Calibration of the OLG Dynamic Scoring Model

Authors here*

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Abstract

This note outlines the parameters of the model, how they will be calibrated, and the data used to do so.

1 Parameters of the model

Tables 1 and 2 outline the parameters of the demand side and supply sides of the model, respectively.

Table 1: Model Parameters, Demand Side

Parameter	Description
Consumer Preferences	
σ	Coefficient of relative risk aversion
η	Frisch elasticity of labor supply
$\chi_{n,s}$	Age specific utility weight for labor supply
χ_b	Utility weight of bequest in year $S+E$
β	Rate of time preference
Population Dynamics	
E	Age enter economic life
S	Maximum number of years of economic life
f_s	Age specific fertility rate
i_s	Age specific net immigration rate
ρ_s	Age specific mortality rate
N_0	Initial population
$w_{s,0}$	Initial distribution of ages
Labor Supply/Ability	
J	Number of permanent ability types
λ_j	Fraction born into each ability type
$\tilde{l}$	Labor time endowment
Composite Consumption	
I	Number of consumption goods
$b_{i,s}$	Minimum required consumption of good i at age s
$\beta_{i,s}$	Stone-Geary share parameter of good i at age s
Z	"Transition" matrix relating outputs from firms to consumption goods (dimesions are $I \times M$)
γ_m	Preference weight for corporate good from industry m in CES function
ε_C	Elasticity of substitution between corporate and non-corporate outputs in CES function.

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Table 2: Model Parameters, Supply Side

Parameter	Description
Production Function	
γ_m^C	Capital weighting in CES production function
ϵ_m^C	Elasticity of substitution of capital for labor in CES production function
δ_m^C	Rate of economic depreciation on capital stock in the corporate sector
β_m^C	Scaling parameter for quadratic investment adjustment costs
μ_m^C	Steady-state investment rate
Economic Growth	
n	Rate of population growth (exogenous and implied by fertility, mortality, and net immigration rates)
g_y	Rate of labor augmenting productivity growth (exogenous)
Financial Policy	
ζ_m^C	Fraction of earnings paid out in dividends
b_m^C	Debt/Capital ratio
Tax Policy	
τ_s^b	Corporate business income tax rate
$\delta_{m,s}^{\tau C}$	Rate of tax depreciation on corporate capital
τ_s^{pC}	Property tax rate on corporate capital
τ_s^i	Individual income tax rate on interest income
τ_s^g	Individual income tax rate on capital gains
f_e	Dummy variable for full expensing of investment
f_i	Dummy variable for deductibility of corporate interest paid
f_p	Dummy variable for deductibility of repayment of principle on loans
f_b	Dummy variable for inclusion of proceeds of loan in corp income tax base
f_d	Dummy variable for deductibility of depreciation expenses
Population of firms	
M	Number of industries
Ω	"Transition" matrix relating output os firms to the supply of new capital (dimensions are $M \times M$)
Multi-nationals	
TBD	Will need to parameterize the share of MNCs, the amount of profits overseas, the elasticity of profit shifting w.r.t. tax rates, foreign tax rates, and more

In addition, there are other parameters of fiscal and monetary policy that need to be modeled (outside of the tax rates noted in the tables above). Table **??** summarizes these.

Table 3: Model Parameters, Fiscal and Monetary Policies

Parameter	Description	Calibration
μ	Gov't debt to GDP response rate Parametrizes gov't adjustments to spending to return to constant debt to GDP ratio in steady state.	Estimate gov't response function using data on debt to gdp ratio and gdp
$\bar{d}$	User supplied parameter for gov't debt to GDP ratio in SS (may also be model implied based on tax policy chosen)	User set
$T(\cdot,\cdot,\cdot)$	Individual net tax function. A function of labor and capital income, perhaps age.	Micro-sim model
Monetary Policy	Fed reaction function	Unclear - likely do several cases.

Finally, we have to choose parameters relating to the model solution algorithm. These are summarized in Table 4.

Table 4: Model Parameters, Solution Algorithm

Parameter	Description	Value
T	Number of periods until economy converges to steady state	120
ν	Dampening parameter for TPI	0.2

2 Calibrating the Demand Side

Equations and data used to calibrate the demand sides are summarized in Table 5.

