumption positively.

We see from the Tax Revenue pane in Figure 2 that all of the rates are economically plausible in that they are to the left of the peak of the Laffer curves by a wide margin. In other words, I am not picking tax rates that maintain revenue neutrality and exist on the slippery slope of the Laffer curve, although such rates do exist.

Table 2: Revenue Neutral Tax Rates (in percent)

<table>
<thead>
<tr>
<th>Reform</th>
<th>$\tau^c$</th>
<th>$\tau^n$</th>
<th>$\tau^k$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>5.68</td>
<td>28.11</td>
<td>28.47</td>
</tr>
<tr>
<td>Pure consumption tax</td>
<td>38.54</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Pure labor income tax</td>
<td>0</td>
<td>39.42</td>
<td>0</td>
</tr>
<tr>
<td>Hybrid</td>
<td>19.27</td>
<td>19.58</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 3: Long-Run Effect over Baseline (percent change from baseline)

<table>
<thead>
<tr>
<th>Reform</th>
<th>$\Delta y$</th>
<th>$\Delta n$</th>
<th>$\Delta c$</th>
<th>$\Delta k$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pure consumption tax</td>
<td>9.3</td>
<td>1.2</td>
<td>6.4</td>
<td>23.8</td>
</tr>
<tr>
<td>Pure labor income tax</td>
<td>3.9</td>
<td>-3.7</td>
<td>-0.1</td>
<td>17.7</td>
</tr>
<tr>
<td>Hybrid</td>
<td>7.1</td>
<td>-0.7</td>
<td>3.8</td>
<td>21.4</td>
</tr>
</tbody>
</table>

4 Foresight and Comprehensive Tax Reform

Three flavors of reform are considered: a pure consumption tax, a pure labor income tax and the hybrid reform as discussed in Section 3.2. The thought experiment in this section is that the household receives news of comprehensive tax reform a number of periods prior to implementation. For example, if news is issued to the household 4 quarters in advance of implementation of the new tax rates, then the household will make decisions at the time of receiving the news that alter the current equilibrium. On the other hand, if there are zero periods of foresight the household is surprised by the tax reform and does not have an opportunity to change behavior prior to implementation.

[Why is foresight about taxes important? Cite Susan Yang (2005) and others.]

The following discussion centers on figures that are generated using the forward solution to the above linearized neoclassical growth model in Appendix B. I also discuss how to use the forward solution to the model in order to feed in a sequence of tax rates that the household is certain will occur with some degree of foresight.
4.1 Mechanics of Foresight

The experiment that results in Figure 3 is as follows. The household is taxed in period 0 at the baseline rates given in Table 2. With a perfect degree of foresight, they fully anticipate permanent comprehensive tax reform occurring in quarter 80. In quarter 80, the tax rates change to match one of the three types of reform. This experiment demonstrates how agents adjust their decisions in response to the news leading up to implementation of the new tax rates and the effect of foresight on the resulting post-reform equilibrium as compared to the long-run calculations in Table 3.

Under perfect foresight, all reforms lead to an increase in output that vary slightly from the calculated effects in Table 3. However, the order is preserved: the pure consumption tax reform results in the largest output gain followed by the hybrid and pure income tax reforms. Drastic differences exist in the transition paths to the post-reform steady state. Figure 4 will help sort out these differences by showing the individual effects of each tax rate change, while holding the other two rates at their baseline.

4.1.1 The Pure Consumption Tax Reform

The pure consumption tax reform consists of increasing the consumption tax rate to 38.54% while taking the labor and capital income tax rates to 0%. On implementation, this reform elicits a short-run surge in output that pushes beyond a 10% increase over the baseline in the long-run. However, the anticipation of the reform leads to a terrifying recession where output dips below -10% under the baseline. In order to explain this result I consider the effects of each tax rate change individually under perfect foresight.

