OVERVIEW OF JOINT COMMITTEE MACROECONOMIC MODELING

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of the
JOINT COMMITTEE ON TAXATION

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INTRODUCTION

One of the responsibilities of the staff of the Joint Committee on Taxation ("Joint Committee staff") is providing the Congress with estimates of the budgetary impacts of proposed tax legislation. In providing conventional estimates, the Joint Committee staff (consistent with analysts at the Congressional Budget Office and the Office of Tax Analysis of the U.S. Department of the Treasury) follows the long-standing scorekeeping convention that a proposal does not change total income. Within this modeling framework, the Joint Committee staff holds gross national product ("GNP") fixed. Under House Rule XIII(8)(b) and similarly in section 5107 of the Concurrent Resolution on the Budget for Fiscal Year 2018, the Congress asks for budgetary impacts that reflect changes in macroeconomic growth that may be estimated to result from proposed policy changes that are deemed "major legislation."[1] This document presents an overview of the models that the Joint Committee staff uses to prepare macroeconomic analysis of proposed changes in tax policy.[2]

In May 2017, the National Tax Association ("NTA") invited two think tanks and the staff of the Joint Committee to participate in a panel discussion as part of the annual spring symposium of the NTA ("NTA Symposium"). This panel presented broad overviews of the macroeconomic modeling of proposed changes in tax policies undertaken by the respective organizations. The NTA subsequently published the material presented at that NTA symposium in the *National Tax Journal*.[3] In an effort to reach a broader audience, in this report the Joint Committee staff reproduces and augments the material presented at that the NTA symposium.

The Joint Committee staff welcomes comments from interested readers who have studied modeling of the Federal tax system.[4]

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[1] "Major legislation" is generally defined as any legislation that results in a gross budget effect (as conventionally estimated) of at least a quarter percent of Gross Domestic Product in any year of the budget period.

[2] This document may be cited as follows: Joint Committee on Taxation, *Overview of Joint Committee Macroeconomic Modeling* (JCX-33-18), April 23, 2018. This document can be found on the Joint Committee on Taxation website at www.jct.gov.

[3] See, Alan J. Auerbach and Itai Grinberg, "Macroreconomic Modeling of Tax Policy: A Comparison of Current Methodologies," *National Tax Journal*, vol. 70, December 2017, pp. 818-835. The other organizations presenting their models at the NTA Spring Symposium were the Tax Policy Center and the Tax Foundation. The published Auerbach and Grinberg article provides descriptive material from those two organizations comparable to that reported here by the Joint Committee staff.

[4] Direct comments to Chief of Staff, Thomas A. Barthold, Joint Committee on Taxation, 502 Ford House Office Building, Washington, D.C. 20515-6453.

A. The Joint Committee Staff's Three Macroeconomic Models

Modeling the macroeconomic consequences of tax law requires grappling with two very difficult features of economic and tax policy modeling. First, economic models used for the analysis must be sufficiently nuanced to deal with the most important aspects of our highly complex tax law and proposed changes to it. Second, while there is a reasonable degree of common understanding among economists about the basic building blocks of economic behavior, there is less unanimity when it comes to characterizing how these building blocks should be aggregated to predict whole-economy responses to policies affecting decision-making of individuals. To address the first concern, the Joint Committee staff makes use of a number of separate models that have been developed and refined over a long period for the purpose of producing conventional revenue estimates.[5] To address the second, the Joint Committee staff has developed a modeling capacity with three types of macroeconomic models to inform our macroeconomic analysis of tax policy proposals. This approach enables the Joint Committee on Taxation to get a better idea of the range of possible modeling outcomes, as well as to explore the sensitivity of results to modeling frameworks and parameter assumptions.

Given its role in the tax policy process, the Joint Committee staff has focused on ensuring that the details of proposed changes to tax policy are represented as faithfully as possible in modeling their macroeconomic effects. This effort starts with maximizing the information about the policy provided by conventional estimates. An array of tax models, including separate modeling of the individual income tax, the corporate tax, taxation of pass-through entities, taxation of foreign activity of U.S. multinationals, and a number of other, smaller taxes, are brought into play in producing conventional estimates. Of course, the level of detail in these models cannot tractably be included in models that are designed to represent the general equilibrium interactions of consumers, producers, workers, and investors in various sectors of an economy — at least not within the short-run timeframe required for producing analysis in time for legislative consideration. Any macroeconomic model used by the Joint Committee staff necessarily requires significant simplifying assumptions about the economy and the tax sectors in it. Because all economic models make simplifying assumptions, no one specific model will automatically be ideally configured to analyze each future policy proposal. The three different macroeconomic models used by the Joint Committee staff differ in which sectors are simplified as well as in other modeling respects.

