Equation List of The Model
(equilibrium condition)

(001) A growth =
    \( \text{Av alpha chg} \times \ln(\text{Capital labor ratio}/\text{Capital labor ratio initial}) \times 100 \)
Units: Percent/Year

(002) Adjusted labor force =
    \( \text{Labor force} \times (1 - \text{Minimum unemployment rate}) \)
Units: Person

(003) Aggregate demand =
    \( \text{Final sales} + \text{Desired inventory investment} \)
Units: Unit/Year

(004) Alpha =
    \( \text{Capital output ratio} \times ((1/\text{Life of capital}) + \text{Interest rate}) \)
Units: Dmnl

(005) Alpha growth =
    \( \text{Av alpha chg}/\text{Alpha} \)
Units: 1/Year

(006) Alpha initial =
    0.25
Units: Dmnl

(007) Av alpha chg =
    \( (\text{Alpha} - \text{Average alpha})/\text{Time to average alpha} \)
Units: 1/Year

(008) Average alpha =
    \( \text{INTEG} (\text{Av alpha chg}, \text{Alpha initial}) \)
Units: Dmnl

(009) Average demand =
    \( \text{INTEG} (\text{Avr demand chg}, \text{Initial production}) \)
Units: Unit/Year

(010) Average production =
    \( \text{INTEG} (\text{Prod chg}, \text{Initial production}) \)
Units: Unit/Year

(011) Average wage =
    \( \text{INTEG} (\text{Avr wage chg}, \text{Wage}) \)
Units: Unit/(Year*Person)
(012) Avr demand chg =
\[(\text{Aggregate demand-Average demand})/\text{Time to establish trend in demand}\]
Units: Unit/(Year*Year)

(013) Avr wage chg =
\[(\text{Wage-Average wage})/\text{Trend time of productivity growth}\]
Units: Unit/(Year*Person)/Year

(014) Capacity utilization =
0.5
Units: Dmnl

(015) Capital =
\[\text{INTEG (Investment-Depreciation, Initial capital)}\]
Units: Unit

(016) Capital growth =
\[\{(\text{Investment-Depreciation}/\text{Capital})*100\}\]
Units: Percent/Year

(017) Capital labor ratio =
\[\text{Capital/Labor}\]
Units: Unit/Person

(018) Capital labor ratio growth =
\[\text{Technology growth}\]
Units: Percent/Year

(019) Capital labor ratio initial =
\[\text{Initial capital/Initial labor}\]
Units: Unit/Person

(020) Capital output ratio =
\[\text{Initial capital/Initial production}\]
Units: Year

(021) Change from labor availability =
\[\text{WITH LOOKUP (Relative labor availability, }\]
\[\{(0,-0.1)-(2,0.12),(0,-0.1),(0.25,-0.09),(0.5,-0.07),(0.75,-0.04),(1,0),(1.25,0.04),(1.5,0.075),(1.75,0.1),(2,0.12)\}\]
Units: 1/Year

(022) Change from productivity =
\[\text{Avr wage chg/Average wage}\]
Units: 1/Year
(023) Consumption=
\[ \text{Desired consumption} \times \text{Effect inventory} \]
Units: Unit/Year

(024) Consumption per capita=
\[ \text{Consumption per capita initial} \times \text{Effect income on consumption per capita} \]
Units: Unit/(Year*Person)

(025) Consumption per capita initial=
\[ \text{Propensity to consume} \times \text{Initial permanent income/Initial population} \]
Units: Unit/Year/Person

(026) Correction for growth in desired production=
\[ \text{Perceived growth in demand} \times \text{Time to smooth SRD} \times \text{Shortrun demand} \]
Units: Unit/Year

(027) Correction to desired production =
\[ \text{WITH LOOKUP (Correction for growth in desired production/Shortrun demand,} \]
\[ ((-3,0),(-4,3),(-3,0.01),(-2,0.2),(1,0.5),(0,1),(1,2),(2,2.5), \]
\[ (3,2.8),(4,3)) ) \]
Units: Dmnl

(028) Current disposable income=
\[ \text{Production} - \text{Taxes} \]
Units: Unit/Year

(029) Depreciation=
\[ \text{Capital/Life of capital} \]
Units: Unit/Year

(030) Desired capital=
\[ \text{Alpha} \times \text{Longrun demand} / ((1/Life of capital) + \text{Interest rate}) \]
Units: Unit

(031) Desired consumption=
\[ \text{MIN(Desired consumption from population, Desired consumption from income)} \]
Units: Unit/Year

(032) Desired consumption from income=
\[ \text{Propensity to consume} \times \text{Permanent income} \]
Units: Unit/Year

(033) Desired consumption from population=
\[ \text{Population} \times \text{Consumption per capita} \]
Units: Unit/Year
(034) Desired government spending = 
   GS fraction * Production 
   Units: Unit/Year

(035) Desired inventory = 
   Inventory coverage * Shortrun demand 
   Units: Unit

(036) Desired inventory investment = 
   MAX(0, (Desired inventory - Inventory) / Time to adjust inventory) 
   Units: Unit/Year

