

Table S1.Variables of SD model.

| No. | Variable name | Characterization | Formulas and Equations ¹ |
|-----|----------------------------|------------------|---|
| 1 | Population | Level | $Population(t) = \int (Population\ growth) dt + Initial\ population$ |
| 3 | GDP | Level | $GDP(t) = \int (GDP\ growth) dt + Initial\ GDP$ |
| 4 | GDP growth | Rate | $GDP\ growth = GDP * GDP\ growth\ rate$ |
| 6 | Demand | Level | $Demand(t) = \int (Change\ in\ demand) dt + Initial\ demand(0)$ |
| 7 | Change in demand | Rate | $Change\ in\ demand = (\alpha_1.GDP * \alpha_2.Population)/(\alpha_3.Price)$ |
| 8 | Price | Level | $Price(t) = \int (change\ in\ price) dt + Initial\ price$ |
| 9 | Change in price | Rate | $Change\ in\ price = Price * (1 + Inflation\ rate)$ |
| 10 | Inflation rate | Auxiliary | $Inflation\ rate = (\alpha_4.Demand * \alpha_5.Export)/(\alpha_6.Production * \alpha_7.Import)$ |
| 11 | Cultivated land area (CLA) | Level | $Agricultural\ land\ area(t) = \int (Change\ in\ CLA) dt + Initial\ CLA$ |
| 12 | Change in ALA | Rate | $Change\ in\ CLA = \alpha_8.Value\ added\ per\ worker/\alpha_9.Residential\ land\ area$ |
| 13 | Residential land area | Auxiliary | $Residential\ land\ area = \alpha_{10}.GDP * \alpha_{11}.Population$ |
| 14 | Value added per worker | Auxiliary | $Value\ added\ per\ worker = \alpha_{12}.Farmer\ income * \alpha_{13}.Price * \alpha_{14}.Subsidy$ |
| 15 | Farmers income | Auxiliary | $Farmers\ income = \alpha_{15}.Production * \alpha_{16}.Price$ |
| 16 | Production | Auxiliary | $Production = \alpha_{17}.Agricultural\ land\ area * \alpha_{18}.Productivity$ |
| 17 | Subsidy | Auxiliary | $Subsidy = \alpha_{19}.Government\ expenditure$ |
| 18 | Government expenditure | Auxiliary | $Government\ expenditure = \alpha_{20}.GDP$ |
| 19 | Capital stock | Level | $Capital\ stock(t) = \int (Investment) dt + Initial\ capital\ stock$ |
| 20 | Investment | Rate | $Investment = \alpha_{21}.GDP * \alpha_{22}.Investment\ rate$ |
| 21 | Technology | Level | $Technology(t) = \int (Increase\ in\ technology) dt + Initial\ technology$ |
| 22 | Increase of technology | Rate | $Increase\ in\ technology = \alpha_{23}.Capital\ stock$ |
| 23 | Productivity | Auxiliary | $Productivity = \alpha_{24}.Technology * \alpha_{25}.Available\ water\ resources * \alpha_{26}.Water\ productivity$ |
| 24 | Water productivity | Auxiliary | $Water\ productivity = \alpha_{27}.Technology$ |
| 25 | Available water resources | Auxiliary | $Available\ water\ resources = (\alpha_{28}.Precipitation * \alpha_{29}.Capital\ stock)/\alpha_{30}.CLA$ |
| 26 | Import | Auxiliary | $Import = 1/\alpha_{31}.Trade\ tariff$ |
| 28 | Trade tariffs | Auxiliary | $Trade\ tariff = 1/(\alpha_{32}.Ratio\ of\ In/Out\ price)$ |
| 29 | Export | Auxiliary | $Export = \alpha_{33}.Trade\ incentive$ |
| 30 | Trade incentives | Auxiliary | $Trade\ incentive = 1/\alpha_{34}.Ratio\ of\ In/Out\ price$ |

¹ “GDP Growth Rate”, “Population Growth”, “Precipitation” are exogenous variables. α_1 to α_{34} are coefficients that should be determined based on each case study conditions (here for instance, Iran)