MACROECONOMIC EFFECTS OF REDUCING OASI BENEFITS: A COMPARISON OF SEVEN OVERLAPPING-GENERATIONS MODELS

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In this paper, we evaluate the effects of a reduction in Social Security's Old-Age and Survivors Insurance (OASI) benefits using seven different quantitative general equilibrium overlapping-generations (OLG) models. We compare the effects of an anticipated one-third reduction in OASI benefits beginning in 2031 on an economy that maintains currently scheduled benefits. We find many of the models generate qualitatively similar results concerning budgetary and macroeconomic aggregates; however, the magnitude of the effects varies owing to the models' structure and calibration strategies.

I. INTRODUCTION

Jaeger Nelson and Kerk Phillips

In 2018, the Congressional Budget Office (CBO) projected that, if current laws did not change, Social Security's Old-Age, Survivors, and Disability Insurance (OASDI) joint trust fund would be exhausted in calendar year 2031 (Congressional Budget Office, 2018).[1] In that event, in the absence of legislative action, the Social Security Administration

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[1] The 2019 Social Security Trustee's report projects that the joint OASDI fund will be exhausted by 2035, while the CBO's 2019 Long Term Budget Outlook projects the fund will exhaust in 2032. This paper uses the 2031 date as it was the most recent projected exhaustion date at the time the models were run.

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would no longer be permitted to pay beneficiaries the full amounts to which they were entitled. Subsequently, benefits would be reduced to those that could be financed by the program's total annual revenues, also known as payable benefits. In this paper, we evaluate a stylized payable-benefits scenario — in which benefits are reduced by one-third in 2031 — using seven quantitative overlapping-generations (OLG) models.[2]

This paper has two objectives. The first is to improve our understanding of how a reduction in Old-Age and Survivors Insurance (OASI) benefits would affect the federal budget and the macroeconomy under an OLG framework. OLG models are a staple in Social Security policy analysis, because they incorporate households' life-cycle structure and forward-looking behavior, which allow households' decisions and responses to changes in prices and policies to vary over their life cycle. While there is a significant literature dedicated to analyzing Social Security reforms using OLG models (Conesa and Garriga, 2008; Hosseini and Shourideh, 2019; Imrohoroğlu and Kitao, 2012; Kitao 2014, 2018; McGrattan and Prescott, 2017), this is the first to examine a singular reform across a broad set of models. This affords us the unique opportunity to identify which results are robust across model specifications.

The second objective is to determine the effects of different modeling assumptions on projections of the federal budget and the macroeconomy. While the first objective was about how a policy change affects the projections, this objective is about how modeling choices affect the outcomes of the policy experiment. While all of the models share a common structure, each makes different assumptions about household structure, firm structure, demographics, fiscal policies, the government's borrowing rate, and the economy's degree of openness to the rest of the world. Analyzing these modeling choices under a unified policy experiment provides guidance on how the next generation of OLG models can be designed and used for policy analysis.

While there are significant differences within the models' structures, we find that the models generate similar qualitative results across a range of budgetary and macroeconomic variables. In all seven models, a reduction in OASI benefits lowers the ratio of debt to gross domestic product (debt-to-GDP), increases the aggregate capital stock, raises wages, and lowers interest rates. In most of the models, a reduction in benefits also led to short-run decreases in consumption and increases in labor supply. As OASI benefits are reduced, working-age households begin dedicating more disposable income toward saving in order to smooth consumption over their life cycle. Furthermore, higher wages and a desire to increase saving results in a net increase in the labor supply. While these results are qualitatively robust, there is variability across the results' magnitudes.

Although the groups in charge of the seven OLG models used in this paper — to the greatest extent practical — coordinated on the changes in fiscal policy, other modeling choices influence projected policy outcomes. For example, the choice to allow the gov-

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[2] The choice to cut benefits across the board by one-third was made for two reasons. First, it is simple to implement relative to an actual payable-benefits scenario in which benefits depend on payroll tax revenues. Second, while 33 percent is a few percentage points larger than the 29 percent figure found in the CBO's 2019 Long Term Budget Outlook, it is a reasonable approximation.

ernment to borrow at a rate below the rate of return on capital significantly influences the debt-to-GDP path. The Global Gaidar Model (GGM), for example, requires the government to finance its debt at the rate of return on productive capital. This results in a larger reduction in the debt-to-GDP ratio following the cut in OASI benefits as deficits compound more quickly under the higher financing rate.

Section II provides an overview of OLG models and the OASI benefit policy experiment analyzed in this paper. Section III contains specifics on each of the seven models' structure and highlights areas in which the models are similar and those in which they differ. Section IV presents the economic and budgetary effects of the reduction in OASI benefits as well as discussions on how modeling choices affect the outcomes and limitations of the models.

II. MODEL OVERVIEW AND THE POLICY EXPERIMENT

Jaeger Nelson and Kerk Phillips

This paper uses seven different quantitative general-equilibrium OLG models to analyze the effects of a one-third reduction in OASI benefits beginning in 2031.[3] In each model, a period is equal to one year and the economy is populated with heterogeneous households.[4] In all models, households differ by their age, wealth, and income.[5] Some models also have additional dimensions of heterogeneity (Table 1 provides details). Households make consumption/saving decisions in each period of life and make a labor/leisure choice during their working career.[6] Households are forward looking and their decisions are influenced by current and future prices and policies, as well as their own contemporaneous characteristics. While all seven models share the same underlying structure, they do differ along several dimensions (Table 2 and Section III include details).

To compute the effects of a one-third reduction in OASI benefits, each model is simulated twice. The first simulation is the benchmark economy, which does not include the change in OASI benefits (that is, the economy under scheduled benefits). The second simulation is the counterfactual economy, which includes the reduction in OASI benefits in 2031. In the counterfactual economy, the policy change is announced in 2018 and viewed as credible from the households' perspective. The results of the policy change are presented (Section IV) as the counterfactual economy's deviations from the benchmark (either in percentage or percentage-point terms).

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[3] The one-third reduction in benefits is referred to as a payable-benefits scenario throughout this paper; however, this is a simplification and differs from the payable-benefits scenario analyzed in the CBO's *2019 Long-Term Budget Outlook* (Congressional Budget Office, 2019), in which amounts paid out under the OASI program would be limited to sources of dedicated funding.

[4] In this paper, we use the terms households and agents interchangeably, though it should be noted that different models conceptualize these entities in different ways (Section III offers details).

[5] How income heterogeneity is modeled differs across models.

[6] Retirement age (and, by extension, working age) differs across models.

