A Sensitivity Analysis of a Detailed Macroeconomic Analysis of President Biden's 2020 Campaign Tax Proposals

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July 20, 2021

In DeBacker et al. (2021) we analyze the effects of the tax proposals for the 2020 Biden campaign on the economy and the budget. We find that Biden's proposals would raise significant revenue, about $1.7 trillion over the next ten years. The proposed tax increases are targeted at those at the top of the income distribution, which reduces the labor supply and savings of high-income households. As a result, GDP declines 0.37%, on average, between 2021 and 2030, relative to the forecast under a current law baseline. These behavioral responses and macroeconomic impacts result in the revenue gain being about 20% lower than what one would find without accounting for such behavior.

In this paper, we extend our analysis and consider the sensitivity of our results to the values of important, exogenous parameters. Like any model, the OG-USA model used in DeBacker et al. (2021) relies on a set of assumptions and the calibration of parameter values. Unlike most models, OG-USA is well documented and the source code freely available, allowing anyone to simulate the model under alternative assumptions and parameterizations. Here, we simulate the model under alternative parameterizations to understand how sensitive the results from our analysis of the Biden proposals may be to the choice of parameter values.

This document is organized as follows. In Section 1, we discuss the parameters over which we conduct our sensitivity analysis. We show how the responses of households to changes in tax policy vary across parameterizations in Section 2. Section 3 summarizes how the estimated macroeconomic effects of the Biden proposals vary under alternative assumptions. Section 4 summarizes the effects of the tax provisions we model on the the budget. Section 5 concludes.

1 Parameters for Sensitivity Analysis

OG-USA is a detailed, heterogenous agent model of the United States' economy. As such, there are hundreds of parameters used in the model.[1] Each of these parameters

[1]Full documentation for the OG-USA model can be found at https://pslmodels.github.io/OG-USA/.

has an effect on the determination of the endogenous variables that are determined in the model solution. It is therefore important to consider how those results change when alternative parameter values are used in order to understand how sensitive certain outputs are to various inputs.

Given the large parameter space, we narrow our focus to four important parameters relevant to our findings in DeBacker et al. (2021) of a large reduction in labor supply and saving among high-income households and resulting decline in output and taxable incomes in response to the proposed Biden tax reforms. These parameters include the Frisch elasticity of labor supply (θ), the share of new government debt issues purchased by foreign investors (ζ_D), the underlying long-run growth rate of labor augmenting technological change (g_y), and the year in which government spending begins to be adjusted in order to stabilize the government's debt to GDP ratio at its steady-state value (T_{G1}). For each of these parameters, we choose a high and low value, symmetrically about the values used in DeBacker et al. (2021). We then solve the model under these alternative parameterizations and provide a comparison of the results below.

The Frisch elasticity of labor supply affects how households in the model change their labor supply in response to changes in the after-tax wage rate. A higher Frisch elasticity will generate a larger response to changes in after-tax wages. Therefore, a larger elasticity will result in tax increases generating less revenue than under lower elasticities due to labor supply responses that counter the rate increases. Note that OG-USA uses an elliptical disutility of labor function, which provides advantages in the computational solution. However, we fit the parameters of the elliptical utility function to approximately match the marginal utility function from a constant Frisch elasticity functional form.[2] As that Frisch elasticity changes, so do the parameters of the elliptical disutility function used in OG-USA. In this way, the model can be calibrated using the many estimates of the Frisch elasticity within the range of suggested values from Reichling and Whalen (2012), but the elliptical disutility of labor function provides for a more robust computational solution. The default value of the Frisch elasticity used was 0.4. In this analysis, we compare those results to models solutions with a Frisch of 0.3 and 0.5.

The openness of the economy in OG-USA is characterized by two parameters—the share of excess demand for capital supplied by foreigners, ζ_K, and the share of newly issued government debt purchased by foreigners, ζ_D. As each of these parameters increases, foreign investors play larger role in domestic capital and debt markets, which reduces upward pressure on interest rates resulting from increased demand for government debt or private capital. In this sensitivity analysis, we adjust ζ_D, the share of newly issued government debt purchased by foreigners. The default value used is 0.4, based on U.S. Treasury reports of foreign debt holdings, which show foreign investors purchasing about 40% of newly issued debt.[3] To test the sensitivity of our results to this parameter, we consider values of 0.2 and 0.6. A higher value will

[2]See Evans and Phillips (2017) and the OG-USA documentation on the "Elliptical Disutility of Labor Supply" section of the Households chapter.

[3]See https://www.treasury.gov/resource-center/data-chart-center/tic/Pages/ticsec2.aspx

mean larger foreign purchases and therefore less crowding out of private investment by new government borrowing. Thus, higher values will tend to make deficit-financed tax cuts look relatively better and tax increases look relatively worse for the economy.

