SECM V0.5 ALPHA Simulator User Manual

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1 Introduction

The Societal Evolution Computational Model (SECM) V0.5 ALPHA is a time-agnostic computational framework designed to analyze the co-evolution of three core societal dimensions:

- **Productive Capacity (X)** – A composite indicator reflecting national economic productivity, including primary energy consumption, animal power, and the equivalent productivity of human labor.
- **Societal Stress (Y)** – An aggregated measure of internal social tensions and systemic costs.
- **Net Tension Drivers (Z)** – A dimensionless index that determines the direction of societal stress movement, influenced by technological dividends, inequality, and social complexity.

Unlike conventional forecasting models, SECM does not attempt to predict specific events or dates. Instead, it focuses on identifying **structural relationships** and **ratio dynamics** that govern societal evolution. The model's theoretical foundation draws from historical materialism, capturing the "wave-like" and "spiral" patterns observed in human societal development.

1.1 Core Concepts

1. Growth in productive capacity (X) often leads to increases in societal stress (Y), unless offset by sufficient technological dividends or structural reforms.
2. Societal carrying capacity (Y_{limit}) represents the maximum sustainable level of societal stress before a systemic breakdown occurs.
3. When Y exceeds Y_{limit}, an *overshoot* occurs, frequently followed by a crisis or contraction.
4. The Z-axis (Z) acts as a predictive indicator: rising Z often precedes crises, while declining Z can indicate approaching relief phases.
5. Declines in X cause Y_{limit} to drop faster than Y, increasing societal fragility.

1.2 Purpose of This Manual

This user manual provides step-by-step guidance for installing, configuring, and operating the SECM V0.5 ALPHA Simulator. It is designed for both **non-technical users** and **researchers** who wish to reproduce, explore, and analyze historical or hypothetical societal evolution scenarios.

Through detailed explanations, annotated interface descriptions, and worked examples, readers will be able to:

- Prepare and format input datasets.
- Run simulations using national presets or custom parameters.
- Interpret outputs, including time-series plots and early-warning indicators.
- Export and document results for further analysis.

2 System Requirements & Installation

2.1 System Requirements

The SECM V0.5 ALPHA Simulator is a standalone Windows application. No additional development environment is required.

- **Operating System:** Windows 10 or later (64-bit)
- **Runtime Environment:** Microsoft .NET 8 Desktop Runtime
- **Processor:** Dual-core CPU (Intel i3 / AMD Ryzen 3 or higher recommended)
- **Memory:** 4 GB RAM (8 GB or more recommended for large datasets)
- **Storage:** 200 MB free disk space
- **Display:** 1366x768 resolution or higher

The .NET 8 Desktop Runtime can be downloaded from the official Microsoft website: `https://dotnet.microsoft.com/en-us/download/dotnet/8.0`

2.2 File Structure

The simulator package contains the following files after extraction:

- `SECM_Simulator.exe` – Main executable file.
- `Presets/` – Folder containing JSON parameter presets for specific countries.
- `SampleData/` – Example datasets in CSV/Excel format.
- `Docs/` – Documentation files, including this manual.
- `Logs/` – Automatically generated logs during simulation runs.

2.3 Installation Steps

1. Download the simulator package (`.zip`) from the official repository.
2. Extract the contents to a dedicated folder on your computer.
3. Install the Microsoft .NET 8 Desktop Runtime if not already installed.
4. Double-click `SECM_Simulator.exe` to launch the application.
5. On first launch, verify that the interface loads correctly and that no runtime errors occur.

2.4 First-Time Setup Tips

- Keep all files within the extracted folder to ensure the simulator can access presets and sample data.
- If using custom datasets, store them in a separate folder and avoid overwriting the sample files.
- For high-resolution displays, enable display scaling in Windows settings for better readability.

3 User Interface Overview

The SECM V0.5 ALPHA Simulator interface consists of four main areas:

1. **Control Buttons Area** – Used to run, reset, import/export data, and manage presets.
2. **General Input Data Area** – Contains all annual socio-economic input fields.
3. **Parameter Input Area** – Allows adjustment of model coefficients and sensitivity factors.
4. **Output and Log Area** – Displays simulation progress, numerical outputs, and visual charts.

