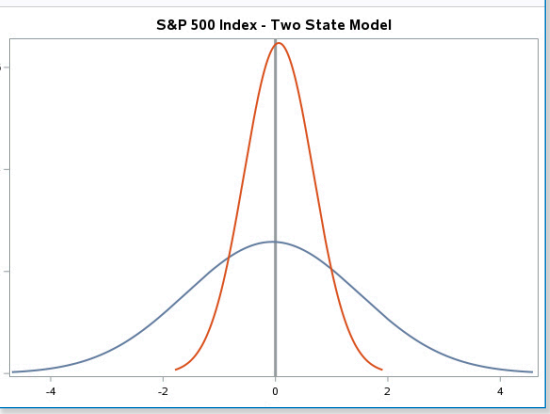
SAS® Econometrics

Model, forecast and simulate economic and business processes for proactive strategic and tactical planning

S&P 500 Index - Two State Model

Parameter Estimates

Parameter	Estimate	Standard Error	t Value	Pr > |t|
TPM1_1	0.963496	0.004115	234.15	<.0001
TPM1_2	0.036504	0.004115	8.87	<.0001
TPM2_1	0.012766	0.001482	8.61	<.0001
TPM2_2	0.987234	0.001482	666.21	<.0001
MU1_1	-0.053720	0.024159	-2.22	0.0262
MU2_1	0.060363	0.005877	10.27	<.0001
SIGMA1_1_1	2.387921	0.071384	33.45	<.0001
SIGMA2_1_1	0.379085	0.007920	47.87	<.0001



What does SAS® Econometrics do?

SAS Econometrics offers a broad array of econometric techniques so you can model and simulate business processes on observational data for improved strategic and tactical planning. It provides state-of-the-art techniques for modeling complex economic and business scenarios.

Why is SAS® Econometrics important?

It can help you understand how factors such as economic and market conditions, customer demographics, pricing decisions and marketing activity affect your business, providing a scientific basis for better decision making. It allows organizations to analyze risks and assess capital adequacy, and respond to regulatory requirements.

For whom is SAS® Econometrics designed?

It's designed for econometricians, business analysts, forecasters and high-end data analysts who supply information for business planning processes and decisions. Users also include analysts and managers responsible for regulatory compliance or supporting a planning process.

Measuring the impact of economic and marketplace factors, and getting a view of the future, are key elements for successful planning. You must be able to model and simulate any business process, and the factors that affect them – no matter how complex. SAS Econometrics is useful whenever time dependencies, simultaneous relationships or dynamic processes complicate your analysis. Forecasting processes combined with econometric analysis can help organizations proactively shape a more profitable future. With SAS Econometrics, you can:

- Run large-scale, multivariate simulations that can be fitted using different specifications.
- Perform count regression, cross-sectional analysis, panel data analysis and censored event estimation for both discrete and continuous events.
- Achieve exceptional processing speeds on even the largest data sets using parallel distributed processing of econometric algorithms.

Benefits

- **Quickly solve complex econometric problems.** This solution takes advantage of the SAS® Viya® scalable, distributed in-memory engine to deliver econometric modeling results at breakthrough speeds. In-memory data persistence eliminates the need to load data multiple times during iterative analyses. So you get faster answers to your time- and event-specific questions.
- **Drive better, more scientific decision making.** SAS Econometrics can help you understand the impact that factors such as economic and market conditions, customer demographics, pricing decisions and marketing activities have on your organization, providing a scientific basis for better decision making.
- **Empower users with the programming language of their choice.** Python, Java, R and Lua programmers can take advantage of SAS Econometrics without learning SAS. They can access powerful, trusted and tested SAS algorithms from the coding environment they are most familiar with.

Overview

SAS Econometrics is part of the industry's most powerful integrated analytics platform that also includes optimization, forecasting, statistical analysis, machine learning, data visualization, data mining and text mining. With a unified system, there's no need to deal with software from various niche vendors. This eliminates manual intervention that is typical when results from one analytical routine are reformatted for use as input into the next.

