Dynamic Analysis of Tax Cuts and Jobs Act

February 2, 2018; Version 1.0

Jason DeBacker and Richard W. Evans*

DeBacker Bio: Jason DeBacker is assistant professor of economics at the University of South Carolina, economist with the Open Source Policy Center, and was formerly a financial economist in the Treasury's Office of Tax Analysis. Jason is a core maintainer of the open source models B-Tax and OG-USA, which model business taxes and macroeconomic effects of tax policy, respectively. His research focuses on tax policy and firm dynamics.

Evans Bio: Richard Evans is Senior Lecturer at the University of Chicago M.A. Program in Computational Social Science, Director of the Open Source Macroeconomics Laboratory (OSM Lab), Fellow with the Becker Friedman Institute, and economist with the Open Source Policy Center (OSPC). Rick is also President of Open Research Group, Inc. (OpenRG). Rick is a core maintainer of the OG-USA open source macroeconomic model for dynamic tax analysis. His research focuses on macroeconomics, fiscal policy, and computational modeling.

Abstract: *This Quantitative Note uses the OG-USA open source dynamic general equilibrium overlapping generations model to simulate the effect of the Tax Cuts and Jobs Act. We simulate this reform under the assumptions of a closed economy and small open economy. In both cases, the TCJA reform causes significant growth in GDP and employment between 1% and 2% per year in the first 8 years. However, the increasing debt-to-GDP ratio quickly crowds out investment and causes a drag on the economy. Wage growth can range from nearly nonexistent to a modest 0.6%, depending critically on the assumption of how much capital will flow into the country.*

In this *Quantitative Note*, we use use the OG-USA open source dynamic general equilibrium overlapping generations model of the U.S. economy to perform a dynamic simulation of the effects of the Tax Cuts and Jobs Act (TCJA), as passed by both houses of Congress and signed into law by the President on December 22, 2017. The final version of the legislation has the following key changes.[1]

- Reduce marginal income tax rate schedule for most filers through 2025 (increase in 2026)
- Use a chain-weighted CPI as an inflation index
- Increase the standard deduction through 2025 (reduce in 2026)
- Increase the child tax credit (CTC), but phase out by 2026
- Cut the top corporate income tax rate from 35% to 21%
- Allow 100% expensing on new investments in assets with less than 20-year depreciable life through 2022 (reduced by 20 percentage points per year starting in 2023)
- Limit intereste deduction to 30% of business income
- Move to a territorial system for taxing foreign earnings, with one-time tax on unrepatriated foreign earnings of 8%
- Repeal the corporate alternative minimum tax
- Provide a 20% deduction for pass-through entity income through 2025 (increase in 2026, some limitations for high income filers)
- Limit state and local income and sales tax deduction to $10,000 through 2025 (eliminate limitation in 2026)
- Increase exemption amount and phaseout range of alternative minimum tax (AMT) through 2025 (revert to 2017 law in 2026)
- Repeal the individual insurance mandate of the Affordable Care Act (ACA)
- Double the exemption amount for the estate tax through 2025 (returns to 2017 law in 2026)

We model many of of the components of the TCJA, however our model is such that several items cannot be addressed.

Quantitative Notes is published by Open Research Group, Inc. (OpenRG), a public benefit corporation. For more *QN*s or to arrange meetings with an expert, please contact experts@openrg.com. The author(s) did not receive funding from any source for the production of this *Quantitative Note*.

[1] See the official summary written by the Congressional Budget Office staff here, the Tax Policy Center final summary and analysis of the law here, and the Joint Committee on Taxation final static analyses here and here.

These include the proposed changes to the estate tax, changes related to provisions of the Affordable Care Act, and proposals related to the treatment of foreign income for multi-national corporations. Thus our results should be interpreted as closely, but not exactly, modeling the full effects of the TCJA. All results, both closed economy and small open economy, are summarized in Tables 1 and 2 and in the panels of Figure 1.