The circles in Figure 4 show the path when the household anticipates an increase in the consumption tax to the pure rate, while the labor and capital income tax are fixed at baseline rates. Output, hours worked, consumption and capital all decrease, which is similar to the dynamic response of an unanticipated one-time increase in the consumption tax rate. Their long-run values are all around -10% below baseline since the change in the rate only distorts the leisure-labor decision—not the consumption-savings decision. The foresight simply brings the effect of a future higher consumption tax to the present. The household foresees spending less time working and more time enjoying leisure since consumption will be more expensive. Therefore, they prepare for this by gradually decreasing hours worked and the capital stock. At the time of reform there is an immediate and large substitution away from consumption and into leisure since the opportunity cost of leisure decreases.

Taking the labor income tax rate to 0% has a symmetric response to the path of the triangles in the figure, which results from an increase in the labor income tax rate from the baseline to the pure rate. A positive wealth effect results from anticipated higher after-tax life-time earnings and
induces the household to reduce hours worked leading up to the reform period. There is an immediate and large substitution into hours worked that bolsters output when the reform is implemented in quarter 80. The amount of capital in the economy at the time of reform is inconsistent with the long-run equilibrium. The increase in hours worked induces further investment until all variables attain their long-run value.

Taking the capital income tax rate to 0%, while holding the consumption and labor income tax rates at the baseline, results in a steady increase in output up until the reform and beyond as demonstrated by the path of the squares in the figure. Lower expected capital tax rates make current consumption relatively more expensive than future consumption encouraging investment. Through complementarity between the marginal product of labor and the capital stock, the household chooses to work more. Once the tax rate decreases to and remains at 0% from quarter 80 on, there is no longer an incentive to save as much and so the capital stock increases gradually. This continued investment allows households to substitute into leisure while smoothing consumption.

Leading up to reform, the net effect is that the positive wealth effect from an anticipated lower labor income tax rate and the increase in the relative price of current consumption to future consumption from the lower capital tax rate cancels out. This leaves the substitution from consumption into leisure resulting from the higher consumption tax rate to dominate, which results in falling output, hours worked, consumption and capital. When the reform is implemented in quarter 80, the immediate and large substitution resulting from a permanently lower labor income tax rate dominates and drives investment higher pushing output up until it attains its long-run value.

I will resort to summarizing the mechanics for the next two types of reform since the driving forces behind the dynamics are clearly outlined in this subsection.

### 4.1.2 The Pure Labor Income Tax Reform

The effects of taking only the consumption tax rate to 0% is symmetric to the path of circles in Figure 4. The household foresees a lower price of consumption in the future, which leads to higher opportunity cost of leisure and more hours worked. In anticipation, they build up the capital stock and at the time of reform there is a large substitution away from leisure into consumption. Also under the pure income tax reform, the household foresees an increase in the labor tax rate, which leads to lower future after tax wages and makes the agent feel comparatively poorer today. This wealth effect encourages the agent increase hours worked. Upon implementation of the 0% labor income tax rate, the household substitutes away from hours worked into leisure. An anticipated 0% capital income tax rate makes current consumption relatively more expensive compared to future consumption. This encourages investment, leading to a higher capital stock, more hours worked and higher output.
The individual effects of all three anticipated tax rate changes lead to more investment, hours worked and higher output. When combined they lead to a significant boost in output leading up to reform. However, at the time of reform in quarter 80, the large substitution away from labor and into leisure due to the higher labor income tax rate causes a rebound in output.

4.1.3 The Hybrid Tax Reform

The effects of increasing the consumption tax rate from 5.68% to 19.27% (at half of the pure rate) are diminished compared to the pure consumption tax reform. There are decreases in investment, hours worked and output leading up to reform and then a large substitution away from consumption into leisure upon implementation. Decreasing the labor income tax rate from 28.11% to 19.58% results in fewer hours worked and lower output up until the time of implementation where there is a big substitution from leisure into hours worked. Taking the capital income tax rate to 0% induces a reduction in consumption and more investment, which boosts output.