The three models that the Joint Committee staff uses are the Joint Committee staff Macroeconomic Equilibrium Growth model (MEG), an Overlapping Generations model (OLG),[6]

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[5] Conventional revenue estimates incorporate many microeconomic behavioral responses, including shifting transactions over time and between sectors in response to tax policy changes. See Joint Committee on Taxation, *Summary of Economic Models and Estimating Practices of the Staff of the Joint Committee on Taxation* (JCX-46-11), September 19, 2011, for more information on conventional estimating by the Joint Committee staff.

[6] The OLG model currently used by the Joint Committee staff is leased from Tax Policy Advisors, LLC.   See Diamond, John W. and George Zodrow, "Dynamic Overlapping Generations CGE Models and the Analysis of Tax Policy: The Diamond-Zodrow Model," in *Handbook of Computer General Equilibrium Modeling*, Peter B. Dixon and Dale W. Jorgenson (Eds.), Elsevier Publishing, 2013, pp. 743-813, for a description of this class

and the Joint Committee staff Dynamic Stochastic General Equilibrium model (DSGE). All three models start with the standard, neoclassical production framework in which the amount of output is determined by the quantity of labor and capital used by firms, and the productivity of those factors of production; and, long-run aggregate demand equals aggregate supply at full employment. Both individuals and firms are assumed to make decisions based on observed characteristics of the economy, including wages, prices, interest rates, tax rates, and government spending levels. In particular, the amount of labor available to the economy is affected by individuals' understanding of their after-tax returns to working, which depends on both wage rates and tax rates. Similarly, the amount of capital available to the economy is determined by investors' predictions of after-tax returns to capital, which depend on anticipated gross receipts, costs of factor inputs, and tax rates that affect those factors. The underlying structure of the MEG model relies more on reduced form behavioral response equations, while the OLG and DSGE models incorporate more theoretical microeconomic foundations.

The degree to which the Joint Committee staff relies more heavily on the results of one model versus the others depends on the specifics of the proposal being analyzed. The MEG model, which does not require a fiscal balance assumption, is better suited to analyze proposals that produce large, conventionally estimated deficit effects.[7] This model allows for the modeling of four separate types of labor, and of separate marginal and average tax rates for all major individual and business income tax sources, while the other two models treat average and marginal rates the same for individual income other than wages. The availability of investment capital to firms is determined by individuals' savings response to changes in the after-tax rate of return on investment as well as by foreign capital flows. Also in the MEG model, monetary policy conducted by the Federal Reserve Board is explicitly modeled, with delayed price adjustments to changes in economic conditions allowing for the economy to be temporarily out of equilibrium in response to fiscal and monetary policy. The myopic expectation framework in the MEG model represents the extreme case of no foresight about future economic conditions, in which individuals assume in each period that current economic conditions will persist permanently.

At the other end of the foresight spectrum, in the OLG model, individuals are assumed to make consumption and labor supply decisions to maximize their lifetime well-being given the resources they can foresee will be available to them. They are assumed to have complete information, or "perfect foresight," about economic conditions, such as wages, prices, interest rates, tax rates, and government spending, over their lifetimes. The OLG model represents a class

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of models, and John W. Diamond and George R. Zodrow, *Modeling U.S. and Foreign Multinationals in an OLG-CGE Model*, James A. Baker III Institute for Public Policy of Rice University, 2015. https://www.bakerinstitute.org/media/files/Research/2548a49b/WorkingPaper-Diamond-ModelingMultinationals-120915.pdf.