We find, in the first 8 years of the reform, the TCJA causes an increase in GDP between 1.0% and 2.0% and an increase in employment of around 1.5%. However, in both our closed economy and open economy simulations, these growth effects deteriorate as investment is crowded out by the increasing government debt. Wage growth is a modest 0.6% under the open economy assumption and is nearly nonexistent (0.3% after a large policy correction and only in the long run) under the closed economy assumption. It is important to note that our simulations assume that a large correction in non-transfer government spending is implemented in 2038 (20 years after the reform) to stabilize the debt-to-GDP ratio at 100%. This correction is necessary to avoid unsustainable and indefinite growth in the debt-to-GDP ratio.

1. Closed vs. Open Economy

In this analysis, we capture two extreme views of capital's ability to move across borders. In the closed economy version of OG-USA, capital demand by firms K_t^D plus the government debt D_t (lending to firms and lending to government) must equal capital supplied by domestic household savings K_t^S.

$$\text{(closed economy)} \qquad K_t^D + D_t = K_t^S \quad \forall t \tag{1}$$

If something causes an increase in firms' demand for capital or government's demand for borrowing, the interest rate will rise. The higher interest rate mitigates the degree to which capital supplied must rise because the quantity of investment demanded declines as the interest rate increases. Thus, in a closed economy setting, government debt has the maximum potential to crowd out investment because the increased deficits divert household savings and thereby reduce investment.

At the other extreme is the assumption of a small open economy. In this case, the interest rate is assumed to be the world interest rate, r^*, and capital supply is perfectly elastic. Foreign capital K_t^F can freely flow into and out of the country to make up for any deficits or surpluses in net domestic capital supply.

$$\text{(small open economy)} \quad K_t^D + D_t = K_t^S + K_t^F \quad \forall t \tag{2}$$

In a small open economy setting, government debt has the minimum potential to crowd out investment because of the perfectly elastic supply of foreign capital. Any increase in the demand for capital—either from domestic firms or from government borrowing—can be met by the free inflow of capital from abroad K_t^F.

By comparing the simulated effects of the TCJA using OG-USA with a closed economy assumption versus a small open economy assumption, we capture the two extremes of how much such a policy can stimulate the U.S. economy.

2. OG-USA Modeling Detail

In any economic model, a number of assumptions must be made. Here, we briefly outline a few important modeling assumptions used in these runs of OG-USA. First, in the closed economy model, there is no trade in goods or services between the U.S. and the rest of the world. Thus in our closed economy model, we will be ignoring the effects that deficit financed tax cuts like the TCJA would have on increasing the trade deficit. In the open economy model, capital goods will flow freely into or out of the U.S.

Second, in a dynamic model where savers are forward looking, the government must retain the ability to sustain its debt in the long run. This means that while the government can run budget deficits indefinitely, those budget deficits cannot grow faster than GDP in the long run. Under current law, the CBO's long term forecasts in CBO Staff (March 2017) predict structural deficits that grow faster than the projected rates for GDP growth. A virtue of the OG-USA dynamic model is that a long-term disconnect between production and debt cannot be sustained.

In our OG-USA simulations, we impose a budgetary rule that is implemented in 20 years and serves to limit the growth in deficits and stabilize the debt-to-GDP ratio at 100% in the long run. This closure rule is implemented in 2038 and lowers government spending in order to stabilize the budget. While other budget closure rules could be used, we choose this rule for our analysis as it takes effect well after the 10-year budget window and adjusts a fiscal variable (non-transfer government spending) that has the smallest impact on the decisions of economic agents in our model. Given this, the reader should interpret our analysis of the TCJA as an analysis of the tax provisions in the legislation and a corresponding decrease in government spending after 20 years that is necessary to stabilize the government budget with reduced tax revenues.

It is important to note that, in our OG-USA simulations, there are no costs associated with a firm adjusting its capital stock over and above the price of those investment goods. As such, firms will adjust their capital stock quickly when the user cost of capital changes. A wide literature has shown that costs to adjusting capital can be important for macroeconomic models to match the patterns of investment observed in data.[2]

[2] See Cooper and Haltiwanger (2006) as a seminal reference in the capital adjustment cost literature.

