

Pavel S. Knopov • Arnold S. Korkhin

# Regression Analysis Under A Priori Parameter Restrictions

 Springer

# Contents

<b>1 Estimation of Regression Model Parameters with Specific Constraints</b> .....	1
1.1 Estimation of the Parameters of a Linear Regression with Inequality Constraints .....	2
1.1.1 Method of Estimating the Solution to (1.7) .....	2
1.1.2 Algorithm of Finding the Solution to (1.9) .....	5
1.1.3 Special Case of the Problem (1.7) .....	6
1.2 Estimation of Parameters of Nonlinear Regression with Nonlinear Inequality Constraints .....	10
1.2.1 Statement of the Problem and a Method of Its Solution .....	10
1.2.2 Solution to the Auxiliary Problem .....	19
1.2.3 Compatibility of Constraints in the Auxiliary Problem .....	19
1.2.4 Calculation of the Constants $\Psi$ and $\delta$ .....	24
1.3 Estimation of Multivariate Linear Regression Parameters with Nonlinear Equality Constraints .....	25
<b>2 Asymptotic Properties of Parameters in Nonlinear Regression Models</b> .....	29
2.1 Consistency of Estimates in Nonlinear Regression Models .....	29
2.2 Asymptotic Properties of Nonlinear Regression Parameters Estimates Obtained by the Least Squares Method Under a Priorsy Inequality Constraints (Convex Case) .....	38
2.2.1 Introduction .....	38
2.2.2 Auxiliary Results .....	40
2.2.3 Fundamental Results .....	52
2.3 Asymptotic Properties of Nonlinear Regression Parameters Estimates by the Least Squares Method Under a Priorsy Inequality Constraints (Non-Convex Case) .....	57
2.3.1 Assumptions and Auxiliary Results .....	57
2.3.2 Fundamental Result .....	58

2.4	Limit Distribution of the Estimate of Regression Parameters Which Are Subject to Equality Constraints .....	61
2.5	Asymptotic Properties of the Least Squares Estimates of Parameters of a Linear Regression with Non-Stationary Variables Under Convex Restrictions on Parameters .....	64
2.5.1	Settings .....	64
2.5.2	Consistency of Estimator .....	65
2.5.3	Limit Distribution of the Parameter Estimate .....	67
<b>3</b>	<b>Method of Empirical Means in Nonlinear Regression and Stochastic Optimization Models .....</b>	<b>73</b>
3.1	Consistency of Estimates Obtained by the Method of Empirical Means with Independent Or Weakly Dependent Observations .....	74
3.2	Regression Models for Long Memory Systems .....	81
3.3	Statistical Methods in Stochastic Optimization and Estimation Problems .....	85
3.4	Empirical Mean Estimates Asymptotic Distribution .....	89
3.4.1	Asymptotic Distribution of Empirical Estimates for Models with Independent and Weakly Dependent Observations.....	89
3.4.2	Asymptotic Distribution of Estimates for Long Memory Stochastic Systems .....	99
3.4.3	Asymptotic Distribution of the Least Squares Estimates for Long Memory Stochastic Systems .....	101
3.5	Large Deviations of Empirical Means in Estimation and Optimization Problems.....	104
3.5.1	Large Deviations of the Empirical Means Method for Dependent Observations .....	104
3.5.2	Large Deviations of Empiric Estimates for Non-Stationary Observations .....	112
3.5.3	Large Deviations in Nonlinear Regression Problems .....	118
<b>4</b>	<b>Determination of Accuracy of Estimation of Regression Parameters Under Inequality Constraints .....</b>	<b>121</b>
4.1	Preliminary Analysis of the Problem.....	121
4.2	Accuracy of Estimation of Nonlinear Regression Parameters: Truncated Estimates .....	123
4.3	Determination of the Truncated Sample Matrix of m.s.e. of the Estimate of Parameters in Nonlinear Regression .....	137
4.4	Accuracy of Parameter Estimation in Linear Regression with Constraints and without a Trend .....	138
4.4.1	Auxiliary Results .....	139
4.4.2	Main Results .....	148
4.5	Determination of Accuracy of Estimation of Linear Regression Parameters in Regression with Trend .....	154

4.6	Calculation of Sample Estimate of the Matrix of m.s.e. Regression Parameters Estimates for Three Inequality Constraints ..	159
4.6.1	Transformation of the Original Problem .....	159
4.6.2	Finding Matrix $M_v[3]$ .....	162
4.7	Sample Estimates of the Matrix of m.s.e. of Parameter Estimates When the Number of Inequality Constraints Is less than Three .....	175
4.7.1	Case $m = 2$ .....	175
4.7.2	Case $m = 1$ .....	177
4.7.3	Comparison of the Estimate of the Matrix of m.s.e. of the Regression Parameter Estimate Obtained with and Without Inequality Constraints for $m = 1, 2$ .....	177
<b>5</b>	<b>Asymptotic Properties of Recurrent Estimates of Parameters of Nonlinear Regression with Constraints</b> .....	<b>183</b>
5.1	Estimation in the Absence of Constraints .....	183
5.2	Estimation with Inequality Constraints .....	191
<b>6</b>	<b>Prediction of Linear Regression Evaluated Subject to Inequality Constraints on Parameters</b> .....	<b>211</b>
6.1	Dispersion of the Regression Prediction with Inequality Constraints: Interval Prediction Under Known Distribution Function of Errors .....	211
6.2	Interval Prediction Under Unknown Variance of the Noise .....	215
6.2.1	Computation of the Conditional Distribution Function of the Prediction Error .....	215
6.2.2	Calculation of Confidence Intervals for Prediction .....	220
	<b>Bibliographic Remarks</b> .....	<b>223</b>
	<b>References</b> .....	<b>227</b>
	<b>Index</b> .....	<b>233</b>