SAS Econometrics supports a range of econometric model types with a single framework. It's fully integrated with all of the contributing analytics that coincide with econometrics, and with data preparation, exploration, presentation and reporting capabilities in SAS that are essential to successful econometric analysis.

In addition, you get an open analytics coding environment that supports SAS, Python, Java, R and Lua languages. It also lets you add the power of SAS Analytics to other applications using public RESTful APIs.

Hidden Markov models

The HMM procedure is a very powerful tool for modeling and predicting hidden Markov models (HMMs).

The hidden Markov model is the most popular machine learning algorithm for sequential data analysis. It is used in science and engineering in areas such as robotics, pattern recognition of speech and handwriting, gene finding, protein secondary structure recognition, multiple sequence alignment and machine status monitoring.

HMMs are used in economics and finance in areas like macroeconomics, risk management, asset pricing, quantitative trading and marketing science. Econometric applications include regime-switching models, stochastic volatility models, time-varying-parameter VARMA models and nonlinear state space models.

Spatial econometrics modeling

Spatial econometrics is a subfield of econometrics that deals with spatial interaction (spatial autocorrelation) and spatial structure (spatial heterogeneity) in regression models for cross-sectional and panel data. Everything is related to everything else, but near things are more related than distant things. Spatial structure refers to the distribution of studied events that vary across the area.

The CSPATIALREG procedure allows users to conduct spatial regressions, taking advantage of data with a spatial element (e.g., location and mapping data). This enables you to include spatial information in your analysis and improve the econometric inference and statistical properties of estimators.

Econometric models for cross-sectional data

Cross-sectional data can have large numbers of observations, but just one observation per time period. These procedures can be used to solve many problems, including media mix marketing, customer lifetime value, churn, policy and environmental impact, credit risk modeling, consumer choice modeling and more.

SAS Econometrics includes these models for cross-sectional data analysis: count regression, severity regression, qualitative and limited-dependent variables, and copula methods with compound distribution.

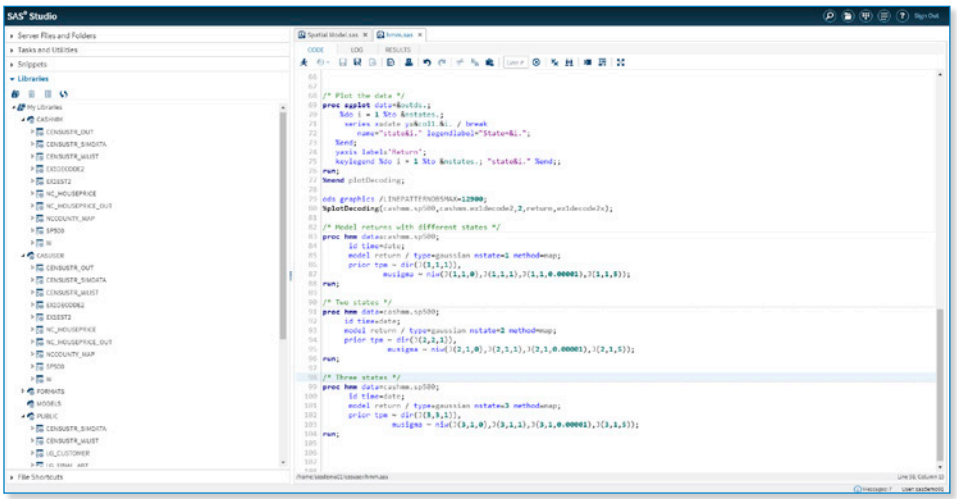
Panel data econometric models

Panel data can have a large number of observations and more than one observation per time period. Regression models for panel data solve problems such as predicting the effect of changes in policies and strategies by analyzing relationships between the past and the future.