The resulting investment from the reduction in the capital income tax rate dominates as the change in hours work resulting from the anticipated higher consumption tax rate and the lower labor income tax rate offset one another. At the time of reform, the effects of substitution away from consumption into leisure due to a higher consumption tax rate and the substitution away from leisure into hours worked due to a lower labor income tax rate are small relative to the effects of a 0% capital income tax rate.

4.2 The Degree of Foresight

Figure 5 shows the simulated post-reform steady state values of the model’s variables. I take quarter 320 from the simulation at varying degrees of foresight and plot the results. The pure consumption tax reform results in a greater increase in output the shorter the degree of foresight. An unanticipated pure consumption tax reform yields a long-run increase in output beyond 30% over the baseline. The pure labor income tax reform represents the other extreme. An unanticipated reform of this flavor yields a long-run level of output -10% below baseline. This is significantly below the 3.9% increase between pre-reform and post-reform steady states reported in Table 3. The household must be aware of the pure consumption tax reform more than 8 years in advance of implementation in order to achieve that rate of growth.

I compare two degrees, perfect and 8 quarters, of foresight for each type of tax reform to shed light on why the degree of foresight plays such an important role in determining the effectiveness of comprehensive tax reform to stimulate growth in the economy. Figure 6 shows this comparison for the pure consumption tax reform. Foreknowledge of the decrease in the labor tax rate leads to an optimal substitution away from current labor to future labor more so under perfect foresight.
As the households work less leading up to reform the capital stock diminishes due to its falling marginal product. This means that by the time of reform the capital stock has been reduced far more under perfect foresight. When the huge substitution into hours worked away from leisure at the time of reform hits the economy, the marginal product of that labor is lower under 8 quarter foresight compared to perfect foresight. This results in a smaller increase in output at the time of reform. The output paths then grow at a similar rate since tax rates are not expected to change after reform until they reach their different long-run levels. Announcement of a fall in the labor income tax has immediate recessionary consequences that diminishes this reform’s ability to bolster long-run output.

Figure 7 shows the same comparison for the pure consumption tax reform. However, in this case the labor income tax is expected to decrease at the time of reform. Greater foresight then leads to a higher capital stock at the time of reform coupled with the substitution into hours worked upon implementation of the reformed tax rates leads to greater output compared to 8 quarter foresight. The result is that more foresight improves the effectiveness of the reform’s ability to stimulate growth contrary to the pure consumption tax reform.

Figure 8 shows the same comparison for the hybrid tax reform. Once again the effect of the falling labor income tax rate causes an immediate recession when the news is received by the household. However, the recession is diminished compared to the pure consumption tax reform since the change in the labor income tax rate is much smaller. Furthermore, the increase in the consumption tax leads to a greater level of investment, which serves to bolster long-run output. It is because of these two offsetting effects that the long-run results for the hybrid tax reform are relatively invariant to the degree of foresight.

5 Conclusion

I have analyzed the effects of comprehensive tax reform in a neoclassical growth model calibrated to the United States. I show that foresight alters any one type of reform’s ability to stimulate output despite promising long-run calculations. The primary cause of these differences is whether the labor income tax rate is expected to increase or decrease upon implementation of reform.

If the steady state labor income tax rate is expected to decrease then the household chooses to work less from the time that reform is announced leading up to its implementation. This causes a recession at the time of announcement resulting from an eroding labor supply and capital stock. At the time of reform the household makes a large substitution into hours worked away from leisure due to higher after tax returns. The effect of this large substitution on output is small relative to an economy with a high capital stock at the time of reform. In this case, a higher degree of foresight leads to a smaller increase in long-run output, which corresponds to a pure consumption tax reform.
where the labor tax income tax is replaced entirely with a consumption tax that maintains revenue neutrality. The bottom-line with the pure consumption tax reform is that a surprise reform is better than an anticipated reform since it avoids a recession and maximizes long-run output.