Table 1

Household Characteristics and Other Features of the OLG Models

Model	Household Characteristics			Production Inputs	Openness	Demographics
	Life Cycle	Heterogeneity	Choices			
CBO's OLG model	Maximum life: 80 periods mortality risk labor productivity risk	Age, wealth, labor productivity, and average earnings	Labor/Leisure, consumption/saving, and retirement age (65–75)	Capital and labor	Large open	Stationary
DZ model	Maximum life: 55 periods	Age, wealth, and lifetime income level	Labor/Leisure, consumption/saving, and bequests	Capital and labor sector(s): corporate, noncorporate, owner-occupied housing, and rental services	Large open	Stationary
EY QUEST model	Maximum life: 55 periods	Age, wealth, average earnings, and access to capital markets	Labor/Leisure and consumption/saving	Capital and labor sector(s): 36 industries, each with a corporate and pass-through sector	Large open	Stationary
GGM	Maximum life: 91 periods mortality risk	Age, wealth, labor productivity, and family composition	Labor/Leisure and consumption/saving	Capital, labor($\times 2$), and natural resource endowment sector(s): energy and nonenergy	Global model	Nonstationary
JCT's In-House model	Maximum life: 66 periods mortality risk	Age, wealth, labor productivity, and family composition	Labor/Leisure, consumption/saving, charitable giving, and housing (rent/own)	Private capital, public capital, and labor sector(s): corporate and noncorporate	Large open	Stationary
OG-USA model	maximum life: 80 periods mortality risk	Age, wealth, and lifetime income level	Labor/Leisure and consumption/saving	Capital and labor	Large open	Nonstationary
PWBM	Maximum life: 81 periods mortality risk labor productivity risk	Age, wealth, labor productivity, and average earnings	Labor/Leisure and consumption/saving	Capital and labor sector(s): corporate and pass-through	Large open	Nonstationary

Table 2

Government Characteristics and Closure Rules of the OLG Models

Model	Government Characteristics		Closure Rule
	Revenues	Outlays	
CBO's OLG model	Income taxes on capital and labor, payroll taxes, consumption tax, and a lump-sum tax	OASI program that depends on average earnings, lump-sum transfers (general, SSDI, and Medicare), and nondistortionary spending	Nondistortionary government spending; debt-to-GDP stabilized at 2050 level
DZ model	Income tax, payroll taxes, proportional tax on capital income, and corporate taxes	Pension program that depends on income level, other transfer payments, and nondistortionary spending	Nondistortionary government spending; debt-to-GDP stabilized at 2050 level
EY QUEST model	Income tax on capital and labor, payroll taxes, and a lump-sum tax	OASI program that depends on average earnings, other transfer payments, and spending on public goods	Lump-sum transfer payments; debt-to-GDP stabilized at 2050 level
GGM	Income taxes, payroll taxes, consumption taxes, corporate taxes, and natural resource revenues	Pension program that depends on average earnings, nonage specific transfer program, and health and education spending	Nondistortionary government spending;[1] debt-to-GDP stabilized at 2050 level
JCT's In-House model	Detailed internal tax calculator for households' tax liability corporate and noncorporate taxes	OASI program that depends on aggregate average earnings, non-OASI transfer payments, capital expenditures, and nondistortionary spending	Nondistortionary government spending; debt-to-GDP stabilized at 2050 level
OG-USA model	Income tax and corporate taxes	Pension program that depends on income level and nondistortionary spending	Nondistortionary government spending; debt-to-GDP stabilized at 200% of GDP in 2050 for all scenarios
PWBM	Income tax (preferred and ordinary), payroll taxes, consumption tax, and corporate taxes	OASI program that depends on average earnings and nondistortionary spending	Nondistortionary government spending; debt-to-GDP stabilized at 2050 level

[1] In addition to nonvalued government spending, small changes in income and consumption tax rates were necessary to solve the model.

Each model simulation begins in an initial period calibrated to the recent U.S. economy, including — as projected under current law — government deficits and growing government debt as a share of GDP (Congressional Budget Office, 2019). The government in each model collects revenues from households via a mix of income, payroll, consumption, and lump-sum taxes. Tax treatment on firms differs across models. Expenditures vary across models; however, all models include some version of a public pension system. In any given period, the government is allowed to run a budget surplus or deficit; however, because households in the model are forward looking, all models require that debt as a share of GDP stabilizes in the long run.[7] If government immediate debt as a share of GDP were to rise perpetually, domestic households in the model would at some point no longer be able to absorb the debt not held by the rest of the world and the model would fail to solve.

To address that technical limitation, in both the benchmark and counterfactual economies, we assume that the government enacts a fiscal policy change that stabilizes the debt-to-GDP ratio from 2050 onward. That type of policy change is referred to as the closure rule in fiscal policy models. Closure rules have two design aspects. The first is the policy tool used to stabilize the debt-to-GDP ratio and the second is the timing. When comparing policy analysis across models, it is crucial to have a common closure rule — both in terms of structure and timing — because different closure rules lead to different projections.[8]

In this paper, we chose the least distortionary policy tools available in each model to stabilize debt-to-GDP. This includes nonvalued government spending and lump-sum transfers or, equivalently, lump-sum taxes.[9] These policy tools have a limited effect on households' decisions and allow us to push the closure date as far into the future as possible (2050).[10] While pushing the closure date further into the future limits the closure rule's effect on the projections over the period of interest, the longer we wait, the larger the policy change needs to be to stabilize debt-to-GDP. In some cases, the policy change becomes infeasible within the model economy. To illustrate this latter point, in a simulation beyond the scope of this paper, when the GGM (outlined in Section III.D) used income and consumption taxes to stabilize the debt-to-GDP ratio — instead of nonvalued government spending — 2045 was the latest closure date at which the model economy could raise enough revenue to stabilize debt-to-GDP.

III. MODEL DESCRIPTIONS

Jaeger Nelson and Kerk Phillips

This section contains a detailed overview of each of the seven OLG models used in this paper: (1) CBO's OLG model, (2) Diamond–Zodrow (DZ) model, (3) EY QUEST model,[11] (4) GGM, (5) Joint Committee on Taxation's (JCT's) In-House model,

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[7] The term "long run" in this paper refers to the terminal steady state. The number of years it takes for the economy to transition to its steady states varies across models.

[8] For a more in-depth discussion, see Moore and Pecoraro (2018).

[9] In some models, nonvalued government spending may be negative.

[10] All closure rules used in this paper stabilize debt-to-GDP immediately and are not phased in over time.

[11] EY QUEST refers to Ernst & Young LLP's Quantitative Economics and Statistics (QUEST) group.

(6) OG-USA model, and (7) Penn Wharton Budget Model (PWBM). A synopsis of the models' key characteristics can be found in Tables 1 and 2.