[7] The other models require a fiscal balance assumption when modeling policies that may cause deficits to grow faster than the growth rate of the economy. The Joint Committee staff attempts to mitigate potential distortions from imposition of a fiscal balance assumption in the OLG model by deferring the implementation of any such assumption. Deferring implementation reduces the present value of the effects of the policy changed imposed to return the deficit to a stable trajectory. Research on the effectiveness of this approach in reducing the impact of the closing assumption within the budget window is ongoing.

of models with "micro-foundations" and life-cycle effects modeled separately for each of a number of "generations" (in this case 55). Taxes on labor affect the decisions of each cohort by impacting the trade-off between consumption and leisure. Individuals substitute between labor and leisure both contemporaneously and over time. The labor leisure trade-off is one aspect of the consumption/savings tradeoff, which is affected by anticipated after-tax returns to savings. Firms' investment decisions respond to the effects of tax policy on the projected future value of the firm. The OLG model includes a more differentiated business sector than the other two models, importantly including a multinational sector through which changes in international capital flows affect the availability of investment capital. Changes in marginal tax rates on firm profits, and changes in the value of deductions for investment affect this future valuation.

The DSGE model allows for some analysis of the effects of uncertainty about future fiscal policy on the modeling outcome, representing a less extreme foresight assumption than either of the other models. Because the uncertainty about future fiscal conditions is eventually resolved as time passes, the DSGE model is closer to the OLG model than to the MEG model on this spectrum. As in the MEG model, the reaction of monetary policy to economic conditions is explicitly modeled. As in the OLG model, individuals make consumption and labor supply decisions to maximize their present discounted value of consumption over time. In the DSGE model there are two types of individuals who make decisions about labor supply and consumption, only one of which has the liquidity to make investment decisions ("savers and non-savers"). The savers supply productive business capital to the economy, and receive income from investment returns. The non-savers, who do not have access to financial markets, are unable to invest. The existence of these two types of individuals allows for some explicit distributional analysis of taxes on capital versus taxes on labor. In addition, the inability of the non-savers to finance consumption through borrowing implies that changes to their transfers and taxes will have direct effects on current period consumption and the current level of output. These features of the DSGE model allow the model to capture real short-run effects of economic policy changes.

<center>**B. Specific Modeling Assumptions**</center>

The moderators of the NTA Symposium posed five specific questions to the panelists regarding modeling decisions incorporated in each of their models. This section reproduces the five questions, including the moderator's motivation for each question, and provides the Joint Committee staff's response to the questions.

1. Long-run budget constraint assumption

> Over the long term, the Federal government may need to make fiscal adjustments not specified in a given proposal in order to maintain some measure of fiscal balance. Such future adjustments are typically irrelevant for traditional modeling approaches. However, for macrodynamic models, particularly for models that incorporate expectations about future fiscal variables, some assumptions regarding these future fiscal adjustments may be needed even to produce short-term forecasts.
>
> Do your model(s) assume long-run fiscal sustainability? In particular, do you incorporate any fiscal changes beyond those specified in the legislation to reflect the government's long-run budget constraint?

<u>Joint Committee staff response</u>

<u>MEG</u>: −Because this model has myopic agents, it can solve for a substantial period of time even when changes in the deficit are growing more quickly than changes in aggregate income. Thus, it is generally not necessary to assume long-run fiscal sustainability to analyze the changes in aggregate income within the typical 10-year budget window, and usually for at least another 10 years beyond that.

<u>OLG</u>: −The policy is simulated as proposed, allowing debt to endogenously grow or shrink, for 10 to 40 years. At the end of this period, the Joint Committee staff phases in adjustments to transfer payments until debt stabilizes and grows at the same rate as aggregate income. Because business capital gets crowded out the larger the debt is allowed to grow, there are policy-dependent limits to how long the closing assumption can be delayed. The Joint Committee staff is currently experimenting with other closing assumptions, such as government spending adjustments.

<u>DSGE</u>: −The closing assumption used depends on the extent of the policy uncertainty faced by individuals within the model. In one specification of policy uncertainty, decision rules are calculated by giving agents 100 percent certainty over the policy as specified in the legislation for the first 2.5 years of the budget window. Every quarter thereafter they apply some small but increasing probability that fiscal policy returns to steady state. Under the simulation, shocks are set to model the policy as-is for the entire 10-year window, and then return to steady state thereafter. Unlike the OLG model, the DSGE model results within the budget window under this specification of policy uncertainty are not sensitive to pushing the closing window past year 10 because agent expectations regarding policy were set during the decision rule stage.