Table 1. Time path and steady-state percent changes for macroeconomic variables from the TCJA, closed economy

Macro	Year										Avg.	Steady
var.[a]	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	10-yr	state
Y_t	1.12%	1.11%	1.07%	1.03%	0.97%	0.91%	0.84%	0.77%	-0.53%	-0.67%	0.66%	0.18%
C_t	0.47%	0.75%	0.97%	1.14%	1.27%	1.37%	1.44%	1.48%	1.25%	1.07%	1.12%	0.37%
I_t	2.88%	2.07%	1.36%	0.72%	0.13%	-0.38%	-0.87%	-1.26%	-5.75%	-5.80%	-0.69%	0.87%
K_t	-0.24%	0.04%	0.22%	0.32%	0.36%	0.34%	0.29%	0.20%	0.08%	-0.39%	0.12%	0.87%
L_t	1.86%	1.68%	1.53%	1.41%	1.30%	1.21%	1.14%	1.09%	-0.86%	-0.82%	0.95%	-0.19%
w_t	-0.73%	-0.57%	-0.45%	-0.37%	-0.33%	-0.30%	-0.30%	-0.31%	0.33%	0.15%	-0.29%	0.37%
r_t	4.87%	4.36%	3.99%	3.74%	3.58%	3.51%	3.50%	3.54%	1.46%	2.03%	3.46%	1.30%
Rev_t	-9.16%	-8.87%	-8.71%	-8.53%	-8.40%	-8.21%	-8.00%	-7.80%	-1.18%	-0.98%	-6.98%	-1.60%
D_t/Y_t[b]	0.00%	1.64%	3.27%	4.90%	6.54%	8.20%	9.88%	11.59%	14.42%	15.16%	7.56%	-0.00%
G_t/Y_t[b]	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.00%	0.00%	-0.31%

[a] The macroeconomic variables in the table are GDP (Y_t), aggregate consumption (C_t), aggregate investment (I_t), aggregate capital stock (K_t), aggregate labor (L_t), average wage (w_t), interest rate or rate of return on savings (r_t), government revenue (Rev_t), government debt (D_t), government spending on public goods (G_t), debt-to-GDP ratio (D_t/Y_t), and government spending as a percent of GDP (G_t/Y_t).
[b] The changes in debt-to-GDP ratio (D_t/Y_t) and government spending as a percent of GDP (G_t/Y_t) are reported as percentage point differences (simple differences) rather than percent changes to avoid zeros in the denominator.

Table 2. Time path and steady-state percent changes for macroeconomic variables from the TCJA, open economy

Macro	Year										Avg.	Steady
var.[a]	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	10-yr	state
Y_t	2.41%	2.24%	2.11%	2.02%	1.97%	1.94%	1.95%	2.00%	-0.28%	-0.14%	1.62%	0.56%
C_t	1.45%	1.61%	1.72%	1.78%	1.82%	1.81%	1.77%	1.68%	1.41%	1.22%	1.63%	0.33%
I_t	1.52%	1.89%	2.21%	2.51%	2.86%	3.24%	3.67%	-24.77%	2.54%	2.39%	-0.19%	1.71%
K_t	3.59%	3.41%	3.28%	3.19%	3.14%	3.11%	3.12%	3.17%	0.87%	1.00%	2.79%	1.71%
L_t	1.79%	1.61%	1.49%	1.40%	1.34%	1.32%	1.33%	1.37%	-0.89%	-0.75%	1.00%	-0.06%
w_t	0.62%	0.62%	0.62%	0.62%	0.62%	0.62%	0.62%	0.62%	0.62%	0.62%	0.62%	0.62%
r_t	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Rev_t	-9.88%	-9.68%	-9.60%	-9.49%	-9.41%	-9.26%	-9.07%	-8.87%	-2.29%	-2.10%	-7.96%	-1.79%
D_t/Y_t[b]	0.00%	1.49%	2.91%	4.28%	5.59%	6.87%	8.11%	9.29%	12.58%	12.72%	6.38%	-0.00%
G_t/Y_t[b]	-0.00%	0.00%	0.00%	-0.00%	0.00%	0.00%	0.00%	0.00%	-0.00%	0.00%	-0.00%	-0.25%