(037) Desired investment = 
   Depreciation + (Desired capital - Capital) / Time to adjust capital 
   Units: Unit/Year

(038) Desired labor = 
   MIN(Indicated desired labor, Adjusted labor force) 
   Units: Person

(039) Desired production = 
   Shortrun demand * Correction to desired production 
   Units: Unit/Year

(040) Economic growth = 
   Alpha * Capital growth + (1 - Alpha) * Labor growth + A growth 
   Units: Percent/Year

(041) Effect income on consumption per capita = 
   WITH LOOKUP (Production per capita average / Production per capita initial, 
   \[(0.0,0.0)-(5.5,5.0)\], \[(0.0,0.5),(0.5,0.66),(1.1,1.169),(2.2,2.65),
   (2.5,3.46),(3.3,99),(3.5,4.36),(4.63),(4.5,4.85),(5.5,5.0)\]) 
   Units: Dmnl

(042) Effect inventory = 
   WITH LOOKUP (Inventory availability, 
   \[(0.0,0.0)-(1.1,1.1)\], \[(0.0,0.025),(0.2,0.32),(0.3,0.64),(0.4,0.75),
   (0.5,0.84),(0.6,0.9),(0.7,0.96),(0.8,0.99),(0.9,1.1)\]) 
   Units: Dmnl

(043) Effect of desired labor on fire time = 
   WITH LOOKUP (Desired labor / Labor, 
   \[(0.0,0.0)-(2.3,2.3)\], \[(0.0,0.25),(0.2,0.3),(0.4,0.39),(0.6,0.53),(0.8,0.7),
   (1.1),(1.2,1.51),(1.4,2.29),(1.6,2.71),(1.8,2.91),(2.3)\]) 
   Units: Dmnl
Effect of desired labor on hire time =
    WITH LOOKUP (Desired labor/Labor,
        ([(0,0)(2,2)],(0,2),(0.2,1.93),(0.4,1.81),(0.6,1.68),(0.8,1.46),
        (1,1),(1.2,0.77),(1.4,0.64),(1.6,0.58),(1.8,0.54),(2,0.5) ))
    Units: Dmnl

Final sales=
    Consumption+Government spending GS+Investment
    Units: Unit/Year

FINAL TIME = 350
    Units: Year
    The final time for the simulation.

Fire=
    Labor/Fire time
    Units: Person/Year

Fire time=
    Fire time normal*Effect of desired labor on fire time
    Units: Year

Fire time normal=
    19
    Units: Year

Fractional change in wage=
    Change from productivity+Change from labor availability
    Units: 1/Year

Government spending GS=
    Desired government spending*Effect inventory
    Units: Unit/Year

Growth of A=
    Capital output ratio*(Wage/Capital labor ratio)*LN(Capital labor
    ratio/Capital labor ratio initial)*
    ((Capital labor ratio growth/100)-(Wage growth/100))*100
    Units: Percent/Year

GS fraction=
    Initial GS fraction+STEP(GS fraction increase, GS increase start time)
    Units: Dmnl

GS fraction increase=
    0
    Units: Dmnl
(055) GS increase start time=
    1000
    Units: Year

(056) Hire=
    Unemployment/Hire time
    Units: Person/Year

(057) Hire time=
    Hire time normal*Effect of desired labor on hire time
    Units: Year

(058) Hire time normal=
    1
    Units: Year

(059) Indicated desired labor=
    (1-Alpha)*Shortrun demand/Wage
    Units: Person

(060) Indicated life of capital=
    Initial life of capital-STEP(Initial life of capital-Minimum life of capital,Innovation start time)
    Units: Year

(061) Initial capital=
    Alpha initial*Initial production/((1/Initial life of capital)+Interest rate)
    Units: Unit

(062) Initial depreciation=
    Initial capital/Initial life of capital
    Units: Unit/Year

(063) Initial GS=
    3e+011
    Units: Unit/Year

(064) Initial GS fraction=
    Initial GS/Initial production
    Units: Dmnl

(065) Initial labor=
    1e+008
    Units: Person

(066) Initial labor force=
    Initial labor+Initial unemployment
    Units: Person
(067) Initial life of capital = 14
Units: Year

(068) Initial permanent income = (1 - Tax rate) * Initial production
Units: Unit/Year

(069) Initial population = Initial labor force / Labor participation figure
Units: Person

(070) Initial production = 2e+012
Units: Unit/Year

(071) INITIAL TIME = 0
Units: Year
The initial time for the simulation.