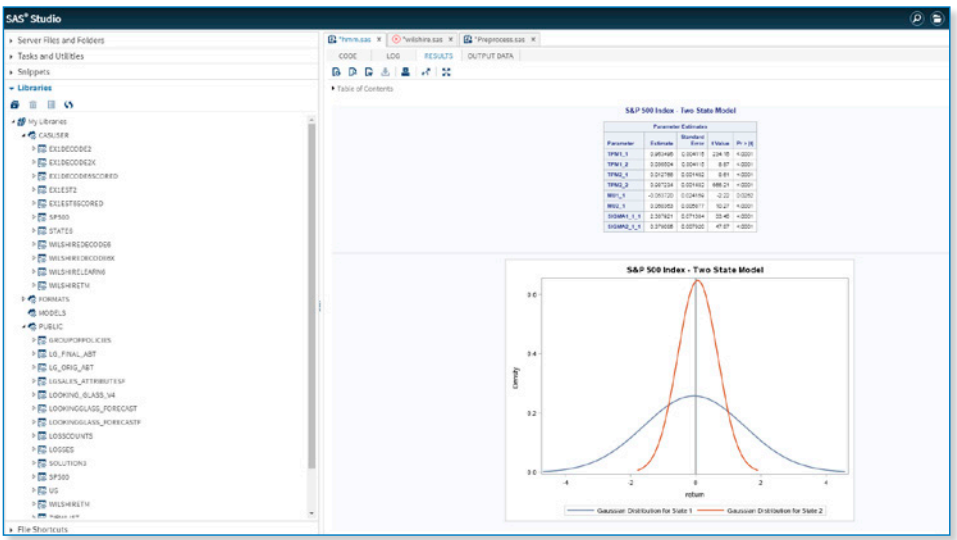
SAS Econometrics includes these models for analyzing data that combines both time series and cross-sectional dimensions: panel data models, count regression models and regression models for qualitative and limited-dependent variables.

Econometric models

- Count regression models: The CNTSELECT procedure produces regression models for integer-valued dependent variables. It analyzes the number of times specific events occur during a time period.
- Severity regression models: Severity modeling estimates probability distributions for the severity (magnitude) of random events. Events can be those with negative effects like the magnitude of damages caused by natural disasters or the distribution of losses claimed under



Hidden Markov models procedure code (PROC HMM) in SAS Studio.



Output from PROC HMM.

insurance policies, or those with positive effects like intermittent demand for certain products.

- Qualitative and limited-dependent variable regression models: The CQLIM procedure estimates regression models for univariate qualitative and limited-dependent variables.
- Copula models: Copula models let you model multivariate dimensions of risk factors. These can be useful when you have to model many correlated risk factors that are non-normally distributed. It supports simulations from normal, t, Clayton, Gumbel and Frank copulas.

Economic capital modeling

Frequency, severity and copula modeling are combined to simulate portfolio risks and estimate VaR, TVaR, etc. This approach is used to model the need for capital reserves, and comply with prudential regulation and capital adequacy directives.

Forecasting models for time series data

SAS Econometrics provides techniques for modeling complex economic and business scenarios, so you can analyze the impact that specific events might have over time. More accurate forecasting enables better business decisions. Time series models include user-defined ARIMA and exponential smoothing models. Time series analysis includes decomposition capabilities and diagnostic testing.

Accessible, cloud-enabled, in-memory engine

SAS Econometrics takes advantage of the SAS Viya engine for even quicker insights. SAS Viya brings new enhancements to the SAS Platform, including high availability, fast

Key Features

Hidden Markov models

- Fits and applies hidden Markov models to time series data.
- Does fitting (or learning), smoothing, filtering, decoding and scoring.
- Supports univariate or multivariate models, regime-switching regression models and regime-switching autoregression models.
- Supports discrete state Gaussian models and Gaussian mixture models.
- Provides methods to efficiently handle very long (big data) series.
- Provides automated selection of number of states and number of lags.