[a] The macroeconomic variables in the table are GDP (Y_t), aggregate consumption (C_t), aggregate investment (I_t), aggregate capital stock (K_t), aggregate labor (L_t), average wage (w_t), interest rate or rate of return on savings (r_t), government revenue (Rev_t), government debt (D_t), government spending on public goods (G_t), debt-to-GDP ratio (D_t/Y_t), and government spending as a percent of GDP (G_t/Y_t).
[b] The changes in debt-to-GDP ratio (D_t/Y_t) and government spending as a percent of GDP (G_t/Y_t) are reported as percentage point differences (simple differences) rather than percent changes to avoid zeros in the denominator.

The absence of adjustment costs does not affect our long run (steady-state) results. But it does mean that our macroeconomic time series will respond quickly to changes in the user cost of capital induced by the tax reform.

Finally, we assume no responses from the Federal Reserve to offset the interest rate changes induced from the tax reform.

3. Modeling Individual Income Tax Changes

To model the changes to the individual income tax code incorporated in the TCJA, we use the Tax-Calculator open source microsimulation model. In particular, we feed into this model a set of parameters describing the legislation. The microsimulation model then gives us average and marginal tax rates (by income source) for each filer in our dataset in each year of the 10-year budget window. The micro data that underly our Tax-Calculator Simulations come from the 2009 IRS Public Use File matched to the Current Population Survey (to incorporate non-filers) and extrapolated out from 2009 to 2027 using the open source Tax Data model. OG-USA only models differences across filers in terms of income, wealth, and age. So we estimate parametric tax functions separately by age and tax year year and for capital and labor income using the method of DeBacker et al. (2017). It is these parameterized functions that summarize current and proposed tax policy in OG-USA.

4. Government fiscal variables

Fiscal variables undergo large changes from the TCJA, under both the closed economy and open economy assumptions, as shown in Figures 1e and 1f. We find that tax revenues decline an average of nearly 7% per year for the first 10 years of the TCJA.[3] Given the reduced revenues, it is not surprising that the TCJA causes dramatic increases in the debt-to-GDP ratio. Under the closed economy assumption, the U.S. debt-to-GDP ratio is forecast to be 15 percentage points higher in 2027 than it would be without the tax reform. In the small open economy assumption, debt-to-GDP rises more slowly due to the lower interest rates.

The differences in predicted increases in government debt over the next 20 years shown in Figures 1e and 1f are key to explaining the differences between macroeconomic variables in the closed economy and open economy scenarios. In the closed economy, the increased debt burden puts significant upward pressure on interest rates, which dampen the effects of the TCJA on investment in the short-run. In the small open economy model, foreign capital freely flows into the U.S. to satisfy the increased borrowing needs of the government.

5. Macro Effects, Closed Economy

Table 1 shows the percent change from the baseline to the reform in macroeconomic variables, interest rates, and average wage, and fiscal variables over the first 10 years, the 10-year average, and long-run values (steady-state) under the closed economy assumption. Figures 1a, 1c, and 1e show the same percent changes for the macroeconomic variables, prices, and fiscal variables, respectively, over a 60-year time path, after which point the economy is close to its long-run steady state. The vertical black lines at $t = 2038$ in each figure represent the period in which government spending adjusts in order to begin stabilizing the debt-to-GDP toward 100%.

The TCJA reform represents a tax cut for the majority of filers in the economy until 2026.[4] A lower corporate income tax rate and lower tax rates on pass-through business income both provide incentives to increase private investment. This increase in the demand for capital and the increase in government borrowing must be met by increased household saving. The shift outward in investment demand causes the increase in interest rates seen in Figure 1c. Interest rates are about 5% higher than the baseline in 2018 because of the TCJA. Growth in GDP and in the capital stock in the short run resulting from the TCJA are tempered by the household savings being diverted to the new debt requirements of the government. As the debt increases, the percent change in U.S. investment becomes negative by 2023. The percent change in output becomes negative by 2026.