3.1 Main Window Layout

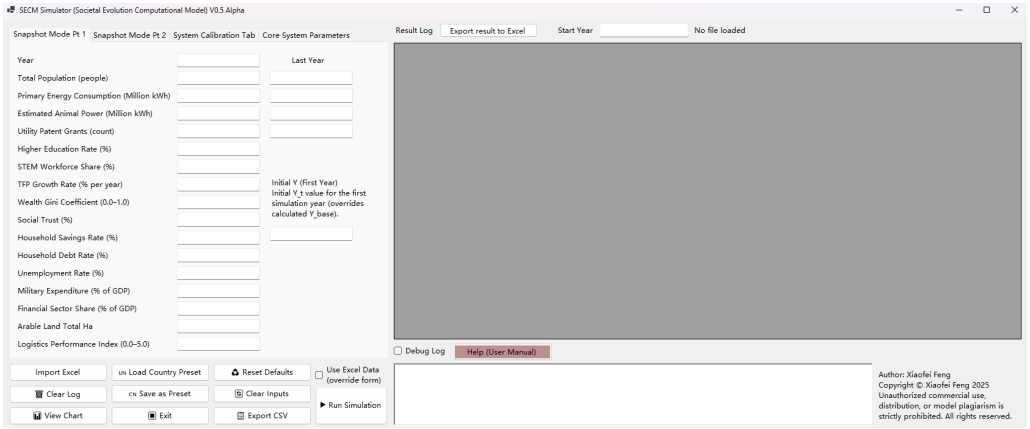


Figure 1: SECM V0.5 ALPHA Simulator Main Interface

3.2 Control Buttons

Control Name	UI Label	Function
btnRun	`Run Simulation`	Execute the simulation with current input and parameter values.
btnClear	`Clear Inputs`	Clear all input fields.
btnReset	`Reset Defaults`	Restore default presets or load first row from Excel.
btnExportCSV	`Export CSV`	Export simulation history to a CSV file.
btnPlotChart	`View Chart`	Generate visual charts from simulation data.
btnClearLog	`Clear Log`	Clear the log output window.
btnExit	`Exit`	Exit the simulator.

btnLoadNation	`Load Country Preset`	Load national parameter preset (JSON).
btnSaveNation	`Save as Preset`	Save current parameters as a JSON preset.
btnImportExcel	`Import Excel`	Load input data from an Excel file.
btnExportExcel	`Export Excel`	Export simulation results to Excel.

3.3 General Input Data Fields

UI Label	**Textbox Name**	**Description**
Year	`txtYear`	Simulation year for the current input row.
Population	`txtPopulation`	Total population (persons).
Population (Last Year)	`txtPopulationLast`	Population in the previous year.
Primary Energy (kWh)	`txtPrimaryEnergy`	Annual primary energy consumption in kWh.
Primary Energy (Last Year)	`txtPrimaryEnergyLast`	Primary energy consumption in previous year.
Animal Power (kWh)	`txtAnimalPower`	Estimated annual mechanical energy from animal labor.
Animal Power (Last Year)	`txtAnimalPowerLast`	Animal power in the previous year.
Patent Count	`txtPatentCount`	Number of patents filed in the current year.
Patent Count (Last Year)	`txtPatentLast`	Number of patents filed in the previous year.
Bonus ϑ (Theta)	`txtBonusTheta`	Coefficient for technology bonus calculation.
Bonus P	`txtBonusP`	Exponent in productivity growth component for bonus calculation.
Education Rate (%)	`txtEduRate`	Share of population with higher education.
STEM Workforce Share (%)	`txtSTEMShare`	Share of labor force in STEM fields.
TFP Growth (%)	`txtTFPGrowth`	Total Factor Productivity growth rate.
Gini Coefficient	`txtGini`	Gini index for inequality (0–1).
Trust Index	`txtTrust`	Social trust index (0–1).
Savings Rate (%)	`txtSavingsRate`	Household savings rate.
Debt Ratio (%)	`txtDebtRate`	Household debt as % of GDP.