A. CBO's OLG Model

Jaeger Nelson and Kerk Phillips

In the CBO's model, a period is equal to one year and the economy is populated with heterogeneous households that differ according to their age, wealth, labor productivity, and average lifetime earnings.[12] Households become economically active at age 21 and live for a maximum of 80 periods. In each period of life, households face age-dependent mortality risk. For ages 21–75, households' labor productivity is uncertain and follows a discrete Markov process. Households optimally choose their labor supply on both intensive and extensive margins until age 75, when they are forced to retire. In each period, households also make a consumption/saving decision.

Firms are perfectly competitive and have access to a constant-returns-to-scale (CRS) Cobb–Douglas production technology that uses capital and labor as inputs. The government collects revenues from a progressive income tax on labor and capital income, payroll taxes, consumption taxes, and a lump-sum tax. The government operates an OASI program that follows current law's primary insurance amount benefit formula and proxies for households' average indexed monthly earnings (AIME) with households' average labor income using wage growth as the index.[13] The government also makes lump-sum transfers to households on a per capita basis that account for aggregate disability insurance, hospital insurance, and other transfer program outlays. Accidental bequests are collected by the government and are redistributed to surviving working-age households in every period. The government is free to operate a budget surplus or deficit in any given period and pays an interest rate on its debt that is a fraction of the rate of return on capital. The government's budget also includes a nonvalued government spending category.

The version of CBO's model that is presented in this paper uses a large open economy and steady-state demographics.[14] The debt-to-GDP ratio is stabilized at its endogenous level in 2050 by changing nonvalued government spending in each period after 2050.

B. DZ Model

John Diamond and George Zodrow

In the Diamond–Zodrow (DZ) model, the economy is populated with heterogeneous households that live for 55 periods with certainty, with a working life of 45 years, and differ according to their age, wealth, and lifetime income level.[15] In each period

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[12] For a full description of the model, see Nishiyama and Reichling (2015).

[13] In the model, households begin receiving OASI benefits once they turn 65, but they may choose to continue working until age 75 if they find it optimal to do so.

[14] The openness of the economy is controlled by a parameter, χ, where χ is the weight placed on factor prices resulting from a closed economy, and $(1-\chi)$ is the weight placed on the initial steady-state factor prices in the small open economy case. For CBO's standard benchmark economy, we set $\chi = 0.30$.

[15] For a full description of the model, see Zodrow and Diamond (2013).

of the households' working life, they make a labor/leisure choice and a consumption/saving choice to maximize their lifetime utility, and, once retired, they save to finance a fixed-target bequest. Household consumption is a composite commodity comprised of a composite nonhousing good and composite housing services.

The nonhousing consumption is produced via a constant-elasticity-of-substitution (CES) aggregator of corporate and noncorporate goods. The composite housing service is produced via a CES aggregator of owner-occupied housing and rental services. The corporate sector includes all businesses subject to the corporate income tax. The noncorporate sector encompasses all pass-through entities including S corporations, partnerships, limited liability corporations, limited liability partnerships, and sole proprietorships. Owner-occupied housing and rental housing services — operated by noncorporate landlords — produce housing services with the same CES production function.

The government collects tax revenues from corporate income taxes, progressive labor income taxes, and a proportional tax on capital income. The DZ model includes separate tax treatment of corporate and pass-through entities, separate tax treatment of owner-occupied and rental housing, and separate tax treatment of new and old capital, including explicit calculation of asset values before and after the reduction in OASI benefits. The model also includes progressive taxation of labor income for households at different income levels, and it captures differential proportional taxation of different types of capital income. Government expenditures include purchases of a fixed amount of the composite goods, transfer payments, and interest payments on existing government debt. Transfer payments include non–Social Security payments and a Social Security system funded by payroll taxes with a cap on earnings of high-income households.

The version of the DZ model presented in this paper is a large open economy that uses stationary demographics. In the simulations presented in this paper, the debt-to-GDP ratio is stabilized at its endogenous level in 2050 by changing nonvalued government spending in each period after 2050.

C. EY QUEST Model

Robert Carroll, James Mackie, and Brandon Pizzola

In the EY QUEST model, households differ according to their age, wealth, average lifetime earnings, and access to capital markets.[16] The model distinguishes between two types of individuals: those that have access to capital markets (savers) and those that do not (nonsavers or rule-of-thumb individuals).[17] Households become economically relevant at age 21 and live for 55 periods with certainty. In each period of the households' life, they make a labor/leisure choice and, if they have access to capital markets, a consumption/saving choice to maximize their lifetime utility.

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[16] For a full description of the model, see Pizzola, Carroll, and Mackie (2018).

[17] Across all age cohorts, the model assumes that 50 percent of U.S. households are permanently nonsavers and that 50 percent are permanently savers.

Firms are perfectly competitive and have access to a CES production function that uses capital and labor as inputs. The EY QUEST model includes industry-specific details (36 industries) through its use of differing costs of capital, factor intensities, and production-function scale parameters.[18] The cost-of-capital measure models the extent to which the tax code distinguishes by asset type, organizational form, and source of finance. Each of the industries has a corporate and pass-through sector except for owner-occupied housing and government production. Each industry's output is modeled as a fixed proportion of an industry's value-added and intermediate inputs to capture linkages within industries. Those industry outputs are then bundled into consumption goods that consumers purchase.

The government collects revenues from income taxes on labor and capital income, payroll taxes, and lump-sum taxes. Government spending is classified as either transfer payments or the provision of public goods. Social Security payments are calculated in the model on the basis of the 35 years in which a representative individual earns the most income from labor. Other transfer payments are distributed on a per capita basis. Public goods are provided by the government in fixed quantities through the purchase of industry outputs as specified in a Leontief function.

The EY model assumes a large open economy with international capital flows modeled through the constant portfolio elasticity approach of Gravelle and Smetters (2006). Products made in the United States are assumed to be imperfect substitutes versus production from the rest of the world.

The demographics in the model are stationary. For this paper, the debt-to-GDP ratio is stabilized at its endogenous level in 2050 by changing lump-sum transfers in each period after 2050.

D. Global Gaidar Model

Seth G. Benzell, Laurence Kotlikoff, Guillermo LaGarda, and Victor Yifan Ye

The GGM features 17 regions, each of which contains its own demographic trends and set of fiscal policies.[19] The 17 regions in the model include 99 percent of the world's population. Each region is inhabited by heterogeneous households that differ according to age, wealth, labor productivity, and family composition. Dynamic demographic transitions and households' preferences are calibrated separately by region. Capital moves frictionlessly across regions. The model also includes age, skill group, and region-specific net immigration. The model includes common productivity growth in the form of a fixed growth rate of the time endowment of successive new cohorts as well as cohort-specific and region-specific catch-up productivity growth. The United

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[18] The industry details included in the EY QUEST model correspond approximately with three-digit North American Industry Classification System codes and are calibrated to a stylized version of the 2014 U.S. economy.