Long-run economic growth in OG-USA is driven by the population growth rate and long-run rate of labor-augmenting technological change. Although the model is made stationary in order obtain a solution, higher rates of labor-augmenting technological change with tend to reduce the burden of government debt on the economy, via crowding out, over time. Therefore, a higher growth rate makes policies such as the Biden proposal, which reduces the level of debt, less beneficial to the economy. The default value for labor-augmenting technological change, g_y, is 3%. Here, we additionally consider rates of 2% and 4%.

OG-USA is a forward looking model, which necessitates a recursive solution algorithm. Therefore, for the model to solve there needs to be a long-run equilibrium. This has important implications for fiscal policy and the trajectory of government debt. Debt cannot grow faster than the underlying rate of economic growth or else interest payments on debt will exceed GDP in the long run. To ensure that this this constraint is met, OG-USA imposes a fiscal closure rule that works as follows. First, the OG-USA user specifies a target debt-to-GDP level in the long run. A closure rule is then enacted to ensure that the debt-to-GDP ratio hits this target in the steady-state by adjusting the path of government spending. The window over which the adjustment is made is determined by a start year for the closure rule (T_{G1}), an end year for the closure rule (T_{G2}), and an adjustment rate (ρ_G). Of these parameters describing the closure rule, the most important parameter for the economy in the short run is the year in which the closure rule begins T_{G1}. The default value used for the analysis in DeBacker et al. (2021) is $T_{G1} = 20$ years out (or 2041, since the model runs used for the Biden analysis start the economy in 2021). This puts the start date for the closure rule well outside the traditional 10-year budget window. Here, we consider two alternatives to the 20 year start date: start dates of 2031 and 2051 years. The closure rule returns debt to the level it would hit at 2040 under current law, so it undoes the beneficial effects of debt reduction under the Biden proposal. Making this negative effect occur sooner makes people anticipate being worse off sooner, so may make them work and save more before the policy change, offsetting some of the direct negative effects of the proposal.

2 Household Behavioral Responses Under Alternative Assumptions

We begin our sensitivity analysis by looking at the behavioral responses of households to the Biden proposals under various parameterization of OG-USA. Figure 1 summarizes the responses of households under different Frisch elasticities. Each figure that follows takes the same format. The figures contain four panels, one for each behavioral response considered: percentage changes in consumption, labor supply, savings, and before tax income. The percentage changes are computed over the first

ten years of the policy, 2021-2030. The bars in each figure are grouped by lifetime income group: the bottom 25%, the 25th-50th percentile, the 50th-70th percentile, the 70th-80th percentile, the 80th-90th percentile, the 90th-99th percentile, and then the top 1% broken out into four groups, 99-99.5%, 99.5-99.9%, 99.9-99.99%, and the top 0.01%. Red bars represent the default parameterization used in DeBacker et al. (2021), while green and blue bars represent the low and high values, respectively.

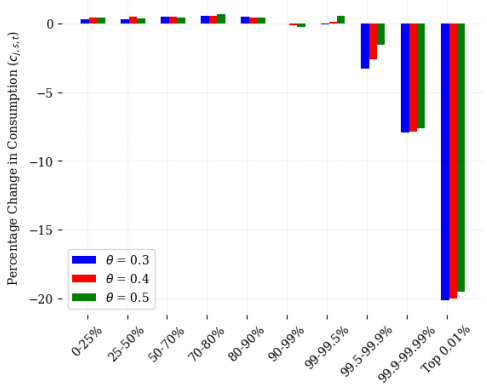
Considering how these behavioral responses change alternative Frisch elasticities, we turn to Figure 1. Panel b shows that a larger Frisch elasticity generally results in larger labor supply responses to the changes in tax rates under the Biden proposals. Lower income households, who experience a tax cut, increase labor supply more with a Frisch of 0.5 than when the Frisch is 0.4 or 0.3. Higher income households, who tend to experience large tax increases, have declines in labor supply. These declines in labor supply tend to grow larger for those higher income groups as the Frisch elasticity increases. Although, we notice that this pattern does not hold for all the top income groups. In these cases, the interaction of the Frisch with other parameters, such as discount rates, produces instances where the income effects are relatively larger than the substitution effects.

Changes in consumption and before tax income tend to follow the same pattern as changes in labor supply. The percentage changes in savings across different Frisch elasticities also generally mirror these changes, but you can see that for households as the very top of the income distribution that savings responses move opposite to the labor supply responses. As households reduce work more (less), they reduce savings (less) more.