(072) Initial unemployment = Hire time normal * (Initial labor / Fire time normal)
Units: Person

(073) Innovation delay = 50
Units: Year

(074) Innovation start time = 1000
Units: Year

(075) Interest rate = 0.03
Units: 1/Year

(076) Inventory = INTEGRAL (Production - Final sales, Inventory coverage * Initial production)
Units: Unit

(077) Inventory availability = Inventory / Desired inventory
Units: Dimensionless

(078) Inventory coverage = 0.3
Units: Year
(079) Investment=
    Desired investment*Effect inventory
Units: Unit/Year

(080) Labor=
    INTEG (Hire-Fire,Initial labor)
Units: Person

(081) Labor availability=
    Desired labor/Labor force
Units: Dmnl

(082) Labor force=
    Labor+Unemployment
Units: Person

(083) Labor force increase=
    Labor participation figure*Population growth rate
Units: Person/Year

(084) Labor growth=
    ((Hire-Fire)/Labor)*100
Units: Percent/Year

(085) Labor participation figure=
    0.4
Units: Dmnl

(086) Life of capital=
    SMOOTH3I( Indicated life of capital, Innovation delay, Initial life of capital)
Units: Year

(087) Longrun demand=
    INTEG (LRD chg,Initial production)
Units: Unit/Year

(088) LRD chg=
    (Aggregate demand-Longrun demand)/Time to smooth LRD
Units: Unit/(Year*Year)

(089) Minimum life of capital=
    14
Units: Year

(090) Minimum unemployment rate=
    0.02
Units: Dmnl
Normal availability of labor = 0.95
Units: Dmnl

Perceived growth in demand = ACTIVE INITIAL (SMOOTH(Trend in demand, Time to perceive trend in demand), 0)
Units: 1/Year

Permanent income = INTEG (Permanent income change, Initial production - Taxes)
Units: Unit/Year

Permanent income change = (Current disposable income - Permanent income) / Time to smooth income
Units: Unit/Year/Year

Population = INTEG (Population growth rate, Initial population)
Units: Person

Population growth = Population growth fraction * 100
Units: Percent/Year

Population growth delay = 50
Units: Year

Population growth fraction = SMOOTH3I(STEP(Population growth fraction scenario, Population growth start time), Population growth delay / 4, 0)
Units: 1/Year

Population growth fraction scenario = 0
Units: 1/Year

Population growth rate = Population growth fraction * Population
Units: Person/Year

Population growth start time = 1000
Units: Year
(102) Potential production = 
Initial production *((Capital/Initial capital)^Alpha)*((Labor/Initial labor)^((1-Alpha)))
Units: Unit/Year

(103) Prod chg = 
(Production - Average production)/Time to average production
Units: Unit/(Year*Year)

(104) Production = 
(1-Capcity utilization)*Potential production + Capcity utilization * Desired production
Units: Unit/Year

(105) Production growth = 
(Prod chg/Average production)*100
Units: Percent/Year

(106) Production per capita = 
Production/Population
Units: Unit/(Year*Person)

(107) Production per capita average = 
ACTIVE INITIAL (SMOOTH(Production per capita, 
Time to average production per capita),Production per capita initial)
Units: Unit/(Year*Person)

(108) Production per capita initial = 
Initial production/Initial population
Units: Unit/(Year*Person)

(109) Production per labor = 
Production/Labor
Units: Unit/(Year*Person)

(110) Production per labor growth = 
Production growth - Labor growth
Units: Percent/Year

(111) Propensity to consume = 
(Initial permanent income - Initial depreciation)/Initial permanent income
Units: Dmnl

(112) Relative labor availability = 
Labor availability/Normal availability of labor
Units: Dmnl
(113)   SAVEPER =
         TIME STEP
         Units: Year
         The frequency with which output is stored.

(114)   Shortrun demand=
         INTEG (SRD change,Initial production)
         Units: Unit/Year

(115)   SRD change=
         (Aggregate demand-Shortrun demand)/Time to smooth SRD
         Units: Unit/(Year*Year)

(116)   Tax rate=
         Initial GS/Initial production
         Units: Dmnl

(117)   Taxes=
         Tax rate*Production
         Units: Unit/Year

(118)   Technology growth=
         Capital growth-Labor growth
         Units: Percent/Year

(119)   TIME STEP  = 0.0625
         Units: Year
         The time step for the simulation.

(120)   Time to adjust capital=
         3
         Units: Year

(121)   Time to adjust inventory=
         0.4
         Units: Year

(122)   Time to average alpha=
         0.0625
         Units: Year

(123)   Time to average production=
         0.0625
         Units: Year

(124)   Time to average production per capita=
         2
         Units: Year
(125) Time to establish trend in demand = 
5
Units: Year

(126) Time to perceive trend in demand = 
5
Units: Year

(127) Time to smooth income = 
2.5
Units: Year

(128) Time to smooth LRD = 
4
Units: Year

(129) Time to smooth SRD = 
0.5
Units: Year

(130) Trend in demand = 
Avr demand chg/Average demand
Units: 1/Year

(131) Trend time of productivity growth = 
5
Units: Year

(132) Unemployment = 
INTEG (Fire+Labor force increase-Hire,Initial unemployment)
Units: Person

(133) Unemployment rate = 
(Unemployment/Labor force)*100
Units: Percent

(134) Wage = 
INTEG (Wage change,(1-Alpha)*Initial production/Initial labor)
Units: Unit/Year/Person

(135) Wage change = 
Fractional change in wage*Wage
Units: Unit/(Year*Person)/Year

(136) Wage growth = 
Fractional change in wage*100
Units: Percent/Year