[19] For a full description, see Benzell, Kotlikoff, and LaGarda (2017).

States is only one of the 17 regions, and so the GGM is unique among the models considered in that it allows for the United States to transition from a large open to small open economy as it shrinks as a share of global GDP.

Each region's total economic output is comprised of energy and nonenergy production. The energy sector models fossil fuel endowments as a fixed stream of output through the date of exhaustion; fossil fuel extraction ceases in 2083 in the current calibration. The nonenergy sector has access to a Cobb–Douglas production technology that uses capital and the two types of labor as inputs. As a result, low-skilled and high-skilled individuals earn different wages. Individuals who die before the maximum lifespan (91) leave accidental bequests. Bequests of individuals under 68 are redistributed within their own age-skill cohort, while bequests of individuals 68 or older are uniformly redistributed to adult children of the decedent's skill type.

Each region has a government that collects revenues from natural resources, corporate taxes, payroll taxes, consumption taxes, and income taxes. The GGM is carefully calibrated to the International Monetary Fund's fiscal and economic aggregates. To generate realistic marginal and average corporate tax rates, individuals receive a fraction of gross corporate tax revenues, via a lump-sum rebate, that is proportional to their asset holdings. The government expends resources on healthcare and education that depend on a region's demographics. Each region's pension program transfers a fixed fraction of average lifetime earnings to individuals after they reach their exogenous retirement age. Initial period debt by region is calibrated to interest payments on the national debt as a share of GDP. All additional government borrowing beyond the initial period is assumed to be at the world interest rate. In the simulations presented in this paper, the debt-to-GDP ratio is stabilized at its endogenous level in 2050 by reducing, or setting as negative, nonvalued government spending in each period after 2050.[20]

E. JCT's In-House Model

Rachel Moore and Brandon Pecoraro

In the JCT's In-House model, the economy is populated with heterogeneous households that differ according to their age, wealth, family composition (single or married), labor productivity, and average lifetime earnings.[21] Households become economically active at age 25, retire by age 65, and live for a maximum of 66 periods. Households are assigned children, the number and age of which depend on the household's age, family composition, and productivity type.

Individuals in each household optimally choose their labor supply from a discrete set of options — unemployed, part time, or full time. For married households, that labor supply decision is made jointly by primary and secondary earners. Individuals face

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[20] Government expenditures were set to approximately stabilize the debt-to-GDP ratio with fixed tax rates, but the latter fluctuate slightly to keep the debt-to-GDP ratio precisely fixed after 2050.

[21] For a full description, see Moore and Pecoraro (forthcoming) and Moore and Pecoraro (2019).

costs for working, including child care costs. Households also optimally choose their charitable giving, leisure, consumption, and saving levels. All households derive utility from market consumption, charitable giving, housing services, and home production, and disutility from market work. Home production is generated from hours not spent in market work or leisure. Housing services are realized from either a rental unit or an owner-occupied home.

Households deposit savings with the financial intermediary who maintains a portfolio of investments on their behalf, optimally allocating deposits across investment vehicles and passing all returns back to the households. Distinct corporate and noncorporate sectors are perfectly competitive and have access to a CRS production technology that uses government capital, private capital, and labor as inputs. Sectors differ with respect to firm financing and tax treatment. Hiring and investment decisions are made optimally over an infinite planning horizon and incorporate the incentive effects of fiscal policy.

Tax liability on household income is determined by an internal tax calculator that incorporates key aspects of income tax law. Labor income is taxed jointly with ordinary capital income, while preferred capital income receives special tax treatment. Government expenditures include OASI payments following current law's benefit formula, non-OASI transfer payments, capital expenditures, and nonvalued spending. An exogenous risk wedge allows the government to pay a lower interest rate on debt than the rate paid by firms. In the simulations, the debt-to-GDP ratio is stabilized by changing nonvalued government spending after 2050. This version of the model is a large open economy.[22]

F. OG-USA Model

Jason DeBacker and Richard Evans

In the OG-USA model, the economy is populated with heterogeneous households that differ according to their age, wealth, and lifetime income group (or labor productivity).[23] Households become economically relevant at age 21 and may live to a maximum age of 100.[24] In each period of life, households face age-dependent mortality risk. Households receive lump-sum bequests (both intentional and unintentional) in each period of life that vary according to their age and lifetime income group. Households optimally choose their labor supply and make a consumption/saving decision in each period to maximize their lifetime utility.

In the OG-USA model, one representative firm has access to a CES production function that uses capital and labor as inputs. The firm pays a corporate income tax and is allowed to expense a percentage of its capital depreciation. The OG-USA model uses

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[22] The model assumes that 40 percent of newly issued government debt is taken up by foreign investors.

[23] For a full description of the model, see Evans and DeBacker (2018).

[24] A model period is equal to one year.

the methodology from DeBacker, Evans, and Phillips (2019) to incorporate detailed federal tax information into the OLG model by using an open-source microsimulation model called Tax-Calculator.[25]

The version of the OG-USA model used in this paper is a large open economy in which foreign investors purchase a fraction of newly issued government debt and hold a fraction of domestic capital.[26] In addition, capital is imported and exported via the holdings of immigrants. The model incorporates nonstationary population dynamics that include mortality, fertility, and net immigration by age.

The government is free to operate a budget surplus or deficit in any given period and pays an interest rate on its debt. The budget closure rule used in the OG-USA model differs from other models in this paper. In the simulations presented in this paper, the debt-to-GDP ratio is stabilized at 200 percent of GDP in 2050 by changing nonvalued government spending in each period after 2050.

G. Penn Wharton Budget Model

Efraim Berkovich and Jagadeesh Gokhale

The PWBM runs at an annual frequency with the economy populated by agents differentiated by age, wealth, labor productivity, and average lifetime earnings.[27] Agents live for a maximum of 81 periods corresponding to ages 20–100. Each agent faces an age-dependent risk of death. Agents' labor productivities are uncertain and follow discrete Markov processes. Individuals optimize their labor supply through their birth-cohort-dependent retirement date. Agents also decide their consumption/saving allocations out of available resources each year.

The economy's representative price-taking firm uses CRS Cobb–Douglas production technology with capital and labor inputs. The firm is split into a corporate and a pass-through sector where both can issue one-period debt to maximize profits via the interest rate tax deduction. Firms are exposed to capital adjustment costs, other production expenses, tax credits, and the tax code's preferential treatment of investment and capital depreciation as scheduled under current law.