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2. Cross-border profit shifting effects

Models vary in their sophistication about cross-border activities of multinational companies, a complex area of potential taxpayer responses that has taken on increased importance over the years and is central to the evaluation of business tax reform proposals.

Do your model(s) include the effects of tax reform on cross-border shifting of profits and real activities in estimating dynamic changes in tax revenue? If so, do they distinguish between the two types of shifting (that is, changes in the actual scale of U.S. production vs. changes in reported U.S. profits)?

Joint Committee staff response:

Under the fixed GNP convention, the Joint Committee staff's conventional estimates incorporate effects of tax policy changes on the location of reported U.S. profits that are not associated with changes in actual economic activity.

MEG: −Cross-border flows are modeled in the form of changes in imports and exports between the United States and a generic international sector, and associated changes in capital flows. These flows respond to the effects of tax policy on consumption demand and to return on investment. These changes flow through to changes in labor, capital investment, and GDP.

OLG: −This model includes the shifting of both profits and productive capital in response to a change in tax policy. Changes to profit shifting do not have first-order effects on domestic production, as the associated revenue effects from conventional estimates enter the government's budget constraint exogenously (to avoid double counting the conventionally estimated effects). Changes in the location of productive capital, both ordinary and intellectual property, directly affect domestic production in the multinational corporate sector. The degree to which the location of intellectual property matters for production is not generally agreed upon in the literature, therefore the Joint Committee staff often reports results with various intellectual property shifting elasticities.

DSGE: −This is a closed economy model, but revenue from profit shifting can be incorporated as an exogenous revenue component of the government's budget.

3. View of dividend taxation

There is a long-standing controversy in the economics literature about the extent to which different types of capital income taxation affect business investment, and the channels through which such effects occur. There is a particularly large potential range of effects associated with changes in dividend taxation.

In your model(s), how do changes in dividend taxation influence U.S. business investment? In particular, does the dividend tax rate affect the incentive to invest, either through the user cost of capital or through effects of dividend payouts on liquidity?

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Joint Committee staff response:

As described in the introductory section, each of the Joint Committee staff models takes a different approach to modeling the channels through which taxes on capital affect the investment decision. The different approaches effectively dictate the treatment of dividend taxation, which, as the question indicates, is the subject of a substantial amount of uncertainty in economic research. The "traditional view" of dividend taxation is that corporations finance new investment out of new share issuance more readily than out of retained earnings, and thus the taxation of dividends at the shareholder level is an important component of the after-tax return on corporate investment. In an alternate "new view" of corporate finance, corporations finance new investment out of retained earnings rather than new share issuance, and thus the after-tax cost of capital for new corporate investment is not affected by taxation of dividends.[8]

MEG: −Dividend taxation influences U.S. business investment through its effects on the user cost of capital. Within the cost of capital equations in the MEG model, it is possible to adjust the portion of changes in dividend taxation that flows through to the user cost of capital. Generally, the default assumption is about 50 percent.

OLG: −Corporate firms finance their desired quantity of investment from new share issues to households when retained earnings are insufficient. Because dividend payouts to shareholders are assumed to be an exogenous portion of after-tax profits, a change in the tax rate on dividends will alter shareholders' after-tax portfolio return. The implied change in corporate firms' user cost of capital will then influence their desired level of business investment. The strength of this effect will depend on the exogenous dividend payout ratio and leverage ratio parameters, which can be specified as policy-dependent.

DSGE: −Dividends are not modeled explicitly. This kind of policy change would be modeled by a change to the marginal tax rate on capital income, which would affect investment through its effects on savings incentives, as well as revenues.

4. Does the exchange rate affect the economy?

Exchange rate responses are particularly relevant to business tax reforms that influence incentives to import and export, such as the destination-based cash-flow tax. But there is a wide range of potential approaches to modeling exchange rate responses.

Do your model(s) incorporate the effects of tax reform on the dollar exchange rate? If so, how is the exchange rate determined and through what channels does the exchange rate affect the U.S. economy?

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[8] See George Zodrow, "On the 'Traditional' and 'New' Views of Dividend Taxation," *National Tax Journal*, Vol. 44, no. 4, December 1991, pp. 497-509, and Alan J. Auerbach, "Taxation and Corporate Financial Policy," in Alan J. Auerbach and Martin Feldstein (eds.), *Handbook of Public Economics*, volume 3, pp. 1252-1292. Elsevier Science, Amsterdam, Netherlands, for discussions of the different views.