Unemployment Rate (%)	txtUnemploymentRate	Unemployment rate.
Military Expenditure (% of GDP)	txtMilitaryRatio	Military spending as % of GDP.
Market Cap / GDP Ratio	txtMCapGDP	Stock market capitalization / GDP.
Arable Land per Capita (ha/person)	txtArableLandCapita	Arable land per person.
Logistics Performance Index (0–5)	txtLPI	World Bank LPI score.
Healthcare Coverage (%)	txtHealthcareCoverage	Population with healthcare access.
Pension Coverage (%)	txtPensionCoverage	Population with pension access.
Free Education Coverage (%)	txtFreeEduCoverage	Population with free education access.
Unemployment Insurance Coverage (%)	txtUnempInsCoverage	Population with unemployment insurance.
Social Security Index (0–1)	txtSocialSecIndex	Composite index of social safety net.
Z Shock	txtZShock	External social destabilization shock.
Omega Shock	txtOmegaShock	External structural resilience shock.
Murder Rate (%)	txtMurderRate	Annual homicide rate.
Poverty Rate (%)	txtPovertyRate	Population below poverty line.
Gamma S	txtGammaS	Sensitivity coefficient for Z from social complexity.
Gamma X	txtGammaX	Sensitivity coefficient for Z from technology bonus.
Drift	txtDrift	Long-term Z-axis drift.
Zc Weight (w_Zc)	txtZcWeight	Weight multiplier for Zc.
YBase A0	txtYBaseA0	Coefficient A0 for Y_base.
YBase B1	txtYBaseB1	Coefficient B1 for Y_base.
YBase A1	txtYBaseA1	Coefficient A1 for Y_base.
Mu Y0	txtMuY0	Baseline Y adjustment parameter.
Land Cap Limit Coefficient	txtLandCapLimitCoef	Coefficient for land capacity limit.
K Limit	txtKLimit	Scaling factor for Y_limit.
K Y	txtKY	Coefficient linking X to Y production.
S Decay Rate	txtSDecayRate	Decay rate for crisis pool S_t.
K S	txtKS	Scaling factor for S_t accumulation.
S0 (Initial Crisis Pool)	txtS0	Initial S_t value.

Initial Y (First Year)	`txtYFirst`	Initial Y_t value for first year.

4 Data Preparation

Before running simulations, the SECM V0.5 ALPHA Simulator requires structured input datasets. This chapter explains where to obtain the data, how to format it, and how to handle missing values.

4.1 Data Sources

The simulator can work with either:

- Official historical datasets (recommended for backtesting).
- Custom datasets created by the user for hypothetical or counterfactual scenarios.

For historical testing, official data sources are available via the project's GitHub repository:

- **Main dataset (1980–2020)**: `https://github.com/Strangethought2025/SECM-Project/tree/main/Data/DATAsource/1980_2020%20Source`
- **Extreme test datasets**: `https://github.com/Strangethought2025/SECM-Project/tree/main/Data/DATAsource/ExtremeTest%20Source`
- **Bibliographic references**: `https://github.com/Strangethought2025/SECM-Project/blob/main/Data/DATAsource/1980_2020%20Source/Citation.xlsx`

These datasets include raw values as well as **LOCF-processed** (Last Observation Carried Forward) values for missing entries.

4.2 File Format Requirements

- Accepted formats: `.xlsx`, `.csv`
- Each row represents a year of data.
- Columns must correspond to the simulator's **General Input Data Fields** (see Chapter 3).
- The first row should contain headers matching the simulator's expected field names.
- All numerical values should be in standard decimal notation (dot as decimal separator).

Example header row:

`Year,Population,PopulationLast,PrimaryEnergy,PrimaryEnergyLast,`
`AnimalPower,AnimalPowerLast,PatentCount,PatentLast,BonusTheta,BonusP,`
`EduRate,STEMShare,TFPGrowth,Gini,Trust,SavingsRate,DebtRate,`
`UnemploymentRate,MilitaryRatio,MCapGDP,ArableLandCapita,LPI,`
`HealthcareCoverage,PensionCoverage,FreeEduCoverage,UnempInsCoverage,`
`SocialSecIndex,ZShock,OmegaShock,MurderRate,PovertyRate,`
`GammaS,GammaX,Drift,ZcWeight,YBaseA0,YBaseB1,YBaseA1,MuY0,`
`LandCapLimitCoef,KLimit,KY,SDecayRate,KS,S0,YFirst`

4.3 Handling Missing Data (LOCF Method)

The simulator is not tolerant of blank cells in the input dataset. If official datasets have missing values, the **LOCF method** is used:

- If a year's value is missing, use the last available value from a previous year.
- LOCF maintains trend continuity and avoids artificial spikes caused by interpolation.