Government revenues include corporate taxes, foreign investor capital-income taxes, ordinary-rate individual income taxes, preferred-rate levies on some business income, payroll taxes, and consumption taxes. Tax parameters are based on effective tax rate schedules calculated from PWBM's microsimulation model. In particular, tax functions and OASI benefit calculations are informed by evolving demographic changes in the

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[25] See "USA Federal Individual Income and Payroll Tax Microsimulation Model," https://github.com/PSLmodels/Tax-Calculator.

[26] The OG-USA model also has settings for a closed economy and a small open economy. In the latter setting, the interest rate is fixed at the world interest rate and capital can flow freely across borders to satisfy capital market clearing at the world interest rate.

[27] For a full description of the model, see PWBM (2018).

U.S. population. The government's Social Security program follows current-law benefit formulae calculated using agents' AIME. Accidental bequests are redistributed by the government to surviving individuals in every period. The government can accrue budget surpluses or deficits and it pays a variable interest rate depending on the term structure of its total liabilities. Government expenditures other than for Social Security are nondistortionary and generate no welfare for individuals in the model economy.

The PWBM model used for this study is a large open economy wherein new government debt is partly acquired by foreigners.[28] Foreigners also contribute to the formation of domestic private capital. The model uses demographic projections from PWBM's microsimulation, which includes age-dependent immigration rates. PWBM's integrated microsimulation and general-equilibrium OLG model stabilizes the debt-to-GDP ratio at its endogenous level in 2050 by changing nonvalued and nondistortionary government spending in each year after 2050.

IV. DISCUSSION OF RESULTS

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This section of the paper contains two parts. The first part overviews the budgetary and macroeconomic implications of the one-third reduction in OASI benefits in 2031 across all seven models outlined in Section III. Areas where model results are consistent with one another are identified and areas where model results diverge are discussed. While all seven models share the same underlying structure, they vary significantly in terms of household structure, household heterogeneity, income dynamics, firm structure, tax treatment, demographics, degree of openness to the rest of the world, OASI program structure, and many other dimensions that can influence the models' results. Despite those differences, the qualitative implications — as measured by the aggregate budgetary and economic effects — of the policy change remain remarkably consistent across the models.

The second part of this section discusses additional modeling choices and model limitations that do not directly map into one of the budgetary or macroeconomic variables presented in the first part.

A. The Budgetary and Economic Effects of a Reduction in OASI Benefits

All results presented in this paper are framed in terms of the counterfactual economy (reduced benefits) relative to the benchmark economy (scheduled benefits), either in percentage or percentage point terms. Before discussing each of the bud-
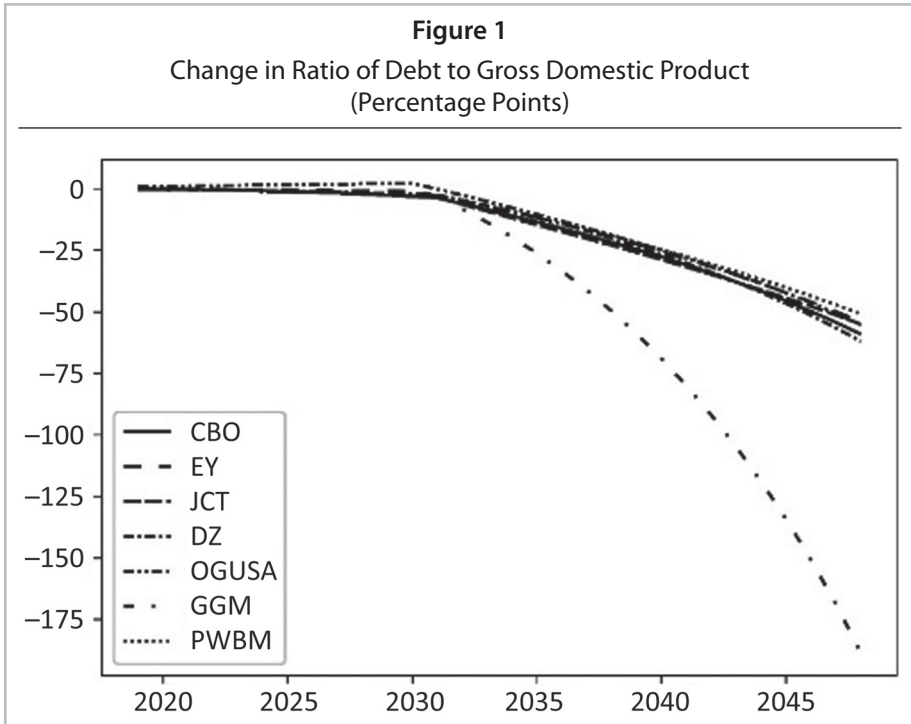
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[28] Under PWBM's assumptions, 40 percent of newly issued government debt is taken up by foreign investors.

getary and macroeconomic aggregates individually, we will briefly summarize the results.

Unsurprisingly, the debt-to-GDP ratio is lower along the economy's transition path under the reduced benefits scenario. The capital stock begins rising immediately follow-ing the policy announcement in most models. Along those same lines, the labor supply also increases across most models and is fairly consistent across time. The increase in both factors of production increases GDP along the transition, again for most models. Household consumption falls immediately after the policy announcement, though the size of the drop varies greatly across models. The short-run effect on wages is small, but all models show a higher wage relative to the benchmark economy in the out years. Finally, apart from a few periods early in the simulation, interest rates fall relative to the benchmark economy.

The debt-to-GDP ratio falls slightly between 2018 and 2031 as households begin saving more for retirement and increasing hours worked, thus boosting GDP prior to the benefit cut date. In general, the reductions in the debt-to-GDP ratio are consistent across most models, both in terms of the final level and the transition path (Figure 1) — the lone exception being the GGM, which finds a larger reduction in the debt-to-GDP level relative to the other models. This result is driven by the assumption that the interest rate on government debt is set at the global rate of return on capital. That

Figure 1
Change in Ratio of Debt to Gross Domestic Product
(Percentage Points)

assumption results in very high levels of debt-to-GDP in the benchmark economy as deficits in early years compound more rapidly due to debt servicing costs. Thus, the reduction in the primary deficit due to the OASI benefit cut results in significant debt-to-GDP effects in the long run.

The cut in OASI benefits induces households to increase their private saving, which pushes up the productive capital stock. That result stems from households' desire to smooth consumption over their life cycle and to self-insure against earnings risk. Aggregate capital's response to the reduced benefits scenario is qualitatively consistent across models; quantitatively, however, the differences are economically significant (Figure 2). The degree to which the economy is open to the rest of the world affects net foreign wealth, which in turn effects the magnitude of the capital stock's response to government debt along the transition path. Additionally, the strength of households' risk aversion and desire to smooth consumption over their life cycle differs across models and accounts for some of the variation in the capital stock's response to the benefit reduction. The immediate rise in the capital stock in the GGM is driven by a capital inflow resulting from a relatively large increase in the domestic labor supply.