The tax reform results in an increase in employment of 1.6% in the first four years. But because the capital stock increases more slowly, the capital-labor ratio falls in the first few years and wages are lower than the baseline until 2026 as a result of tax reform. Table 1 and Figure 1c show that wages are briefly higher than the baseline after 2025. However, the effects of the crowding out of private capital formation by increasing government debt quickly causes a decline the capital-labor ratio and thus wages. It is only after the stabilizing decrease in government spending as a percent of GDP in 2038 that any long-run increase in wages results.

6. Macro Effects, Small Open Economy

The most fundamental difference between the small open economy and the closed economy is that the interest rate is fixed in the small open economy. Because the interest rate is fixed, both sources of capital demand—firms' demand and government debt—increase dramatically in response to the tax reform. Because any shortages in capital supply can be made up in net foreign inflows of capital, we see a large increase in the capital stock—averaging nearly 3% higher over the first 10 years.

With the expiration of many pieces of the TCJA in 2026, there is a sharp increase in the marginal effective tax rate on capital in that year. This reduces capital demand and thus investment. OG-USA assumes no frictions to adjusting the stock of capital, so in the open economy version of the model (where interest rates do not adjust due to changes in domestic capital demand/supply), the sharp change in marginal tax rates on capital income lead to a large decline in investment (-25%) relative to 2017 law in 2025. If our OG-USA simulations included quadratic adjustment costs (which are commonly assumed in the macroeconomics and public finance literature), this large investment response would be spread out over a few years. Under such an assumption, firms would be more gradual in their disinvestment in response to the tax increase of 2026 to avoid incurring the high adjustment costs associated with a large change in capital in a single year.

In both closed economy and small open economy cases, labor supply increases moderately until 2026 when many of the tax cuts expire. In the small open economy case, because the capital stock is growing faster than employment, wages rise by about 0.6%. This is in marked contrast to the closed economy case in which average wages decline in the majority of the next 20 years.

A more nuanced comment about the small open economy results is to note that the long-run (steady-state) effect of the TCJA on output is larger in the small open economy simulation (+0.56%) than in the closed economy simulation (+0.18%). First, the long-run results must be interpreted as

[3] As noted above, we do exclude some provisions of the TCJA from our analysis. This includes revenue raisers, such as changes in the tax treatment of international corporate income and the repeal of the ACA individual mandate.

[4] See static analysis of TCJA in Evans and Ham (2017).

the effect of the tax reform followed by a stabilizing cut in government spending in 2038. It is instructive to break the effects of the reform into two parts: (i) the benefits from removal of distortionary taxes that accrue to the U.S. and (ii) the long-run drag or crowding out of stabilizing the debt-to-GDP ratio.

In the closed economy case, all of the benefits of reduced distortions (i) from the reform accrue to the U.S. because it is a closed economy. A portion of those benefits are exported in the small open economy case. However, the crowding out drag from the debt burden (ii) is significantly bigger in the closed economy case than in the open economy case due to the higher closed-economy interest rate and faster growth of the closed economy debt-to-GDP ratio. The overall effect of the reform on output is larger in the small open economy case because the lower debt drag outweighs the lower benefits from efficiency.

7. Concluding Remarks

In both the closed economy and small open economy simulations, output and labor experience significant short-term gains over the first 8 years. And those gains are more pronounced in the first 20 years in the small open economy case. However, the predictions greatly diverge for the effects of the reform on capital, investment, and wages. In the closed economy, crowding out from increased government debt causes causes almost no growth in wages early in the budget window and declines in capital and investment in the medium-term. In the small open economy, wages, capital, and investment experience persistent long-run growth.

It is likely that the true nature of the U.S. economy lies somewhere between the two extremes of the closed economy and small open economy assumptions presented here. The question is how freely does capital flow into and out of the United States? If one believes that capital frictions are minimal, then the optimistic results of the small open economy analysis are the most likely. If one believes that capital supply is much less elastic, then there is a chance for significant crowding out in the medium term of investment and output from the TCJA reform.