4.4 Importing Data into the Simulator

1. Click `Import Excel` or `Import CSV` in the **Control Buttons Area**.
2. Browse to your dataset file and open it.
3. Verify that all fields are correctly populated in the **General Input Data Area**.
4. If using a preset dataset from the GitHub repository, no further adjustments are required.

4.5 Using Preset Country Parameters

Alongside datasets, the simulator uses parameter presets stored as `.json` files in the `Presets/` directory.

- Load a preset via `Load Country Preset` before importing the dataset.
- Presets contain fixed coefficients such as k_Y, k_{Limit}, and technology bonus parameters.
- You may edit presets in a text editor to create custom parameter sets.

5 Basic Operation

This chapter provides a complete walk-through of running a simulation using the SECM V0.5 ALPHA Simulator. For illustration, we use the historical dataset for the **United States (1980–2020)**.

5.1 Step 1 – Launch the Simulator

1. Double-click `SECM_Simulator.exe` to open the program.
2. The main interface will load, displaying the **Control Buttons Area**, **General Input Data Area**, **Parameter Input Area**, and **Log/Output Area**.

5.2 Step 2 – Load a Country Parameter Preset

1. Click `Load Country Preset`.
2. Select the file `USA.json` from the `Presets/` folder.
3. The **Parameter Input Area** will be populated with the recommended coefficients for the United States.

Tip: Always load the preset before importing data to ensure correct parameter alignment.

5.3 Step 3 – Import the Dataset

1. Click `Import Excel`.
2. Navigate to `SampleData/USA_1980_2020.xlsx`.
3. Confirm that all fields in the **General Input Data Area** are correctly filled.

5.4 Step 4 – Verify Initial Y Value (`YFirst`)

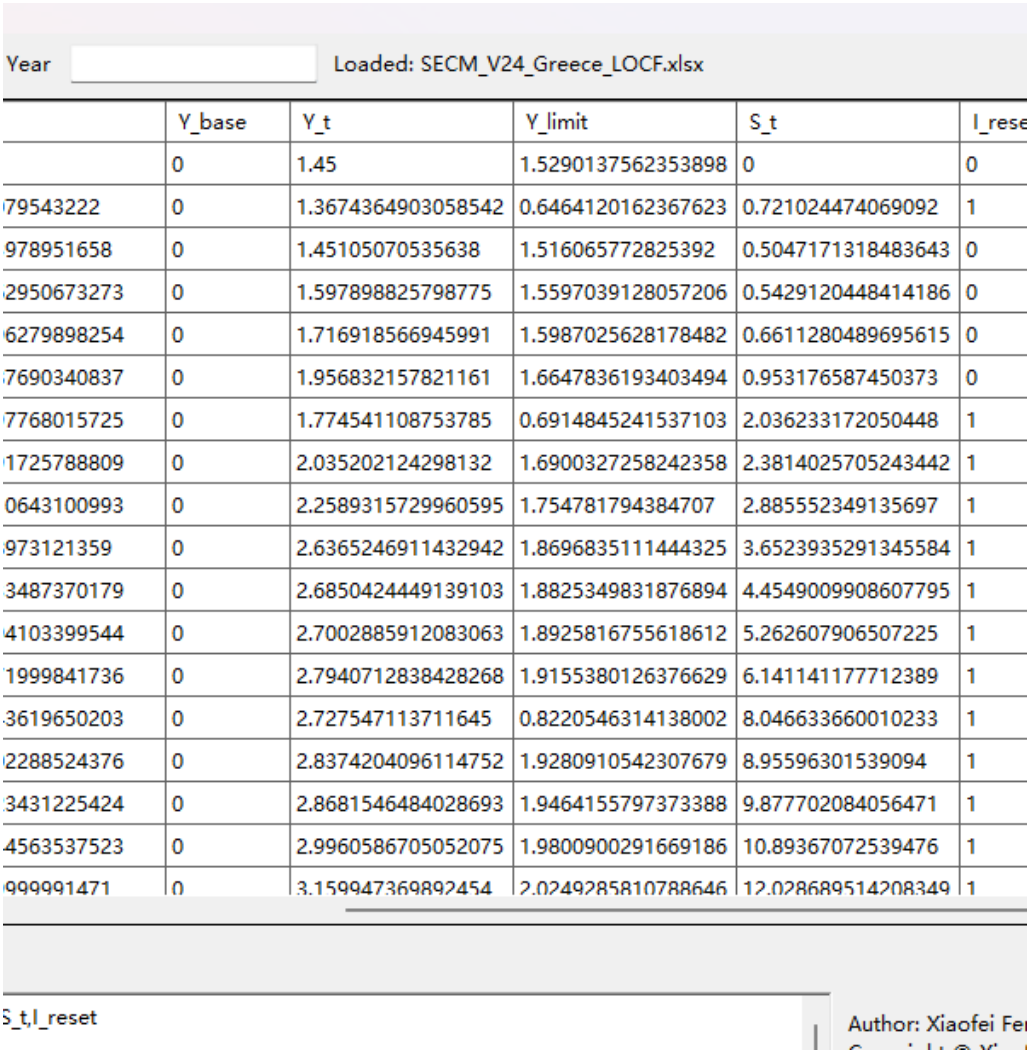
1. In the **Parameter Input Area**, check the `Initial Y (First Year)` field (`txtYFirst`).
2. If using the official dataset, this value will be pre-set based on historical calibration.
3. For custom datasets, set `YFirst` to a realistic starting societal stress level.