In JCT's In-House model, the slower rise in the capital stock is driven by firms' financing and their ability to buy back their stock. Following the policy announcement, the labor supply increases immediately, driving down wages and boosting capital returns.

Figure 2
Change in Aggregate Capital (Percent)

Instead of immediately investing new household savings into productive capital, firms in both sectors of the model substitute toward labor, the relatively cheaper input in the production process. Firms perform stock buybacks and pass higher dividends and distributions along to shareholders for the first three years. Thereafter, capital investment increases above the model's benchmark economy but at lower levels than the increases in models that pass all new savings directly into productive capital. That lower capital stock also results in lower GDP projections in JCT's In-House model (Figure 3).

The reduction in benefits increases the aggregate labor supply in most of the models (Figure 4). Again, the results are qualitatively similar; only the OG-USA model finds a reduction in the aggregate labor supply. As shown in Figure 4, the transition path for aggregate labor in JCT's In-House model is jagged. Those jumps come from the model's inclusion of primary and secondary earners, both of which face a discrete set of labor choices.[29]

Aggregate private consumption is lower in nearly every period along the transition path despite the increase in GDP (Figure 5). In the JCT In-House model, aggregate consumption is higher for a few years near the end of the projection window due to the periods' proximity to the closure rule; however, in the long run, aggregate consumption does fall below benchmark levels. The presence of rule-of-thumb households that are precluded from saving in the EY QUEST model results in a sudden drop in aggregate consumption — primarily driven by households in retirement in 2031 — following the reduction in OASI benefits. While other households in the model are able to increase their savings, these households have no mechanism through which to smooth consumption over their life cycle. The one-third reduction in OASI benefits comes directly from their consumption in retirement.

As the productive capital stock rises proportionally more than the labor supply in most of the models, wages increase along the transition path (Figure 6). Through the same channel, the interest rate that households earn on their asset holdings falls over time before stabilizing in the long run (Figure 7).[30] The relatively higher labor supply and wage rate increases the OASI program's payroll tax revenue under the reduced benefits scenario. Furthermore, for those models that incorporate OASI benefits' dependence on households' AIME, the total reduction in OASI outlays is less than one-third because households' average earnings over their lifetime increase after the reduction in the replacement rates.

B. Modeling Choices and Limitations

All results presented in this paper are calculated under the assumption that the United States is a large open economy. The authors examined alternative assumptions about economy openness and determined — after comparing small and large open economies — that the degree of openness in the model is critical to the results. Even though all of the models are run under a large open economy setting, how the domestic economy

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[29] The discrete labor supply decision is a necessary feature for the model's internal tax calculator.
[30] Interest rates stabilize after the closure rule begins in 2050. As a result, the final steady-state interest rate is not reached during the projection window shown in Figure 7.
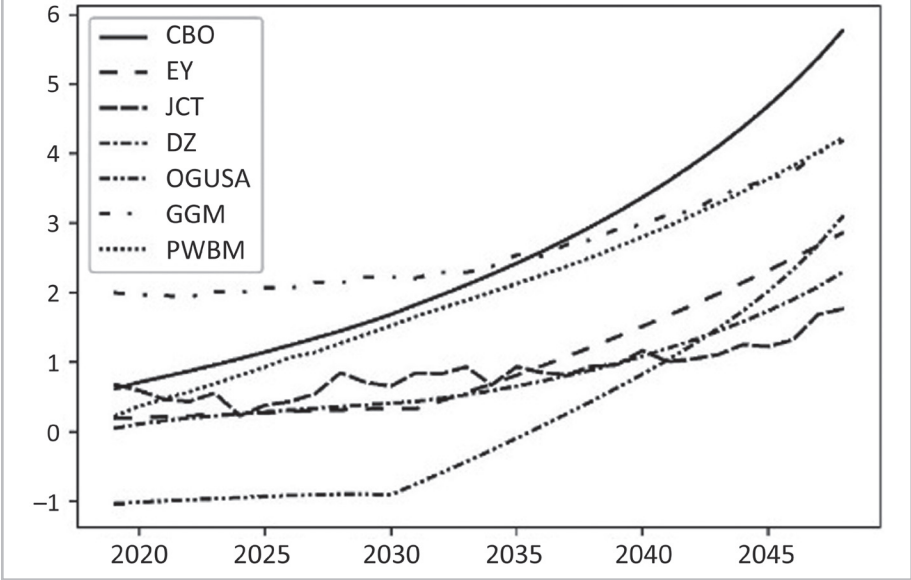
Figure 3
Change in GDP (Percent)

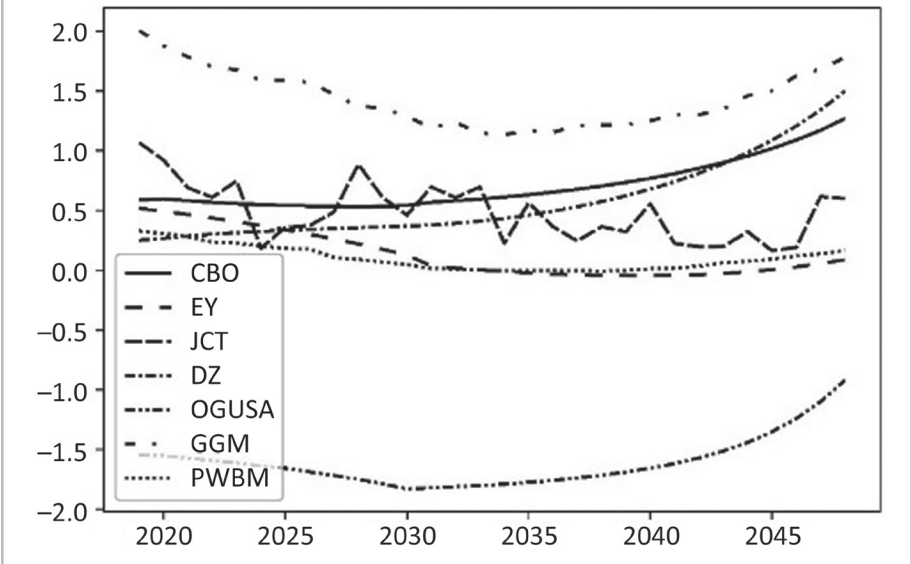**Figure 4**
Change in Aggregate Labor (Percent)
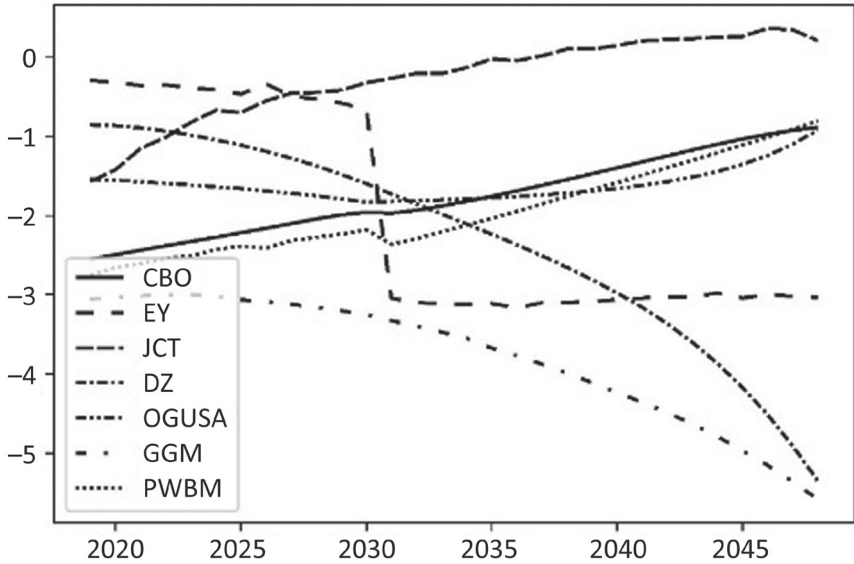
Figure 5
Change in Aggregate Consumption (Percent)