Spatial econometrics modeling

- Supports the following models:
  - Linear models.
  - Linear model with spatial lag of X (SLX) effects.
  - Spatial autoregressive (SAR) models.
  - Spatial Durbin models (SDM).
  - Spatial error models (SEM).
  - Spatial Durbin error models (SDEM).
  - Spatial moving average (SMA) models.
  - Spatial Durbin moving average (SDMA) models.
  - Spatial autoregressive moving average (SARMA) models.
  - Spatial Durbin autoregressive moving average (SDARMA) models.
  - Spatial autoregressive confused (SAC) models.
  - Spatial Durbin autoregressive confused (SDAC) models.

Other econometric models

- Count regression models for integer-valued dependent variables:
  - Model the frequency with which events may occur during a time period.
  - Supports Poisson, negative binomial, and Conway-Maxwell-Poisson (CMP) regression.
  - Supports zero-inflation models conditional on covariates.
  - Supports overdispersion models conditional on covariates (with CMP model).
  - Supports random-effect panel data models for counts.
  - Supports spatial count data models.
  - Supports Bayesian estimation.
  - Provides automated variable selection methods.
  - Provides many diagnostic tests and plots.
- Severity regression models:
  - Fits distribution to the size or severity of losses or other events.
  - Supports regression models for severity distribution scale parameter.
  - Supports left censoring and right truncation (e.g., deductibles and coverage limits).
  - Supports many distributions, including Burr, exponential, gamma, generalized Pareto, Wald, log-normal, Tweedie and Weibull.
  - Ability to program additional distributions.
  - Fits multiple distributions and automatically selects the best.
  - Provides many diagnostic tests and plots.
- Qualitative and limited-dependent variable regression models:
  - Supports censored and truncated models.
  - Supports logit, probit and tobit models, and bivariate probit and tobit models.
  - Supports models with heteroscedasticity.
  - Supports univariate limited-dependent variables models.
  - Estimates stochastic frontier production and cost models.
  - Supports Heckman sample selection model.

in-memory processing, the ability to code from open source languages and native cloud support.

SAS Econometrics procedures are available for both public and private cloud delivery in a scalable and elastic environment. Depending on the size of the problem, processing can speed up or down as needed. You can solve your largest problems, using the appropriate computational resources based on the scale of the problem.

Includes all SAS/ETS® procedures

SAS Econometrics provides access to all procedures in SAS/ETS, enabling you to address virtually any econometrics and time series analysis challenge.

TO LEARN MORE »

To learn more about SAS Econometrics, view screenshots and see other related materials, please visit sas.com/econometrics.

Find full details on SAS/ETS at sas.com/ets.

Key Features (continued)

- Copula models:
  - Simulates copula models of the multivariate dependency structure among sets of potentially many variables.
  - Supports normal, t, Clayton, Gumbel and Frank copulas.
- Regression models for panel data:
  - Supports one-way and two-way models.
  - Supports fixed-effects, random-effects and hybrid models.
  - Supports autoregressive and moving average models.
  - Supports dynamic panel models.
  - Provides Hausman-Taylor and Amemiya-MaCurdy estimators.
  - Provides different kinds of heteroscedasticity and autocorrelation consistent (HAC) covariance matrix estimators.
  - Fits and compares multiple models.
  - Provides many diagnostics and tests.
- Economic capital modeling:
  - Combines results from frequency, severity and copula modeling.

Forecasting models for time series analysis

- Provides ability to programmatically create forecasting models on time series data:
  - Lets you create time series models: user-defined ARIMA and exponential smoothing models (ESM).
  - Lets you conduct time series analysis, decomposition and diagnostic testing.

Distributed, accessible and cloud-ready

- Runs on SAS Viya, a scalable and distributed in-memory engine of the SAS Platform.
- Distributes analysis and data tasks across multiple computing nodes.
- Provides fast, concurrent, multiuser access to data in memory.
- Includes fault tolerance for high availability.
- Lets you add the power of SAS Analytics to other applications using SAS Viya REST APIs.

Analyze data with a spatial regression model in SAS Econometrics and use SAS Visual Analytics for additional visualization and reporting on data and results.

To contact your local SAS office, please visit: sas.com/offices

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