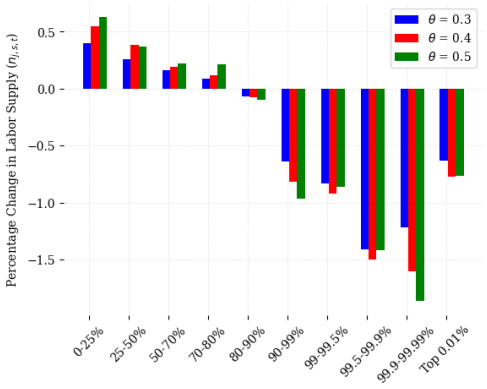
Similarly, Figure 2 shows the distribution of household behavioral responses to the proposed Biden tax reforms in terms of consumption, labor supply, savings, and before-tax income for different values of the percent of new government debt purchased by foreigners (ζ_D). Figures 3 and 4 show the same comparisons for different values of the long-run growth rate of labor productivity (g_y) and the timing of implementation of the budget closure rule (T_{G1}), respectively. Each of these parameters affect macroeconomic outcomes and don't directly determine individual behavior, like the Frisch elasticity. The way individual behavior is affected by ζ_D, g_y, and T_{G1} is through the effect these parameters have on aggregate outcomes, such as the real interest rate and the wage rate. For example, a lower value of ζ_D means that a larger fraction of government deficits need to be financed by domestic savers. This will tend to push up the equilibrium interest rate. Because the Biden proposals raise significant revenue and reduce that reduce these deficits, the percentage change in interest rates between the current law baseline and the Biden proposals is going to be larger when ζ_D is lower. The magnitude of the effects on wages varies in the same way, though wages fall rather than rise. Thus, when we look at individual responses in Figure 2 what we are seeing are the household responses to these changes in interest rates and wage rates. With a lower ζ_D, savings responses tend to be smaller, while labor supply effect (driven more by changes in wages) tend to be larger.

The patterns of behavioral responses follow a similar pattern in Figures 3 and

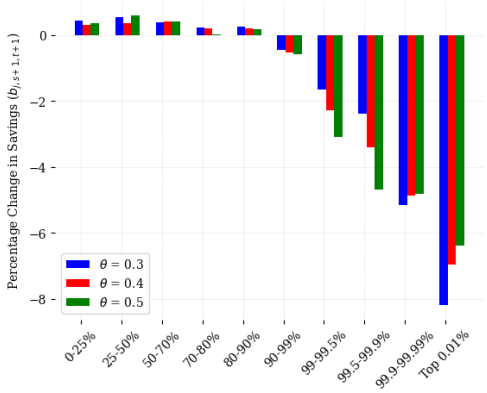
Figure 1: Behavioral Responses by Lifetime Income Group, 2021-2031, Frisch Elasticity



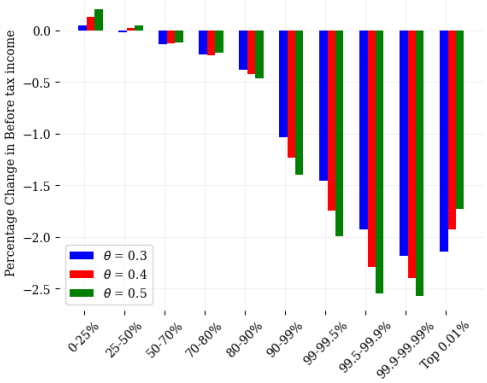
(a) Consumption



(b) Labor Supply

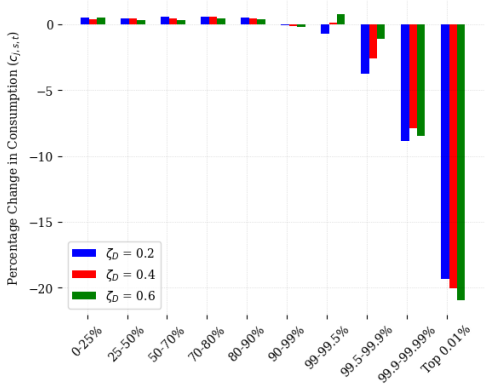


(c) Savings

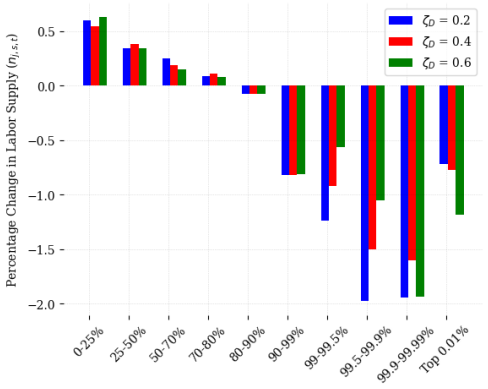


(d) Before-tax Income

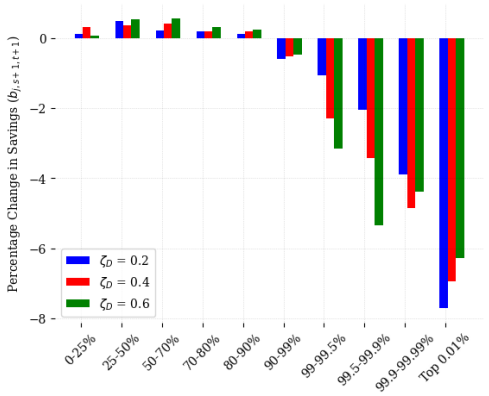
Figure 2: Behavioral Responses by Lifetime Income Group, 2021-2031, Foreign Debt Purchases