Figure 6
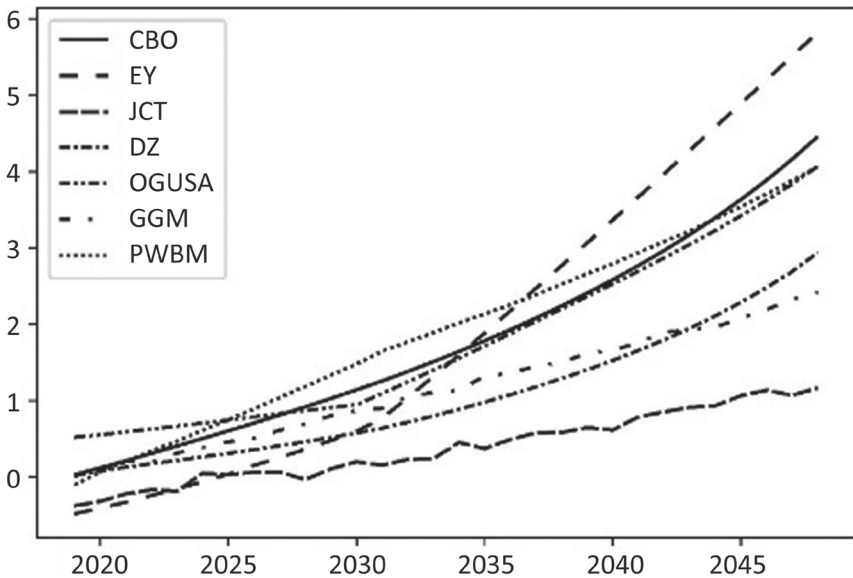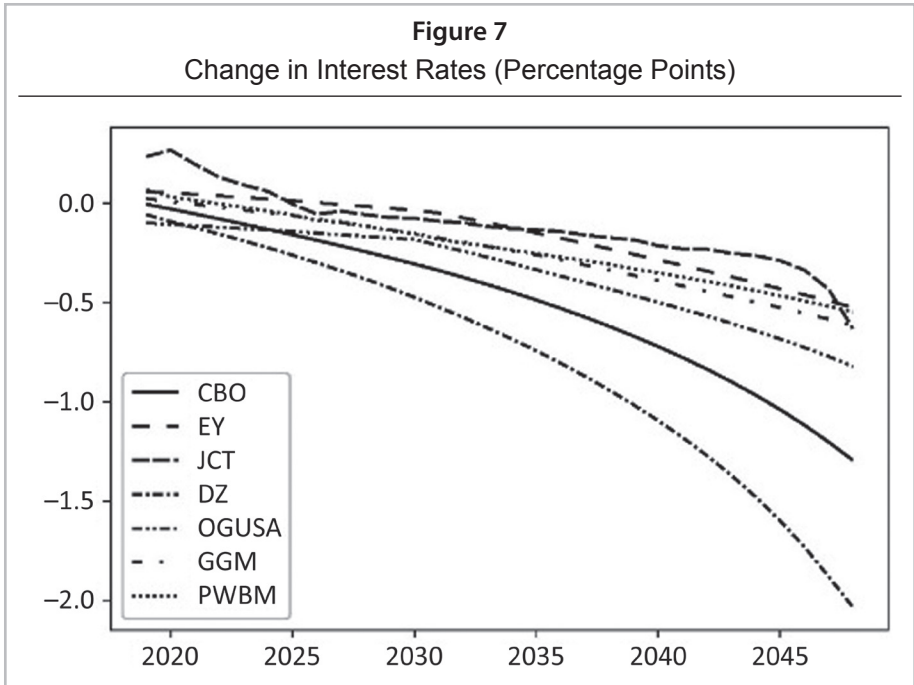Change in Wages (Percent)

Figure 7
Change in Interest Rates (Percentage Points)

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interacts with the rest of the world differs across the models. The GGM allows the U.S. economy to transition from a large open economy to a much smaller open economy as the rest of the world's growth exceeds that of the United States during the projection period. That aspect of the model warrants additional attention.

Including nonstationary demographics appears to have minimal effects on the outcomes of a reduced benefits scenario because demographics are unaffected by the policy change. Similarly — while beyond the scope of this paper — during a round of preliminary analysis, the seven modeling groups found that whether a policy change is anticipated or not appears to make only a small difference in the long run. That is because the response of households to a change in policy 13 years into the future is smooth and modest. However, pre-announcing a policy or not would have important welfare and distributional implications in the short run.

One limitation of models with fully rational and forward-looking households is that the short-run demand effect of a reduction in OASI benefits is modest to nonexistent. The EY QUEST model, which includes a measure of households that are precluded from saving, does find a larger fall in aggregate consumption following the cut in benefits. However, the fall in aggregate consumption occurs while households, in aggregate, increase their labor supply and saving for retirement. These two effects boost GDP in both the short run and long run.