Table 5: Calibration, Demand Side of Model

Parameter	Calibration	Data
Consumer Preferences		
σ	Set using standard values from lit (e.g., $\sigma = 1.5$)	
η	Set using standard values from lit (e.g., $\eta = 2$?	
$\chi_{n,s}$		Wages and hours by age? CPS?
χ_b	$\chi_b = \frac{c_{E+s}}{bq_{E+S}}$	Data avg consumption and bequest in last year of life (use ages 80-100?)
β	$\frac{1}{\beta} = 1 + (1-\tau_i)\bar{r}$	Data on after tax real interest rates
Population Dynamics		
E	Set to 20	
S	Set to 80	
f_s	Fraction having children by age	US vital stats
i_s	Residual from pop change given f_s and ρ_s	
ρ_s	Fraction dying by age	US vital stats
N_0	Set based on population in base year	
$w_{s,0}$	Set based on population in base year	
Labor Supply/Ability		
J	Set to 12	
λ_j	So that steady state distribution	
$\tilde{l}$	Set to some max usable hours in a year (e.g. 4000)	
Composite Consumption		
I	Set to 17	
$b_{i,s}$	See Fullerton and Rogers (1983)	Consumption data by age and consumption good category.
$\beta_{i,s}$	See Fullerton and Rogers (1983)	Consumption data by age and consumption good category.
Z	See Fullerton and Rogers (1983)	
γ_m	Fraction of corp output by industry	Data on output by corp/non-corp and industry
ε_C	See Fullerton and Rogers (1983)	Data on output by corp/non-corp and industry

The composite consumption good for each individual will be made up goods from the I consumption categories according to a Stone-Geary utility function. This function will result in individuals with different incomes and ages consuming different fractions of the consumption goods. Thus, we are better able to model the incidence of consumption taxes and income taxes that differentially affect the prices of consumer goods. Table 6 summarizes the consumption good categories we consider.

Table 6: Consumption Goods Categories

#	Consumption Good Category
1	Food
2	Alcohol
3	Tobacco
4	Household fuels and utilities
5	Shelter
6	Furnishings
7	Appliances
8	Apparel
9	Public transportation
10	New and used cars, fees, and maintenance
11	Cash contributions and personal care (personal services)
12	Financial services
13	Reading and entertainment (recreation)
14	Household operations (nondurables)
15	Gasoline and motor oil
16	Health care
17	Education

Note that these categories do not map directly into the production sectors described in Section 3. To map production goods into consumption goods we use a fixed coefficient model summarized by the "transition matrix" Z. Furthermore, individuals have preferences over the consumption of the same types of goods from both the corporate and non-corporate sectors. Consumer preferences across sectors are summarized by a Constant Elasticity of Substitution (CES) utility function, the parameters of which we estimate.

The calibration of the parameters of the composite consumption good is outlined in Fullerton and Rogers (1993). The process of estimating the parameters of the the CES function for preferences over corporate and non-corporate goods and for estimating the parameters of the Stone-Geary function describing preferences over goods from different consumption categories should be directly analogous (with differences being the number of industries considered and the vintage of the data used).

3 Supply Side Calibration

Equations and data used to calibrate the demand sides are summarized in Table 5. Many of the parameters must be found for each industry, m, and sector $C \in \{\text{Corporate, Noncorporate}\}$.

Table 7: Calibration, Supply Side of Model

Parameter	Calibration	Data
Production Function		
γ_m^C	Need capital and labor shares by industry/sector	BEA national accounts data?
ϵ_m^C	??	
δ_m^C	Weight avg of depreciation rates by capital type, amount of capital by type by industry/sector	BEA estimated deprec rates, BEA capital stock data
β_m^C	??	
μ_m^C	A function of g_y, n, and δ_m^C	
Economic Growth		
n	Implied by f_s, i_s, and ρ_s	
g_y	Avg GDP growth rate?	
Financial Policy		
ζ_m^C	Dividend payout ratio by industry	
b_m^C	$b_m^C = \frac{B_m^C}{K_m^C}$	Total debt and capital by industry, Flow of Funds and BEA cap stock
Tax Policy		
τ_s^b	Top statutory corp rate, Avg marginal rate for owners of non-corp entities (from micro sim model?)	
$\delta_{m,s}^{\tau C}$	Weighted avg of tax deprecation rates by capital type	Amount of capital by type by industry/sector, mapped to tax deprecation r
τ_s^{pC}	User set??	
τ_s^i	Use marginal tax rate of the median individual with interest income	
τ_s^g	Use marginal tax rate of the median individual with capital gains income	
f_e	User set	
f_i	User set	
f_p	User set	
f_b	User set	
f_d	User set	
Population of firms		
M	Set to 24	NAICS Classification Codes
Ω		BEA Input-Output Tables

Note that the exogenous dividend payout ratio, ζ^C_m, will only apply to the corporate sector. Non-corporate entities may not retain earnings so payout all earnings not immediately reinvested.

"Capital type" is not really clear. Probably the best thing to do is to look at the BEA classification of asset types (which is very detailed) and try to map that to the various asset lives used for tax policy. This should be detailed enough for use when calculating economic depreciation and will be very useful when calculating the tax deprecation rates by sector and industry. There are two options to make this mapping: 1) Find the economic life of the asset as determined by the BEA and then assign that a tax type that has a similar (but shorter, since tax depreciation is accelerated) depreciable life. or 2) Use the asset type descriptions from BEA and then map that into the assets descriptions for the various asset types used in tax (see the Form 4562 instructions: http://www.irs.gov/pub/irs-pdf/i4562.pdf). We also have to be careful that we don't just consider assets of the type of Form 4562 (http://www.irs.gov/pub/irs-pdf/f4562.pdf), but also consider assets that received immediate expensing for tax purposes (like intangibles) and inventories.