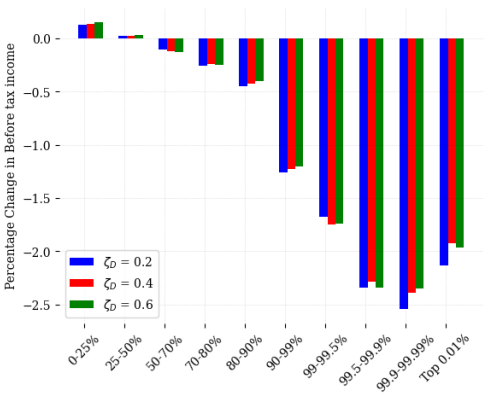
(a) Consumption



(b) Labor Supply



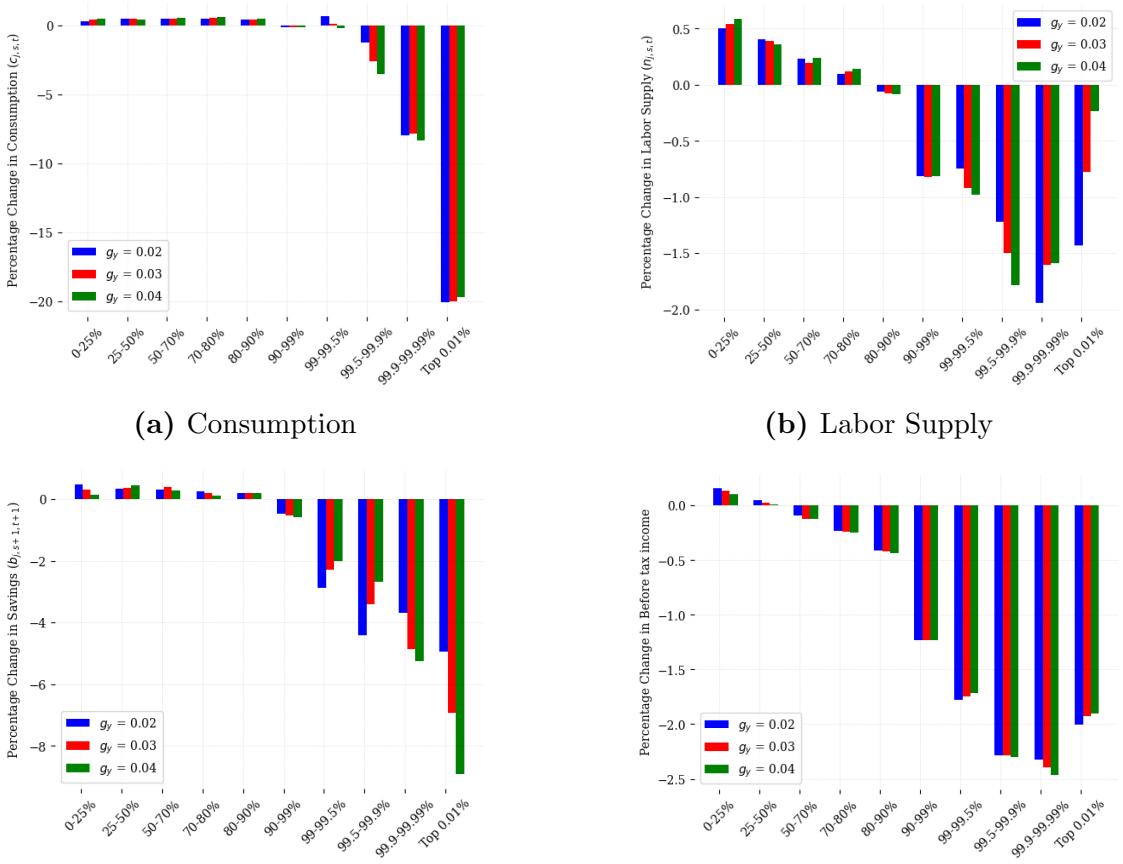
(c) Savings



(d) Before-tax Income

4. We observe the most movement in savings and labor supply behavior and these changes move in opposite directions given movements in interest rates and wages.