Joint Committee staff response:

MEG: −Exchange rates adjust to achieve purchasing power parity; this adjustment feeds back to changes in the flows of goods, services, and capital. Exchange rate adjustments can be modeled with a lag.

OLG: −As a real model, the OLG does not incorporate the dollar exchange rate. The model maintains purchasing power parity for tradable goods across borders in all periods. This is effectively equivalent to instantaneous exchange rate adjustment.

DSGE: −This is a closed economy model, so there are no exchange rate effects.

5. Combined business sector or separate corporate and pass-thru sectors

As the share of business activity undertaken by companies outside the traditional C corporate sector has grown, so has the importance of considering separately the behavior of different types of business entities. This is especially true when evaluating proposals that treat C corporations and pass-through entities quite differently.

Do your model(s) distinguish separately the investment behavior of pass-through entities and C corporations, or do you model a combined business sector?

Joint Committee staff response:

The revenue effects of shifting in entity form between pass-through entities and C corporations are included in conventional estimates.

MEG: −Pass-through entities and C corporations are modeled as a combined business sector; taxes applied to this sector are a weighted average of corporate and pass-through rates. Housing is modeled as a separate sector. These weights in the baseline are drawn from tax data, and are shifted as indicated by the conventional estimate in simulated proposals.

OLG: −Multinational corporate, domestic corporate, and non-corporate firms are modeled separately, with each firm type making its own investment decisions. Each sector has different tax rates, deductions, and credits, all of which affect investment incentives for the respective sector. In modeling tax policy changes, these tax variables are altered from their baseline values as indicated by the changes produced by conventional estimating models.

DSGE: −This model has a combined business sector; taxes applied to this sector are a weighted average of corporate and pass-through rates. These weights in the baseline are drawn from tax data, and are shifted as indicated by the conventional estimate in simulated proposals.

C. Key Parameters Used in Most Recent Macroeconomic Analysis[9]

The following three tables provide the most recently used numerical values for key behavioral assumptions in each of the Joint Committee staff macroeconomic models. These values govern the strength of responses by individuals and firms in the models to the economic incentives implicit in changes in the tax policies simulated.

As discussed above, individuals generally respond to these incentives through their decisions on how much they are willing to work for a given after-tax wage rate, and on how much they wish to consume or save given their after-tax income and after-tax return to that savings (which is dependent on investment returns). Producers of goods and services make their decisions based on comparing expected after-tax receipts from sales given consumer demand with the after-tax costs of production, given the willingness of individuals to supply labor and capital.

Individual decisions

Labor

In the MEG model, the labor supply decision is governed by substitution and income elasticities, which characterize how strongly individuals respond to changes in the marginal tax rate on wages and the average tax rate on personal income, respectively. In particular, the term "substitution elasticity" refers to an individual's willingness to substitute labor for leisure, given the change in the after-tax return to working that occurs as a result of changes in the marginal tax rate on wages. The term "income elasticity" refers to an individual's willingness to supply additional labor given the change in his disposable income (buying power) as a result of changes in average taxes on his income. Generally, a reduction in marginal tax rates on wages is expected to provide an incentive for increased willingness to work by increasing the marginal return to labor, while a reduction in average tax rates on income is expected to provide an incentive for reduced willingness to work by increasing disposable income reaped from a given amount of work. Thus, a simple reduction in the statutory tax rate on wage income can provide competing incentive effects through the income and substitution elasticities. As Table 1 below shows, the substitution elasticity in MEG is higher than the income elasticity overall. The consumption/savings parameters for the MEG model is described in the next section.