5.5 Step 5 – Run the Simulation

1. Click `Run Simulation`.
2. The **Log/Output Area** will display year-by-year results as the model iterates.
3. Progress indicators and key variables (X, Y, Y_{limit}, Z) will update in real-time.

5.6 Step 6 – View Charts

1. Once the simulation completes, click `View Chart`.
2. A visual plot of Y and Y_{limit} over time will be generated.
3. Additional plots (e.g., Y vs. Z) can be exported for analysis.



	Y_base	Y_t	Y_limit	S_t	I_rese
	0	1.45	1.5290137562353898	0	0
79543222	0	1.3674364903058542	0.6464120162367623	0.721024474069092	1
978951658	0	1.45105070535638	1.516065772825392	0.5047171318483643	0
2950673273	0	1.597898825798775	1.5597039128057206	0.5429120448414186	0
6279898254	0	1.716918566945991	1.5987025628178482	0.6611280489695615	0
7690340837	0	1.956832157821161	1.6647836193403494	0.953176587450373	0
7768015725	0	1.774541108753785	0.6914845241537103	2.036233172050448	1
1725788809	0	2.035202124298132	1.6900327258242358	2.3814025705243442	1
0643100993	0	2.2589315729960595	1.754781794384707	2.885552349135697	1
973121359	0	2.6365246911432942	1.8696835111444325	3.6523935291345584	1
3487370179	0	2.6850424449139103	1.8825349831876894	4.4549009908607795	1
4103399544	0	2.7002885912083063	1.8925816755618612	5.262607906507225	1
1999841736	0	2.7940712838428268	1.9155380126376629	6.141141177712389	1
3619650203	0	2.727547113711645	0.8220546314138002	8.046633660010233	1
2288524376	0	2.8374204096114752	1.9280910542307679	8.95596301539094	1
3431225424	0	2.8681546484028693	1.9464155797373388	9.877702084056471	1
4563537523	0	2.9960586705052075	1.9800900291669186	10.89367072539476	1
999991471	0	3.159947369892454	2.0249285810788646	12.028689514208349	1

Figure 2: Example output chart: Y vs. Y_limit for the Greece

5.7 Step 7 – Export Results

1. To export numeric results, click `Export CSV` or `Export Excel`.
2. Choose a save location and filename.
3. The exported file will contain yearly values for all calculated variables, allowing further analysis in Excel, R, or Python.

5.8 Step 8 – Reset or Exit

- Click `Reset Defaults` to clear results and prepare for another run.
- Click `Exit` to close the simulator.

6 Advanced Features

Beyond basic simulation runs, the SECM V0.5 ALPHA Simulator provides several advanced capabilities for research and scenario testing.

6.1 Parameter Adjustment

The **Parameter Input Area** contains coefficients that influence the model's behavior. Adjusting these values allows for:

- Testing model sensitivity to specific societal factors.
- Simulating alternative policy or development paths.
- Calibrating the model to match new datasets or countries.