Foresight has the opposite effect when the labor income tax increases. The household substitutes away from current leisure into future leisure when they anticipate a fall in the labor income tax rate. This causes the capital stock and output to grow up until the time of reform. At the time of reform there is a large substitution into leisure away from hours worked that reduces output. However, if the economy has grown sufficiently by the time of reform, the effect of this substitution is not as dire. Therefore, more foresight in the case of the pure income tax reform leads to greater gains in long-run output.

A nice middle ground was discovered in the hybrid reform. Raising the consumption tax rate and lowering the labor income tax rate lead to results that were relatively invariant to the degree of foresight by households as compared to the pure consumption and pure labor income tax reforms. In this case the lower income tax rate causes only a modest recession prior to implementation and the incentive to increase investment due to a higher consumption tax rate helps long-run growth.

One issue with this analysis is the large change in steady state tax rates. A linear model is not suited for such changes. Moving forward I want to use a non-linear solution to this model so that the approximation error is reduced. Also with a full non-linear model I can deal with issues of uncertainty of outcomes from news. The household hears chatter of tax reform all the time to which I can easily assign a probability, a belief, of how likely the household thinks reform will be implemented given such news. In other words, I can examine the effects of credibility of tax reform news received by the household in addition to any degree of foresight allowed by policy-makers.

News of comprehensive tax reform matters. If households hear news about lower marginal income tax rates then they might optimally change their labor and leisure choices. Foreseeing lower labor income rates might mean that work is postponed until the reform is implemented. News of a national sales tax that raises the effective price of future consumption might also be recessionary. These effects are important to consider when policy makers discuss tax reform and guide household expectations.
REFERENCES


A. Figures

Figure 1: Impulse Responses to Tax Rate Shock
One-time 1% Shock to one of:
○: Consumption, △: Labor Income, □: Capital Income
Figure 2: Steady State: Revenues finance transfers.

X-axis is rate for one of:

○: Consumption Tax Rate, △: Labor Tax, □: Capital Tax

Other rates fixed at baseline given in Table 1
Figure 3: Comparison of comprehensive tax reforms across time under perfect foresight
(Percentage Points from Baseline)
Reform occurs in quarter 80
◁: Pure Consumption Tax, △: Pure Labor Tax, ▽: Hybrid Tax

Output

Hours Worked

Consumption

Capital

Wage Rate

Return on Capital

Tax Revenue

Transfers
Figure 4: Effects of individual tax rate reform across time under perfect foresight (Percentage Points from Baseline)

Reform occurs in quarter 80

Figure 5: Comparison of post-reform outcomes across degrees of foresight (Percentage Points from Baseline)

Cross-section of simulation at quarter 320

◁: Pure Consumption Tax, △: Pure Labor Tax, ▽: Hybrid Tax
Figure 6: Dynamic Comparison of Foresight: Pure Consumption Tax Reform
(Percentage Points from Baseline)
Solid: 8 Quarters of Foresight, Dashed: Perfect Foresight

Figure 7: Dynamic Comparison of Foresight: Pure Labor Income Tax Reform
(Percentage Points from Baseline)
Solid: 8 Quarters of Foresight, Dashed: Perfect Foresight
Figure 8: Dynamic Comparison of Foresight: Hybrid Tax Reform
(Percentage Points from Baseline)
Solid: 8 Quarters of Foresight, Dashed: Perfect Foresight

B. LOG-LINEAR SYSTEM

\[
\frac{1}{\eta} \hat{n}_t + \sigma \hat{c}_t + \frac{\tau^c}{1 + \tau^c} \hat{\tau}^c_t + \frac{\tau^n}{1 - \tau^n} \hat{\tau}^n_t - \hat{w}_t = 0
\]

\[
\frac{\tau^c}{1 + \tau^c} E_t \hat{\tau}^c_{t+1} + \sigma E_t \hat{c}_{t+1} = \hat{R}_t + \sigma \hat{c}_t + \frac{\tau^c}{1 + \tau^c} \hat{\tau}^c_t
\]