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[9] The most recent analyses as of the date of this publication are those provided along with the "dynamic revenue estimates" of the Conference, House, and Senate versions of Public Law no. 115-97, "To provide for reconciliation pursuant to titles II and V of the concurrent resolution on the budget for fiscal year 2018": Joint Committee on Taxation, *Macroeconomic Analysis of the Conference Agreement for H.R. 1, The "Tax Cuts and Jobs Act"* (JCX-69-17), December 22, 2017; Joint Committee on Taxation, *Macroeconomic Analysis of the "Tax Cuts and Jobs Act" as passed by the House of Representatives on November 16, 2017* (JCX-66-17), December 11, 2017; and, Joint Committee on Taxation, *Macroeconomic Analysis of the "Tax Cut and Jobs Act" as Ordered Reported by the Senate Committee on Finance on November 16, 2017* (JCS-61-17), November 30, 2017. See the macroeconomics section on the Joint Committee on Taxation website for links to macroeconomic analyses published by the Joint Committee Staff: https://www.jct.gov/publications.html?func=select&id=4.

Additional behavioral parameters for the OLG and DSGE models are shown in Tables 2 and 3 respectively. The aspect of the labor/leisure decision in these models that is conceptually most similar to the MEG model is the intratemporal substitution elasticity. The OLG model specifies an intratemporal elasticity that determines the extent to which consumers alter the consumption-leisure combination chosen within any given period in response to changes in the relative price of their time (wage rate) to the price of consumption. In the DSGE model, the utility function is configured such that intratemporal substitution varies with the overall changes in the economy.

For the OLG model, the amount of labor that can be supplied any given year depends on the total amount of time available for a potential worker. On the other hand, in the DSGE model the Frisch elasticity primarily governs the amount of labor supplied in any given period independent of the total amount of time available for a potential worker.

In the OLG and DSGE models, the labor supply decision is also explicitly integrated with the consumption/savings decision, which is governed in part by the rate of time preference. This parameter helps determine the willingness of consumers to trade current consumption or leisure in exchange for respective future quantities by specifying their relative value. This parameter helps determine the willingness of consumers to put off current consumption or leisure in exchange for future enjoyment.

Savings/Consumption

In all three models, the choice individuals make with respect to saving versus consumption in a given period is characterized as a choice about intertemporal substitution. This parameter helps determine the willingness of consumers to trade current consumption or leisure in exchange for future consumption or leisure by specifying their relative value. The elasticity of intertemporal substitution determines the responsiveness of the inverse relationship between consumption and the real interest rate, with higher values implying larger changes in consumption following a given change to the interest rate.

The coefficient of relative risk aversion parameter in DSGE is related to OLG's intertemporal substitution elasticity in that is describes how willing the consumer is to shift consumption over time. Aggregate risk is an additional feature in the DSGE model; this parameter also describes the consumer's aversion to this risk which could cause deviations from planned consumption patterns. Also in the DSGE model, the extent to which investment is affected by policy changes also depends on the ratio of the population that has access to financial markets, allowing them to borrow and save.

Production decisions

The DSGE and MEG models have two production sectors: business and housing, while the OLG model has corporate, multinational corporate, and non-corporate sectors, in addition to housing. The capital share parameter determines how capital intensive production will be for a given factor price ratio, with labor as the other factor of production. In OLG, intellectual property is also a factor of production, which leads to a smaller physical capital share, especially for the multinational sector. In MEG, intellectual property is included in physical capital,

leading to a larger capital share. Because production is Cobb-Douglas in all three models, the substitution elasticity for the factors of production is unity and therefore not reported in the tables.

Table 1.−Key Parameters in the MEG Model

Household		**Income**	**Substitution**
Labor Supply Elasticities			
Low income primary		-0.1	0.2
Other primary		-0.1	0.1
Low income secondary		-0.3	0.8
Other secondary		-0.2	0.6
Wage-weighted population average		-0.1	0.2
Savings			
Annual rate of time preference	0.015		
Intertemporal elasticity of substitution	0.350		
Production			
Business capital share	0.412		

Table 2.−Key Parameters in the OLG Model

Household	
Annual rate of time preference	0.005
Intertemporal elasticity of substitution	0.400
Intratemporal elasticity of substitution	0.600
Leisure share of time endowment	0.403
Production	
Capital share	
Corporate	0.200
Multinational (not including IP)	0.150
Non-corporate	0.300
Housing	0.985

Table 3.−Key Parameters in the DGGE Model

Household	
Annual rate of time preference	0.010
Intertemporal elasticity of substitution	0.465
Frisch elasticity of labor supply	0.200
Fraction of non-Ricardians	0.480
Production	
Capital share	
Business	0.360
Housing	0.360