Figure 3: Behavioral Responses by Lifetime Income Group, 2021-2031, Economic Growth Rate



(a) Consumption

(b) Labor Supply

(c) Savings

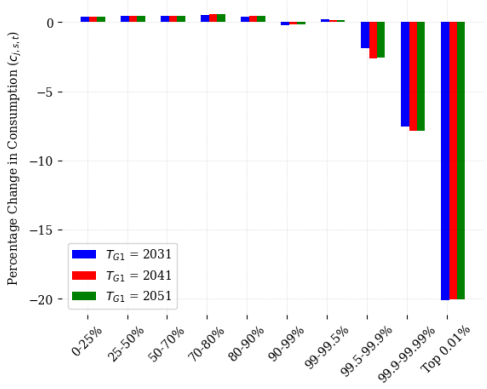
(d) Before Tax Income

3 Macroeconomic Effects Under Alternative Assumptions

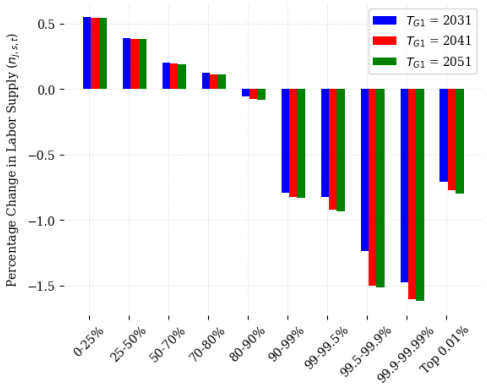
Figure 5 summarizes the effects of different values of the four parameters on four macroeconomic aggregates (the capital stock, consumption, GDP, and labor supply), along with equilibrium real interest rates and wages.

Looking at 5a, we see that a larger Frisch elasticity of labor supply results in larger changes in aggregate labor supply from the change in tax policy. GDP changes tend to mirror this response, while the capital stock moves in the other direction, owing to the smaller changes in interest rates that result when the Frisch is larger

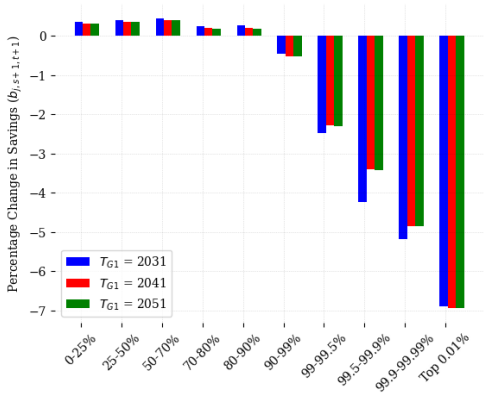
Figure 4: Behavioral Responses by Lifetime Income Group, 2021-2031, Timing of Closure Rule



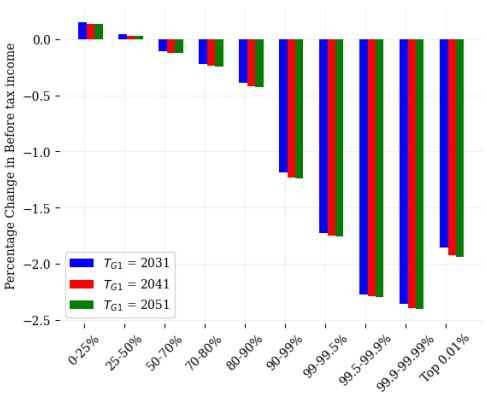
(a) Consumption



(b) Labor Supply



(c) Savings



(d) Before Tax Income

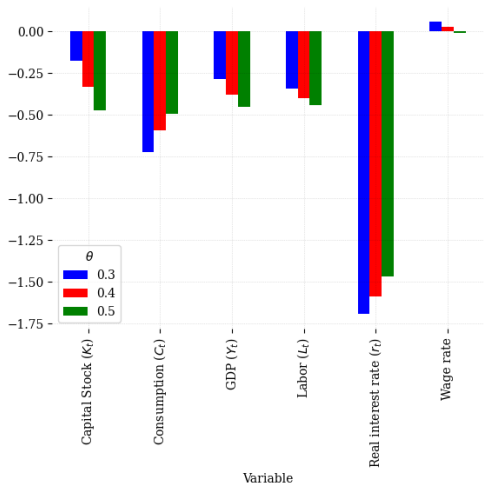
and labor supply responds more. Recall that changes in interest rates reflect changes in the marginal product of capital, which shows larger percentage changes when labor supply is less responsive.

The other three parameters, ζ_D, g_y, and T_{G1} have impacts not through individual behavior, but through aggregate outcomes. Of these,the model is most sensitive to ζ_D, which affects crowding out through the foreign purchases of government debt. A lower ζ_D results in larger changes in interest rates, which means smaller declines in the capital stock under the Biden plan. The effect on GDP mirror the pattern of those effects on the capital stock, but the magnitudes are smaller given that the percentage changes in labor supply move in opposite directions.