OLG models are often used to analyze households' welfare following a change in policy. We omit that analysis because the welfare of households is affected not only by the cut in benefits but also by the closure rule. That is particularly true for younger

generations and those not yet born. Because we chose nondistortionary government spending as the fiscal offset, any welfare analysis on the effect of a cut in benefits could be difficult to interpret. As nondistortionary government spending only affects households through its impact on government debt, and as the reduction in spending is larger in the benchmark economy relative to the counterfactual economy, households prefer the closure rule under the benchmark economy. In contrast, if payroll taxes (or another form of distortionary tax) were used to stabilize debt in the benchmark, households would generally prefer the closure rule that follows a cut in benefits to the one in the benchmark economy as it would result in a smaller increase in tax rates.

CONCLUSION

This paper analyzed the effects of an anticipated one-third reduction in OASI benefits in 2031 using seven quantitative general-equilibrium OLG models operated by seven different modeling groups. The seven modeling groups coordinated on the design of the policy experiment — including the timing and structure of the closure rule — to determine the budgetary and macroeconomic effects of an OASI benefit reduction. This is the first paper to harmonize a large set of OLG models around a singular Social Security policy reform. The benefit of doing this is that it allowed us to identify the outcomes that were robust and gain insight into the effects of modeling choices on policy outcomes.

Given the wide range of model assumptions, we find a remarkable degree of agreement across models as to the qualitative effects of a reduction in OASI benefits. In nearly every case, our models find that a reduction in OASI benefits in 2031 reduces the debt-to-GDP ratio, aggregate consumption, and interest rates, while increasing the capital stock, aggregate labor supply, GDP, and wages. The magnitude of these effects and their variation along the time path can be attributed to the inclusion (or exclusion) of model features or calibration. In particular, we found that the incorporation of secondary earners, broader firm financing options, and rule-of-thumb consumers significantly affects model results. While we found that nonstationary demographics do not appear to be a key driver, the economy's degree of openness with the rest of the world — and how that openness is modeled — does have a meaningful effect on results. Current and future fiscal policy analyses that use OLG models to inform their work should make use of these features by incorporating them into the next generation of models and taking note of their effect on outcomes.

DISCLAIMERS

The results in this paper are intended solely to show how the models compare with each other. Both the scenario and the closure rule are highly stylized, so none of these results should be interpreted as forecasts or projections by any of the participating agencies for which the analysts work.

For the authors associated with the CBO, this paper has not been subject to CBO's regular review and editing process. The views expressed here should not be interpreted as the CBO's.

The contribution to this paper made by the authors affiliated with the JCT In-House model embodies work undertaken for the staff of the JCT, but as members of both parties and both houses of Congress comprise the JCT, this work should not be construed to represent the position of any member of the Committee.

DISCLOSURES

REFERENCES

Benzell, Seth G., Laurence Kotlikoff, and Guillermo LaGarda, 2017. "Simulating Business Cash Flow Taxation: An Illustration Based on the 'Better Way' Corporate Tax Reform." NBER Working Paper No. w23675. National Bureau of Economic Research, Cambridge, MA.

Conesa, Juan C., and Carlos Garriga, 2008. "Optimal Fiscal Policy in the Design of Social Security Reforms." *International Economic Review* 49 (1), 291–318.

Congressional Budget Office, 2018. *The 2018 Long-Term Budget Outlook*. Congressional Budget Office, Washington, DC, www.cbo.gov/publication/53919.

Congressional Budget Office, 2019. *The 2019 Long-Term Budget Outlook*. Congressional Budget Office, Washington, DC, www.cbo.gov/publication/55331.

DeBacker, Jason M., Richard W. Evans, and Kerk Phillips, 2019. "Integrating Microsimulation Models of Tax Policy into a DGE Macroeconomic Model." *Public Finance Review* 47 (2), 207– 275.

Evans, Richard W., and Jason DeBacker, 2018. "OG-USA: Documentation for the Large-Scale Dynamic General Equilibrium Overlapping Generations Model for U.S. Policy Analysis," www. github.com/open-source-economics/ OG-USA/blob/master/documentation/OGUSAdoc.pdf.

Gravelle, Jane G., and Kent A. Smetters, 2006. "Does the Open Economy Assumption Really Mean That Labor Bears the Burden of a Capital Income Tax?" *Advances in Economic Analysis & Policy* 6 (1).

Hosseini, Roozbeh, and Ali Shourideh, 2019. "Retirement Financing: An Optimal Reform Approach." *Econometrica* 87 (4), 1205–1265.

Imrohoroğlu, Selahattin, and Sagiri Kitao, 2012. "Social Security Reforms: Benefit Claiming, Labor Force Participation, and Long-Run Sustainability." *American Economic Journal: Macroeconomics* 4 (3), 96–127.

Kitao, Sagiri, 2014. "Sustainable Social Security: Four Options." *Review of Economic Dynamics* 17 (4), 756–779.

Kitao, Sagiri, 2018. "Policy Uncertainty and Cost of Delaying Reform: The Case of Aging Japan." *Review of Economic Dynamics* 27, 81–100.

McGrattan, Ellen R., and Edward C. Prescott, 2017. "On Financing Retirement with an Aging Population." *Quantitative Economics* 8 (1), 75–115.

Moore, Rachel, and Brandon Pecoraro, 2018. "Dynamic Scoring: An Assessment of Fiscal Closing Assumptions." Working Paper.

Moore, Rachel, and Brandon Pecoraro, 2019. "Modeling the Internal Revenue Code in a Heterogeneous-Agent Framework: An Application to TCJA." Working Paper.

Moore, Rachel, and Brandon Pecoraro, forthcoming. "Macroeconomic Implications of Modeling the Internal Revenue Code in a Heterogeneous-Agent Framework." *Economic Modeling*.

Nishiyama, Shinichi, and Felix Reichling, 2015. "The Costs to Different Generations of Policies That Close the Fiscal Gap." CBO Working Paper No. 2015-10. Congressional Budget Office, Washington, DC, www.cbo.gov/publication/51097.

Pizzola, Brandon, Robert Carroll, and James Mackie, 2018. *Analyzing the Macroeconomic Impacts of the Tax Cuts and Jobs Act on the US Economy and Key Industries*. EY, London, UK, https://tinyurl.com/y4fpbjgf.

PWBM, 2018. "Penn Wharton Budget Model: Dynamic OLG Model." PWBM Working Paper. Penn Wharton Budget Model, Philadelphia, PA, www.budgetmodel.wharton.upenn.edu/dynamic-olg/.

Zodrow, George R., and John W. Diamond, 2013. "Handbook of Computable General Equilibrium Modeling." In Dixon, Peter B., and Dale Jorgenson (eds.), *Dynamic Overlapping Generations Computable General Equilibrium Models and the Analysis of Tax Policy: The Diamond–Zodrow Model*, vol. 1, pp. 743–813. Elsevier, Amsterdam, NL.