To get the economic deprecation rate by industry and sector, we'll take a weighted average. Assume there are I types of capital. We use the depreciation rate for each of those I types find the weighted average where the weights are determined by the amount of capital of each type. Thus the economic depreciation rate for capital in sector C in industry m can be give by:

$$\delta^C_m = \sum_{i=1} I \delta_i \frac{K^C_{i,m}}{K^C_m}, \tag{3.1}$$

where $K^C_{i,m}$ is the amount of capital of type i in sector C in industry m and K^C_m is the total amount of capital in sector C in industry m. Economics depreciation rates, δ_i will be found through the BEA's estimated depreciation rates by asset type. The tax rate of depreciations will be calculated analogously:

$$\delta^{\tau C}_m = \sum_{i=1} I \delta^{\tau C}_i \frac{K^C_{i,m}}{K^C_m}, \tag{3.2}$$

where $\delta^{\tau C}_i$ is the tax depreciation rate of capital of type i and is given by tax law.

Table 8 summarizes the production industries we consider.[1]

sectionSummary of data sources

These are mostly just for the data we do not yet have together/parameters not yet calibrated.

- Consumption: Consumer Expenditure Survey (CEX) (for as many years as possible)
  - Consumption by category and age
  - Use categories in Table 6 or finer categories that can be aggregated up
- Production: BEA: National Account Data (?) (for as many years as possible)
  - Output by sector (corporate and non-corporate) and industry

[1]This excludes the multi-national sector, which we still need to think about.

Table 8: Production Industries

#	NAICS Code	Industry
1	11	Agriculture, Forestry, Fishing and Hunting
2	211	Oil and Gas Extraction
3	212 and 213	Mining and Support Activities for Mining
4	22	Utilities
5	23	Construction
6	32411	Petroleum Refineries
7	336	Transportation Equipment Manufacturing
8	3391	Medical Equipment and Supplies Manufacturing
9	Other codes in 31-33	Manufacturing
10	42	Wholesale Trade
11	44-45	Retail Trade
12	48-49	Transportation and Warehousing
13	51	Information
14	52	Finance and Insurance
15	53	Real Estate and Rental and Leasing
16	54	Professional, Scientific, and Technical Services
17	55	Management of Companies and Enterprises
18	56	Administrative and Support and Waste Management and Remediation Services
19	61	Educational Services
20	62	Health Care and Social Assistance
21	71	Arts, Entertainment, and Recreation
22	72	Accommodation and Food Services
23	81	Other Services (except Public Administration)
24	92	Public Administration

  - Capital by sector and industry and capital type
  - Investment by sector and industry
  - Income shares by sector and industry
    * Payments to capital (Dividends and interest income) (may need Flow of Funds data)
    * Payments to labor (wages, salaries, benefits) (may need Flow of Funds data)
  - Use industries as in Table 8 or finer industries groupings that can be aggregated up

- Economic Depreciation: BEA Estimated Depreciation Rates (http://www.bea.gov/national/pdf/fixed%20assets/BEA_depreciation_2013.pdf)

- Mapping production output from each sector to capital type by sector: BEA Input-Output Tables (?) (http://www.bea.gov/industry/io_annual.htm)
  - Latest tables are probably fine.

- Firm financial policy: Flow of Funds Data (for as many years as possible)
  - Earnings by sector and industry
  - Dividends paid by corp sector by industry
  - Debt held by sector and industry

- Disutility of labor: Current Population Survey (CPS) March Supplement (for as many years as possible)

- Hours and wages by age
- Note: This is already calibrated, but we might want to think about the parameter further

- Mapping output of each production sector to categories of consumption goods: Survey of Current Business, "Make and Use Tables"
  - Latest tables are probably fine.
- Bequests: Data???
  - Not sure of data.
  - Survey of Consumer Finances? Estate Tax Returns? Other?
  - Might want to do a lit review here.

4 Useful references

Fullerton and Rogers (1993) outline in great detail the calibration of the composite consumption preference parameters. They also outline a process for determining the transition matrix that can be used to map production output to the new capital available for investment.

Temple (2012) and Klump, McAdam and Willman (2012) describe the calibration of CES functions generally.

References

Fullerton, Don and Diane Lim Rogers, *Who Bears the Lifetime Tax Burden?*, The Brookings Institution, 1993.

Klump, Rainer, Peter McAdam, and Alpo Willman, "The Normalized Ces Production Function: Theory And Empirics," *Journal of Economic Surveys*, December 2012, *26* (5), 769–799.

Temple, Jonathan, "The calibration of CES production functions," *Journal of Macroeconomics*, 2012, *34* (2), 294–303.