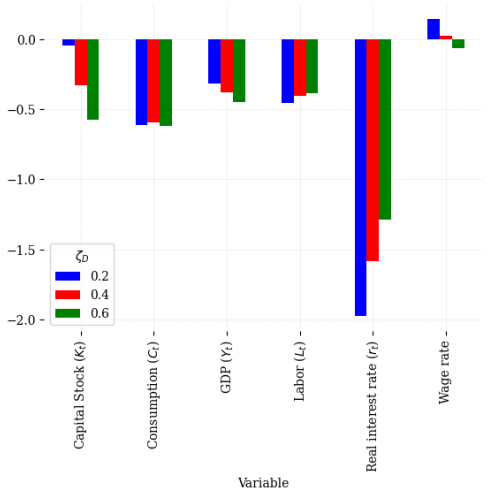
The parameters g_y and T_{G1} have smaller effects on aggregates over the 10 year window considered. While underlying economic growth is important for the level of the economy, Figure 5c relates the percentage changes between two policies, in which case the difference between outcomes under current law and under the Biden proposal for each growth rate mostly net out. When the closure rule begins, government spending is adjusted to stabilize deficits. Figure 5d shows that as long as this closure rule begins beyond the 10 year window, then the percentage changes in macroeconomic aggregates within that initial 10-year window a minimal.

Figure 6 relates the percentage differences in the path of the debt-to-GDP ratio between the current law baseline and the Biden proposals, between 2021 and 2041. Each series in each figure trends downward, illustrating that the increased revenue projected under the Biden tax proposals will lower the debt-to-GDP ratio under the assumption that spending remains unchanged. In the case of the economic growth rate, there is very little differences in the path of debt-to-GDP under the three parameterizations. The closure rule timing, shown in Figure 6d, also shows little difference, except when the closure rule happens within the 2021-2041 period. In that case, we see the line shoot up at 2031, when the $T_{G1} = 2031$ closure rule kicks in. This reflects the closure rule reigning in the debt more under the current law baseline than under the Biden proposals since larger deficits are run in the baseline case. Figure 6a illustrates how the lower labor supply responses that occur when the Frisch elasticity is lower result in higher revenues from teh Biden proposals and therefore reduce deficits to a greater extent than under other parameterizations. The share of new debt issues purchased by foreigners, ζD, have modest effects on the path of the debt-to-GDP ratio. While this parameter affects what types of investors hold government bonds, it does not directly affect the amount of borrowing by the government. Thus, we find that the debt to GDP ratio declines the most (relative to the baseline) when the share of new debt issues purchases by foreigners is lowest. This reflects the fact that the debt-to-GDP ratio grows fastest in the baseline under $\zeta_D = 0.20$ due to the higher interest rates and resulting higher financing costs of debt. The Biden proposals' revenue increases have their largest relative effect in this case, reducing financing costs of the stock of debt and thereby slowing the growth in the debt-to-GDP ratio. This is also why the effects of ζ_D are most apparent later in the 2021-2041 window, as the reduction in these financing costs accumulate.

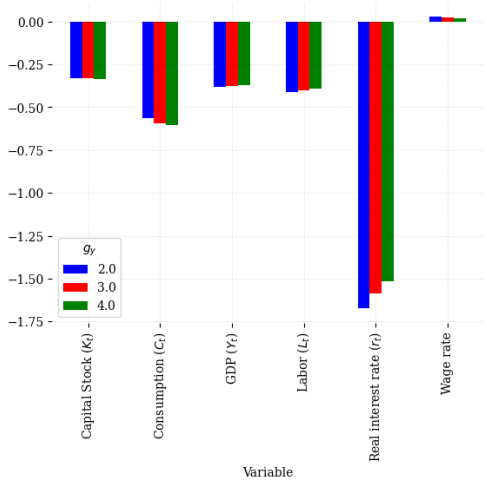
Figure 5: Percentage Point Changes in Macro Variables, 2021-2030 Under Alternative Parameterizations