And finally, even in the small open economy case, the increase in the debt-to-GDP ratio and the required 3-percentage-point cut in 2038 in government spending on public goods as a percent of GDP to stabilize the economy begs the question of how disruptive that type of adjustment might be.

Modeling Notes

OG-USA

OG-USA is an open source dynamic general equilibrium overlapping generations model of the U.S. economy. The OG-USA model is written in Python and includes realistic demographics, productivity growth, household response to consumption, labor supply, and savings, intended and unintended bequests, realistic household taxes, government ability to run deficits and surpluses, and a closed economy or small open economy option. All documentation and code are available in the OG-USA GitHub repository (https://github.com/open-source-economics/OG-USA). Careful documentation for the OG-USA model, its derivation, output, and solution method is available in the OG-USA repository.

Tax-Calculator

Tax-Calculator (release 0.14.3) is an open source microsimulation model that is able to simulate a rich set of policy changes to the U.S. federal individual income tax system. In conjunction with micro data that represent the U.S. population and a set of behavioral assumptions, Tax-Calculator can be used to conduct static revenue scoring and distributional analyses of tax policies. All documentation and code are available in the Tax-Calculator GitHub repository (https://github.com/open-source-economics/Tax-Calculator).

Modeling Assumptions

Our simulations from OG-USA assume a closed-economy, no Federal Reserve response to changes in interest rates, a budget closure rule that takes effect in 2038 and reduces government spending to stabilize the debt-to-GDP ratio at 100%. We model many provisions of the TCJA, but do not include those related to the estate tax, the Affordable Care Act, or the treatment of multi-national corporations foreign earnings.

References

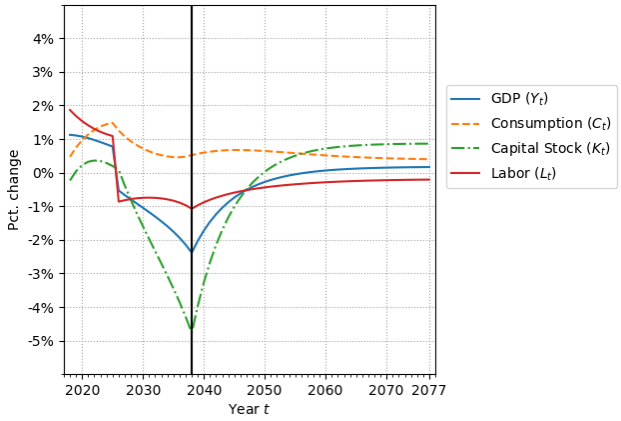
CBO Staff, "The 2017 Long-term Budget Outlook," CBO Report 52480, Congressional Budget Office, March 2017.

Cooper, Russell W. and John C. Haltiwanger, "On the Nature of Capital Adjustment Costs," *Review of Economic Studies*, July 2006, *73* (3), 611–633.

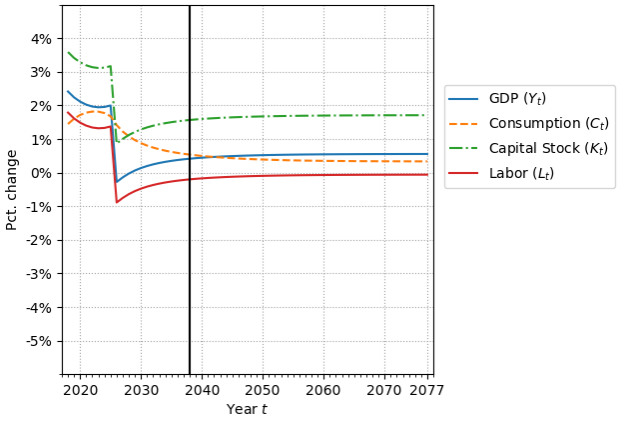
DeBacker, Jason M., Richard W. Evans, and Kerk L. Phillips, "Integrating Microsimulation Models of Tax Policy into a DGE Macroeconomic Model: A Canonical Example," Working Paper November 2017.

Evans, Richard W. and Haylee Ham, "Government Revenue and Distributional Effects of Tax Cuts and Jobs Act," *Quantitative Notes* 2017-3, Open Research Group, Inc., 2017.