\[
\frac{\tau^c}{1 + \tau^c} E_t \hat{\tau}^c_{t+1} + \sigma E_t \hat{c}_{t+1} + \beta (r^K - \delta) r^k \hat{r}^k_{t+1} - \beta \left(1 - \tau^k\right) r^k E_t \hat{r}^k_{t+1} = \sigma \hat{c}_t + \frac{\tau^c}{1 + \tau^c} \hat{\tau}^c_t
\]

\[
\hat{y}_t - (1 - \alpha) \hat{n}_t = \alpha \hat{k}_{t-1}
\]

\[
\hat{r}^k_t - \hat{y}_t = -\hat{k}_{t-1}
\]

\[
\hat{w}_t - \hat{y}_t + \hat{n}_t = 0
\]

\[
\tau^c [\hat{\tau}^c_t + \hat{\tau}^c_t] + \tau^w \eta [\hat{\tau}^w_t + \hat{\tau}^w_t + \hat{\tau}^w_t] + (r^k - \delta) k \tau^k \hat{r}^k_t + \tau^k k r^k \hat{r}^k_t + \hat{b}_t - z \hat{\tau}_t - g \hat{g}_t = \ldots
\]

\[
-\tau^k (r^k - \delta) k \hat{k}_{t-1} + rb (\hat{r}_{t-1} + \hat{b}_{t-1})
\]

\[
c \hat{c}_t + I \hat{I}_t + g \hat{g}_t - y \hat{y}_t = 0
\]

\[
k \hat{k}_t - I \hat{I}_t = (1 - \delta) k \hat{k}_{t-1},
\]
where a circumflex denotes log-deviations from the deterministic steady-state\(^1\).

**C. DATA AND CALCULATIONS**

I use the National Income and Product Accounts from the BEA over the years 1987-1997 to calculate the baseline tax rates and shares of transfers and spending to GDP. I use tables 1.1.5 (Gross Domestic Product), 3.2 (Federal Government Current Receipts and Expenditures) and 3.3 (State and Local Government Current Receipts and Expenditures). To calculate the consumption tax rate for a given quarter I use the sum of sales (table 3.3) and excise (table 3.2) taxes divided by consumption from table 1.1.5. Then I take the average quarterly rate to use in the baseline. Labor income tax revenue is personal current taxes plus contributions for government social insurance (in both tables 3.2 and 3.3). The model gives me the following labor tax rate,

\[
LaborIncomeTaxRevenue = \tau^n w_n
\]

\[
= \tau^n (1 - \alpha) y
\]

\[
\rightarrow \tau^n = \frac{LaborIncomeTaxRevenue}{(1 - \alpha) y}.
\]

After calculating this for each quarter, I take the quarterly average rate to use as the baseline rate. For the capital income tax rate, I take the sum of taxes on corporate income (in both 3.2 and 3.3) and property taxes (table 3.3). The model gives me the following capital income tax rate,

\[
CapitalIncomeTaxRevenue = \tau^k (r^k - \delta) k
\]

\[
= \tau^k \left( \alpha \frac{y}{k} - \frac{I}{k} \right) k
\]

\[
\rightarrow \tau^k = \frac{CapitalIncomeTaxRevenue}{\alpha y - I},
\]

where I take \( I \) as the sum of gross private domestic investment and public investment. Public investment I define as government consumption expenditures and gross investment (table 1.1.5) minus the sum of consumption expenditures (in both tables 3.2 and 3.3). I found that this yields a rental rate of capital that is closer to the calculated steady state given by Equation 14 than if public investment is excluded. It also yields a higher capital income tax rate than if public investment is excluded. For the share of spending to GDP, I take the sum of federal, state and local government consumption expenditures (in both tables 3.2 and 3.3) and divide it by GDP. Government transfers is equal to current government expenditures minus the sum of government consumption expendi-

\(^1\)That is, for some generic variable \( x \), \( \hat{x}_t = \ln x_t - \ln x \approx (x_t - x)/x \)
tures, interest payments and gross government investment (in both tables 3.2 and 3.3) and divide this by GDP.