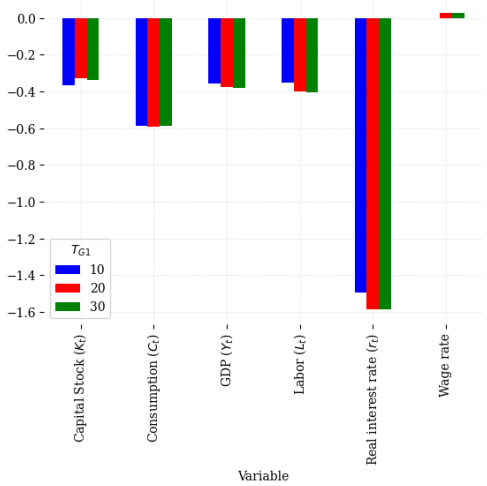
(a) Frisch



(b) Foreign Debt Purchases

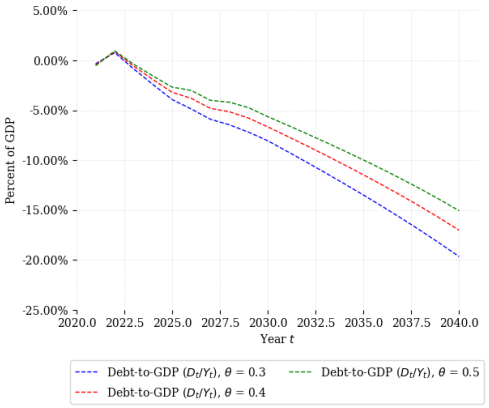


(c) Economic Growth Rate

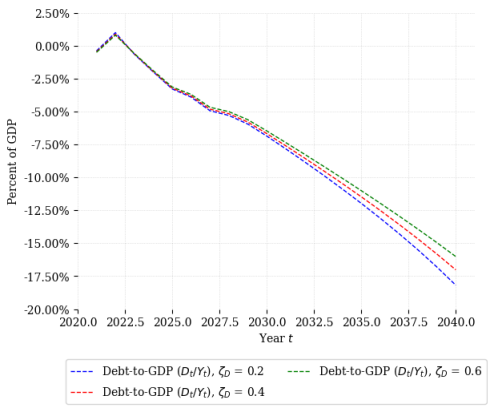


(d) Closure Rule Timing

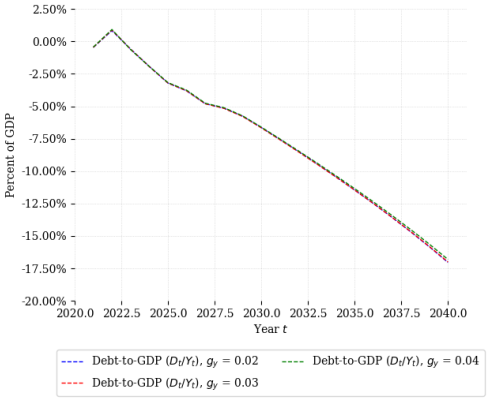
Figure 6: Sensitivity of Differences in the Debt to GDP Ratio (Biden proposals - Current law baseline)



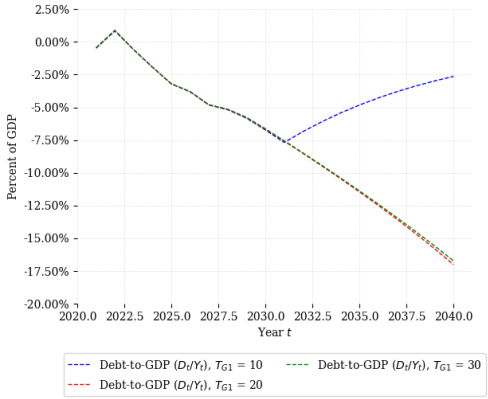
(a) Frisch



(b) Foreign Debt Purchases



(c) Economic Growth Rate



(d) Closure Rule Timing

4 Tax Revenue Under Alternative Assumptions

Table 1 presents the dynamic feedback effects on revenue under alternative assumptions or parameters. The dynamic feedback effects are presented in percentage point changes in tax revenue, over and above the changes in tax revenue due purely to rate increases. Thus, these changes reflect the role of households behaviors (such as reduced labor supply or savings) and changes in macroeconomic variables (such as lower interest rates or wage rates) on tax receipts.

Focusing on the last column, which averages over 2021-2030, we see that a higher Frisch elasticity, which entails larger labor supply responses to tax rates, also has the largest dynamic feedback effects. Moving from a Frisch of 0.3 to 0.5, moves the percentage point changes in receipts from -1.16 to -1.33, an increase of about 15%. Changes in other parameters generally have more modest effects. The parameter governing foreign purchases of government debt, ζ_D shows the next biggest changes, with the dynamic responses declining by about 5% when the share of new debt issues purchased by foreign investors increases from 20% to 60%.

Table 1: Dynamic revenue effects on government revenue: percentage point difference in simulated dynamic revenue effect versus simulated static revenue effect by year for each parameter value of each sensitivity analysis parameter

Parameter	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2021-2030
					Frisch elasticity θ						
$\theta = 0.3$	0.76	-1.59	-0.71	-0.83	-0.98	-1.78	-1.29	-1.92	-1.68	-1.41	-1.16
$\theta = 0.4$	1.00	-1.79	-0.85	-0.92	-1.04	-1.96	-1.35	-2.11	-1.85	-1.48	-1.25
$\theta = 0.5$	1.21	-1.92	-0.97	-1.01	-1.11	-2.12	-1.40	-2.28	-1.99	-1.54	-1.33
					Foreign debt purchases ζ_D						
$\zeta_D = 0.2$	0.89	-2.02	-0.86	-0.94	-1.07	-2.00	-1.36	-2.15	-1.87	-1.50	-1.30
$\zeta_D = 0.4$	1.00	-1.79	-0.85	-0.92	-1.04	-1.96	-1.35	-2.11	-1.85	-1.48	-1.25
$\zeta_D = 0.6$	1.05	-1.70	-0.86	-0.93	-1.05	-1.97	-1.37	-2.12	-1.84	-1.48	-1.24
					Economic growth rate g_y						
$g_y = 2.0\%$	1.03	-1.81	-0.89	-0.94	-1.04	-1.96	-1.35	-2.11	-1.84	-1.47	-1.25
$g_y = 3.0\%$	1.00	-1.79	-0.85	-0.92	-1.04	-1.96	-1.35	-2.11	-1.85	-1.48	-1.25
$g_y = 4.0\%$	0.94	-1.78	-0.79	-0.90	-1.05	-1.97	-1.35	-2.12	-1.86	-1.49	-1.25
					Timing of closure rule T_{G1}						
$T_{G1} = 2031$	1.04	-1.72	-0.85	-0.91	-1.03	-1.94	-1.32	-2.07	-1.79	-1.40	-1.21
$T_{G1} = 2041$	1.00	-1.79	-0.85	-0.92	-1.04	-1.96	-1.35	-2.11	-1.85	-1.48	-1.25
$T_{G1} = 2051$	0.99	-1.80	-0.86	-0.92	-1.05	-1.97	-1.36	-2.12	-1.86	-1.49	-1.26