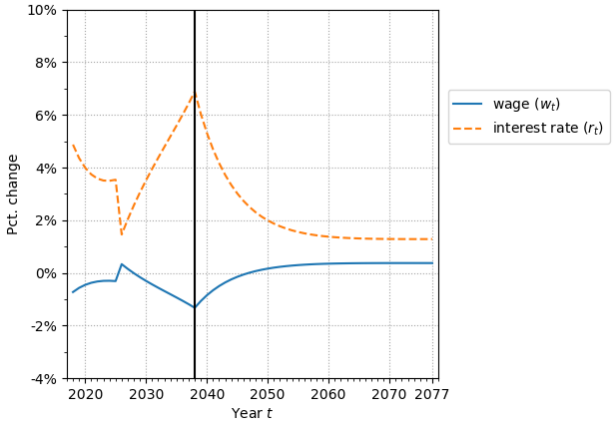
Figure 1. Time path percent changes of aggregate macroeconomic variables, prices, and fiscal variables resulting from the TCJA: closed vs. open economy



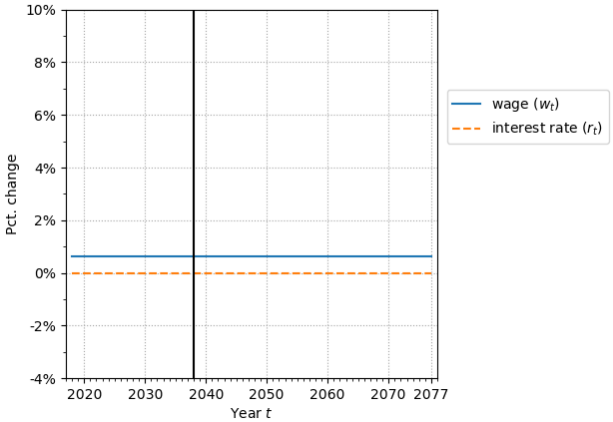
(a) Macro aggregates, closed economy



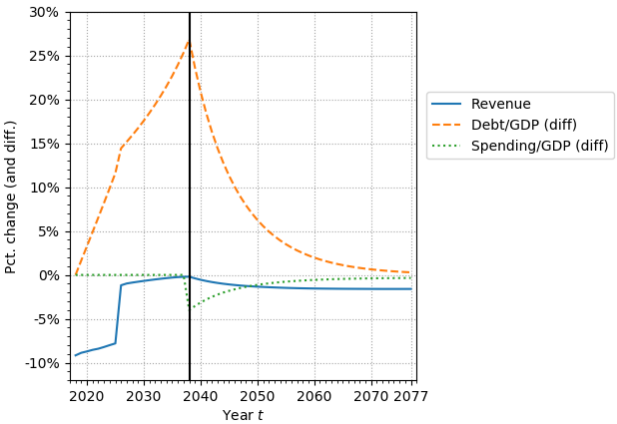
(b) Macro aggregates, open economy



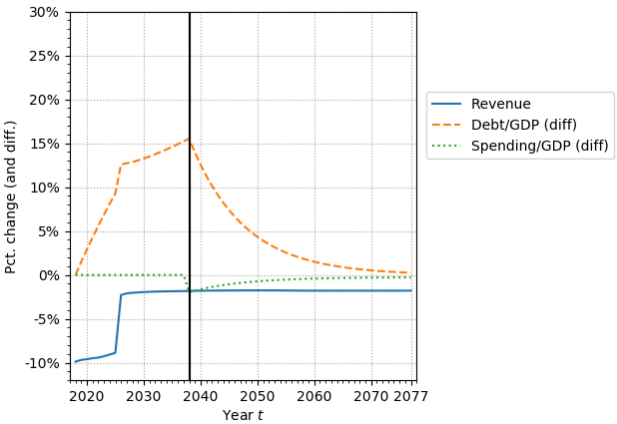
(c) Prices, closed economy



(d) Prices, open economy



(e) Fiscal variables, closed economy



(f) Fiscal variables, open economy