Key parameters include:

- k_Y – Links productive capacity X to societal stress Y.
- k_{Limit} – Scales the societal carrying capacity Y_{limit}.
- θ (Bonus Theta) – Weight for technology bonus.
- P (Bonus P) – Exponent for productivity-driven bonus growth.
- γ_S and γ_X – Sensitivity coefficients for Z-axis response.
- S_0 – Initial crisis pool value.

6.2 Extreme Testing (Stress Tests)

Extreme testing involves deliberately altering inputs to observe model stability and response patterns. Two main approaches are:

1. **Timeframe compression** – Shortening the dataset period to check whether the model preserves long-term trends.
2. **Variable extremes** – Artificially increasing or decreasing a key input (e.g., Y or Y_{limit}) to test how the system responds.

Example: Greece Y-limit Test

- Input: Historical dataset for Greece (1980–2020).
- Modification: Multiply Y_{limit} by 1.5 for all years.
- Observation: The Y curve shifts relative to Y_{limit} without destabilizing the long-term pattern, confirming model resilience.

6.3 External Shock Variables

The simulator includes two special input fields for simulating shocks:

- **ZShock** – External social destabilization (e.g., political polarization). Positive values increase societal stress; negative values represent positive events.
- **OmegaShock** – External structural resilience shock (e.g., natural disasters or infrastructure upgrades). Positive values reduce carrying capacity; negative values improve resilience.

Usage:

1. Enter shock values directly in the input field for the year in question.
2. Run the simulation to observe how the shock propagates through Y, Y_{limit}, and Z.

6.4 Technology Bonus Analysis

The technology bonus (X_{bonus}) reflects the combined effect of education, STEM workforce share, patent activity, and TFP growth:

$$X_{\text{bonus},t} = \theta \cdot \text{STEM}_t \cdot \text{EduRate}_t \cdot (1 + \text{TFP}_t) \cdot \left(1 + \frac{\text{PatentDensity}_t}{\text{PatentDensity}_{t-1}}\right) \cdot \left(1 + \frac{X_t}{X_{t-1}}\right)^P$$

where:

$$\text{PatentDensity}_t = \frac{\text{PatentCount}_t}{\text{Population}_t/10^6}$$

Increasing θ or P amplifies the effect of technological progress on reducing societal stress.

6.5 Stability Verification (Pearson Correlation Test)

A stability check can be performed by running the model with different dataset lengths (e.g., 10-year vs. 40-year periods) and comparing the output curves using Pearson's correlation coefficient:

$$r = \frac{\sum (Y_t - \overline{Y})(\hat{Y}_t - \overline{\hat{Y}})}{\sqrt{\sum (Y_t - \overline{Y})^2 \cdot \sum (\hat{Y}_t - \overline{\hat{Y}})^2}}$$

Values of $r \approx 1.0$ indicate extremely high stability across different timescales.

7 Frequently Asked Questions (FAQ)

This section addresses common issues users may encounter when using the SECM V0.5 ALPHA Simulator.

1. The program shows an error when importing data

Possible causes:

- The file format is unsupported (`.xls` instead of `.xlsx` or `.csv`).
- Column headers do not match the required field names.
- Missing values have not been filled using the LOCF method.

Solutions:

- Save your Excel file as `.xlsx` or `.csv`.
- Ensure headers exactly match the expected names (see Chapter 3).
- Apply LOCF to fill missing values before import.

2. Output curves look unrealistic or flat

Possible causes:

- Incorrect parameter preset for the country.
- Initial Y value (`YFirst`) is set too high or too low.
- Extreme or unrealistic input values.

Solutions:

- Load the correct country preset before running the simulation.
- Adjust `YFirst` to a reasonable starting value.
- Review input dataset for errors or unrealistic values.

3. Changing parameters seems to have no effect

Possible causes:

- The parameter being changed has minimal impact for the given dataset.
- Changes are too small to produce visible effects in short runs.

Solutions:

- Try larger adjustments to parameters (e.g., change θ from 1.0 to 1.5).
- Extend the simulation period to observe cumulative effects.

4. I get blank charts after running the simulation

Possible causes:

- The simulation did not run to completion.
- No output data was generated due to missing or invalid inputs.

Solutions:

- Ensure all required fields are filled before starting the simulation.
- Check the log window for errors during execution.