* Each statistic represents the percentage point difference between the simulated dynamic (full model) percent change in baseline government revenue from the tax reform relative to the simulated static (no behavior or macroeconomic changes) percent change in baseline government revenue.

To see how these dynamic responses affect total dollars of revenue projected in each year, we present Table 2. We focus on the last column, the total effect from

2021-2030. The variation in the Frisch elasticity gives us the lower and upper bounds on the revenue effects. They dynamic feedback effects in the model are estimated to cost between $296 billion and $534 billion over the 10-year window. This helps us to bracket the potential effects of the reform on revenue over the 10 year window. The total estimated revenue effect from a static analysis is $2,092 billion over 2021-2030. The sensitivity analysis here suggests a range for total revenue, including these dynamic feedback effects, of between $1,558 billion and $1,796 billion.

Table 2: Dynamic revenue effects on government revenue: dollar difference (FY, $ billions) in simulated dynamic revenue effect versus simulated static revenue effect by year for each parameter value of each sensitivity analysis parameter

Parameter	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2021-2030
					Frisch elasticity θ						
$\theta = 0.3$	31	13	8	3	1	-51	-41	-79	-125	-55	-296
$\theta = 0.4$	36	12	2	-4	-8	-71	-55	-103	-157	-72	-419
$\theta = 0.5$	40	10	-3	-12	-16	-89	-67	-124	-186	-86	-534
					Foreign debt purchases ζ_D						
$\zeta_D = 0.2$	32	10	1	-4	-8	-73	-55	-105	-160	-73	-435
$\zeta_D = 0.4$	36	12	2	-4	-8	-71	-55	-103	-157	-72	-419
$\zeta_D = 0.6$	38	12	3	-5	-8	-71	-56	-103	-157	-72	-419
					Economic growth rate g_y						
$g_y = 2.0\%$	32	10	1	-5	-9	-74	-56	-106	-161	-74	-443
$g_y = 3.0\%$	36	12	2	-4	-8	-71	-55	-103	-157	-72	-419
$g_y = 4.0\%$	33	11	3	-4	-8	-72	-55	-104	-160	-73	-429
					Timing of closure rule T_{G1}						
$T_{G1} = 2031$	37	12	3	-4	-7	-69	-53	-99	-151	-66	-397
$T_{G1} = 2041$	36	12	2	-4	-8	-71	-55	-103	-157	-72	-419
$T_{G1} = 2051$	35	11	2	-4	-8	-71	-55	-103	-158	-73	-424

* Each amount represents fiscal year $ billions difference between the simulated dynamic (full model) percent change in baseline government revenue from the tax reform relative to the simulated static (no behavior or macroeconomic changes) percent change in baseline government revenue.

** The OG-USA estimate of dynamic feedback effects on revenues have been modified for the purposes of combining them with TPCs conventionally estimated revenue effects in order to avoid double-counting. The OG-USA estimate of the dynamic effect incorporates the impact on revenues of increased corporate taxes reducing taxable incomes for households (who would receive lower returns from owning shares of businesses as a result of the higher corporate taxes). However, that effect is already included in TPCs conventional estimate of the effect on revenues. Therefore the OG-USA estimates of the dynamic effect on revenues shown above have been adjusted to remove the effect of the change in corporate taxes on taxable household incomes.

5 Conclusion

We conduct a sensitivity analysis of the OG-USA model's estimates of the effects of President Biden's campaign proposals by varying four important parameters in the

OG-USA model. Our results show that the Biden tax proposals are likely to raise between $1,558 billion and $1,796 billion over the first ten years.

Of the parameters we examine, the most important in determining aggregate responses and individual behavior is the Frisch elasticity of labor supply, which affects how households respond to changes in after-tax wages. Using a low value of 0.3 and a high of 0.5 for this parameter, we find that the effects of the Biden proposals on GDP over 2021-2030 range from -0.28 percent to -0.45 percent.

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