5. How do I test the impact of a major event?

Answer: Use the `ZShock` or `OmegaShock` fields for the year of the event:

- Positive `ZShock` simulates increased societal stress (e.g., political crisis).
- Negative `ZShock` simulates a positive development (e.g., major peace agreement).
- Positive `OmegaShock` reduces carrying capacity (e.g., natural disaster).
- Negative `OmegaShock` increases resilience (e.g., infrastructure upgrade).

6. Where can I find sample datasets?

Answer: Sample datasets are included in the `SampleData/` folder and in the project's GitHub repository. They cover 1980–2020 data for multiple countries, including the United States, Japan, Greece, and Argentina.

8 Appendix

8.1 A. Control Buttons Reference

Control Name	UI Label	Function
btnRun	`Run Simulation`	Execute simulation.
btnClear	`Clear Inputs`	Clear all input fields.
btnReset	`Reset Defaults`	Restore defaults or load first Excel row.
btnExportCSV	`Export CSV`	Export results as CSV.
btnPlotChart	`View Chart`	Generate simulation charts.
btnClearLog	`Clear Log`	Clear log output.
btnExit	`Exit`	Close the simulator.
btnLoadNation	`Load Country Preset`	Load parameter preset (JSON).
btnSaveNation	`Save as Preset`	Save parameters to JSON.
btnImportExcel	`Import Excel`	Import data from Excel file.
btnExportExcel	`Export Excel`	Export results to Excel file.

8.2 B. Input & Parameter Field Mapping

UI Label	Textbox Name	Variable Purpose
Population	`txtPopulation`	Total population.
Primary Energy (kWh)	`txtPrimaryEnergy`	Annual primary energy consumption.
Animal Power (kWh)	`txtAnimalPower`	Annual animal labor energy.
Patent Count	`txtPatentCount`	Patents filed in current year.
Education Rate (%)	`txtEduRate`	Higher education attainment.
STEM Workforce Share (%)	`txtSTEMShare`	STEM sector employment share.
TFP Growth (%)	`txtTFPGrowth`	Total Factor Productivity growth.
Gini Coefficient	`txtGini`	Inequality index.
Trust Index	`txtTrust`	Social trust level.
Savings Rate (%)	`txtSavingsRate`	Household savings share.
Debt Ratio (%)	`txtDebtRate`	Household debt share of GDP.
Unemployment Rate (%)	`txtUnemploymentRate`	Jobless population share.
Military Expenditure (% of GDP)	`txtMilitaryRatio`	Defense spending ratio.

Market Cap / GDP Ratio	`txtMCapGDP`	Stock market size relative to GDP.
Arable Land per Capita	`txtArableLandCapita`	Agricultural land per person.
LPI (0–5)	`txtLPI`	Logistics Performance Index.
Healthcare Coverage (%)	`txtHealthcareCoverage`	Health service access rate.
Pension Coverage (%)	`txtPensionCoverage`	Pension benefit coverage.
Free Education Coverage (%)	`txtFreeEduCoverage`	Public education access.
Unemployment Insurance Coverage (%)	`txtUnempInsCoverage`	Welfare coverage for unemployed.
Social Security Index (0–1)	`txtSocialSecIndex`	Composite welfare index.
ZShock	`txtZShock`	External societal stress shock.
OmegaShock	`txtOmegaShock`	External resilience shock.
Murder Rate (%)	`txtMurderRate`	Homicide rate.
Poverty Rate (%)	`txtPovertyRate`	Poverty share.
Gamma S	`txtGammaS`	Z sensitivity to social complexity.
Gamma X	`txtGammaX`	Z sensitivity to tech bonus.

8.3 C. Key Variables Explained (Simplified)

- X – Productive capacity, derived from energy, labor, and technology.
- Y – Societal stress level.
- Y_{limit} – Maximum sustainable Y before systemic breakdown.
- Z – Directional driver of Y, integrating tech bonus, inequality, and complexity.
- X_{bonus} – Technological dividend improving system resilience.
- S_t – Crisis pool, accumulates when $Y > Y_{\text{limit}}$.

8.4 D. Data Sources and References

- World Bank – *World Development Indicators*.
- United Nations – *Population and Demographic Statistics*.
- International Energy Agency – *Energy Balances*.
- OECD – *STEM workforce and education statistics*.

- Project GitHub Repository: `https://github.com/Strangethought2025/SECM-Project`